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TEXTILES TO VASCULAR SYSTEM

TEXTILES, the general name applied to the products of the weaver, the derivation of the word being from L. *texere*, to weave. For details *see* the articles under the various fibre headings, such as wool, cotton, silk, flax, jute, artificial silk and cellulose. *See* also SPINNING, WEAVING, CARDING, COMBING, FINISHING, DYEING, etc

TEXTILES AND EMBROIDERIES. Inasmuch as "textile" is a general term for all woven fabrics, and "embroidery" is the ornamentation thereof, it is well, in treating the history and development of the two subjects, to consider the two together The following sections are made· (1) *Europe and the Near East;* (2) *India;* (3) *The Far East.*

EUROPE AND THE NEAR EAST

Weaving was one of the earliest crafts, if not actually the earliest, practised by primitive mankind. Whether its invention goes back to a time when men were still nomads we cannot say, but at the stage of human development when lake-dwellings were erected threads were already woven into fabrics Implements for preparing the threads, and fragments of the fabrics themselves, have been found on such sites There is nothing to show that these stuffs were enriched with a pattern. The first attempts in that direction were probably made by the application of pigments or some sort of simple embroidery

The East is the natural home of patterned fabrics. The Chinese were the first cultivators of the silkworm for the textile threads it provides Recent excavations have shown that the valley of the Indus is the native home of the variety of the cotton plant still cultivated for weaving purposes. To the valley of the Nile has long been attributed the origin of linen weaving To one of these regions we should naturally look for the first patterned stuffs

Egypt and the Crimea.—The earliest known to exist are some linen stuffs from Egypt of the 15th century B.C. (*see* TAPESTRY). In them pattern-weaving has already reached a highly developed stage, and far earlier examples may only await the spade of the excavator. For the thousand years which follow we again have nothing in the way of patterned stuffs The next in chronological sequence come from the graves of Greek colonists in the Crimea, and are now in the Hermitage museum at Leningrad. They are mostly of wool, with woven, painted or embroidered ornamentation. The patterns include figures on horse-back, warriors, goddesses, chariots, animals, birds, vines, flowers, anthemion ornament, scrolls, diapers and stripes A few fragments are of linen; there is one silk stuff of uncertain age, and some of the embroidery is in gold thread For the most part the graves are of the 4th and 3rd centuries B C, but some are earlier and others later. Stuffs of late Graeco-Roman times from the burying-grounds of Egypt share the common features of Graeco-Roman art then spread around the shores of the Mediterranean Linen is the principal material, but coloured woollen threads, particularly in purple, are generally used for the ornamentation, and as time passes the whole fabric is sometimes of wool

For early Christian textiles we are still dependent upon Egypt The Cross, plain or jewelled, and sometimes of the looped form borrowed from an Egyptian hieroglyph, first appears in the 3rd or 4th century, to be followed by Alpha and Omega, the dove and other emblems A little later, subjects from the Gospels and the Old Testament are found By this time two significant changes have come about Embroidery tends to replace woven ornament and silk becomes a common material

Persia and Syria.—Persia, the land whence came the first silk threads used in the West, now claims attention From the beginning Persia held the monopoly of the import trade in raw silk from China, and this it long kept, in spite of efforts made to evade it by exploring a northern route round the upper shores of the Caspian and a southern one by sea The earliest known Persian textiles belong to the time of the Sassanian kings, who ruled from A D 211 until the Mohammedan conquest towards the middle of the 7th century No silk fabrics of that time are now known to exist in Persia, but their nature may be learned from contemporary rock-cut reliefs, representing the royal exploits and amusements Textile-patterns shown in these are so characteristic, and so faithfully rendered, that with their aid a number of silk stuffs from various sources may be identified Chief among them is a green silk with a dragon of peculiar design evidently derived from the art of ancient Babylonia and Assyria It is identical with that on the robe of the Sassanian king Chosroes II in rock-cut reliefs at Tak-i-Bostan near Kirmanshah The same relief identifies as Sassanian a silk stuff with cocks in roundels, found in the Cappella Sancta Sanctorum in Rome in 1905 Other stuffs of this group are in the cathedral treasury at Sens in France, in the treasuries of Sion and Saint Maurice d'Agaune in Switzerland, and at Aachen in Germany Fragments have also been found in the buried sites of the Gobi desert region in Central Asia

A few other silk stuffs of the period are more obviously imbued with the spirit of Greece and Rome, and these may have been woven in Syria. The chief among them, with a pattern of Nereids riding on sea-monsters, is in the church of Notre-Dame de Valère at Sion in Switzerland Another remarkable example, with a leopard attacking a bowman, is in the treasury of Sens cathedral.

One of the finest of all existing early silk stuffs has a pattern of large circles with representations of the Annunciation and the Nativity (Plate II., fig. 3). It was found in the Cappella Sancta Sanctorum in Rome, and it is now in the Vatican museum. Another fragmentary silk of great interest, at Sens, represents the story of the patriarch Joseph. A few silk stuffs with Christian subjects have been found in Egypt, as well as a far larger number of Persian origin. Among the latter, those with bowmen on horseback shooting arrows behind them are typically Persian.

Sassanian influence persisted long after Persia had been overrun by the Mohammedans. It is very plainly seen in two remarkable silk stuffs which were carried to Germany in early mediaeval times. One is in the church of St. Ursula at Cologne It shows a Sassanian king riding on a griffin and slaying a mythical beast In the other, found in the neighbourhood of Trèves, a Sassanian king holds aloft a lion cub which he has snatched from a lioness. This exploit is told of Bahram Gor. The silk is now in the Berlin museum. The most remarkable Persian silk weaving of these times was found in the year 1920 in the church at Saint Josse-sur-Mer near Boulogne, whence it was transferred to the Louvre (Plate I., fig. 2). It has a large design of elephants, and a string of Bactrian camels for a border. An inscription in Arabic characters indicates the province of Khurâsân as the place of origin, and approximately the year A D. 960 as the date

Byzantines.—Very little silk weaving (*q v.*) was done in Europe before the secret of silk-cultivation was learned. Both Aristotle the Greek in the 4th century B.C, and Pliny the Roman in the 1st century A.D., give an account of the silkworm Aristotle seems to have gained some knowledge from the soldiers of Alexander the Great, and apparently he had heard of wild silk, but neither he nor Pliny knew much about the matter. Heliogabalus (A.D. 218–222) is said to have been the first emperor to wear a robe entirely of silk, and Aurelian (270–275) declined to allow his wife a silk mantle because of its high cost.

Silk-weaving was already carried on at Constantinople in the 4th century, but the industry cannot have been of much importance until the eggs of the silkworm were surreptitiously brought over by Persian monks from China in the reign of Justinian (527–565), as Procopius relates, and the long-guarded secret of the Chinese was exposed.

Constantinople was situated at the junction of two continents, and as it was the *entrepôt* of the trade between Europe and Asia, the influence of the East was paramount there. The emperors maintained their own weaving school in the capital, and some of the stuffs were intended solely for the use of the emperor and the court. We learn a little about this from Liutprand, bishop of Cremona, who went to Constantinople in the year 968. He bought some silk stuffs there for Otto I., but five purple stuffs were confiscated by the officers of the customs, on the plea that they were only to be worn by the Byzantines. The bishop protests that he had seen as good stuffs in the West, brought by the merchants of Venice and Amalfi, and he asks why he, a bishop and an emperor's ambassador, should be treated as no better than a Venetian merchant.

Three very remarkable Byzantine silk weavings are of such historical importance that a brief description of them must be given. The first was found in the shrine of St. Anne in the abbey church of Siegburg. Two lions in profile advance towards one another. Between them is a Greek inscription to the following effect: "Under Romanus and Christophorus, our most Christian rulers." These two emperors ruled jointly at Constantinople from 921 to 931. The two lions with the intervening inscription cover a length of about five feet. Perhaps it was a stuff of this kind which formed the subject of Liutprand's complaint. The second silk is similar, but the inscription refers to Constantine and Basil, whose joint rule lasted from 976 to 1025. It was found in a church in the Lower Rhine district, and pieces are now in the Berlin, Düsseldorf and Crefeld museums.

The third fabric was placed over the body of the Emperor Charlemagne in his shrine at Aachen. It has a pattern of large circles, each enclosing an elephant, strongly conventionalized and bearing rich jewelled trappings, Along the bottom there is an abbreviated inscription giving the names of certain officials. This stuff is later than the time of Charlemagne; it probably belongs to the end of the 10th century. For boldness of design and general splendour these three silk fabrics, woven on the imperial looms of Constantinople in the 10th century, are among the chief mediaeval stuffs we now possess. Weavings of this character probably came to an end with the sack of Constantinople by the Latins in 1204.

Sicily and Spain.—It is remarkable that Mohammedan textile art flourished nowhere as it did on European soil, and partly under rulers who were the enemies of Islam. The first Arabic incursions into Sicily took place in the 7th century, and during the course of the 9th century the island fell definitely under Mohammedan rule. Silk and gold stuffs were woven in Sicily in the 10th century, but they cannot be distinguished from those woven in other Mohammedan lands. In the year 1060 the Normans arrived in the island, and the Mohammedans were finally subjugated Weaving went on very much as before, though with greater magnificence and luxury, if we may judge from the two imperial robes produced at Palermo in the years 1134 and 1181 (described later) The lining of the great mantle is woven in silk and gold thread with figures representing the Temptation in the Garden of Eden, trees, birds, interlacing bands and Arabic lettering. A similar stuff, with horsemen, animals, birds and serpents is in the tomb of Roger, Norman ruler of Sicily (1072–1111), at Palermo. A brocade in pink silk, with a small pattern of gazelles, birds and trees in gold, formed part of the robe in which the emperor Henry VI. (d. 1197) was buried at Palermo; there is a fragment of this stuff in the British Museum

The other great centre of Mohammedan weaving in Europe is Spain There the Arabs landed in the year 711, and within seven years they were masters of the whole peninsula except the northwest By the 9th century the weaving of silk fabrics was established in Andalusia. A remarkable woven fabric, known as the "veil of Hishâm," bears the name of Hishâm II, khalif of Córdoba from 996 to 1021. The material is a thin gauze, and the inscription borders a stripe of ornament woven in silk and gold thread, similar to the contemporary weavings of Egypt. In the 12th and 13th centuries some remarkable silk and gold fabrics were woven, with pairs of animals or birds, often in circles. Before the end of the 14th century the peculiar type of arabesque ornament, relieved by bold lettering, associated particularly with the decoration of the Alhambra at Granada, began to be seen in silk fabrics The colours are bright—red, yellow and blue predominating. Upon the final subjugation of the Moors at the end of the 15th century, and the re-entry of the whole peninsula into Christendom, the skill of the Mohammedan weavers was still employed for producing stuffs "oeuvrés à la moresque," but the influence of Italian design grew as the 16th century advanced. With the rise of the textile industry at Lyons French influence began to be felt.

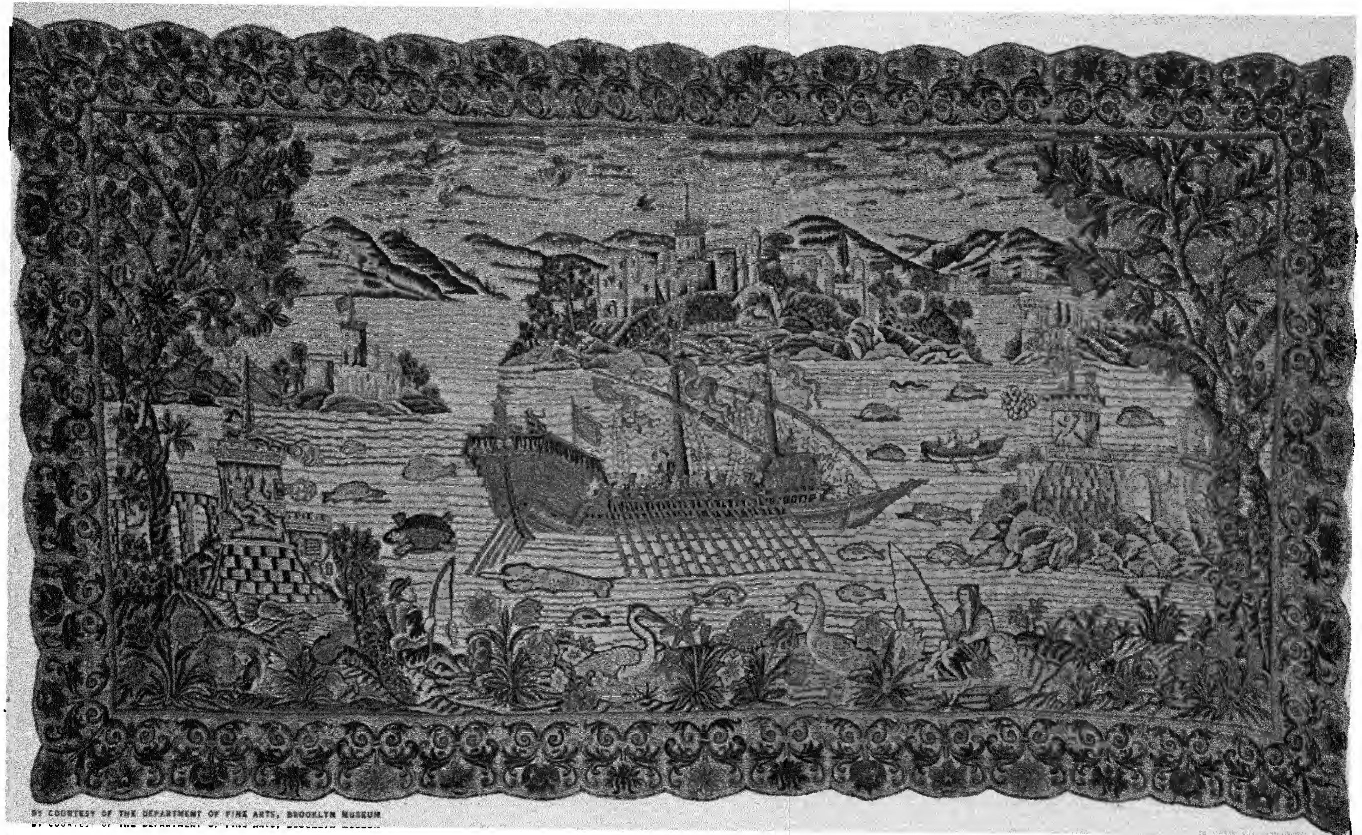
Italy and France.—The great textile industry of Italy, though much influenced by oriental art, followed a more independent course than that of Spain. The soil and climate were favourable to the growth of the silkworm, and Italy became the chief centre of that industry in Europe. Looms were set up for weaving the thread into fabrics. As early as the 12th and 13th centuries silk weaving industries were found in the great cities of the north, such as Florence, Venice or Genoa. In the south they grew up as the political upheavals of Sicily led to the migration of craftsmen to more peaceful industrial centres. In the 14th century Lucca became famous throughout Europe for its woven stuffs.

Silk weaving was also carried on at Venice, Genoa, Vicenza, Florence, Bologna, Milan, Turin, Siena, Naples, Catanzaro, etc. In the second half of the 15th century Florence had a large number of factories, sending stuffs to Rome, Naples, Genoa, Catalonia, Seville, Lyons, Avignon, Antwerp, Turkey and elsewhere. In the 18th century stuffs were still sent to Holland, Germany, Turkey,

BY COURTESY OF YAMANAKA AND COMPANY

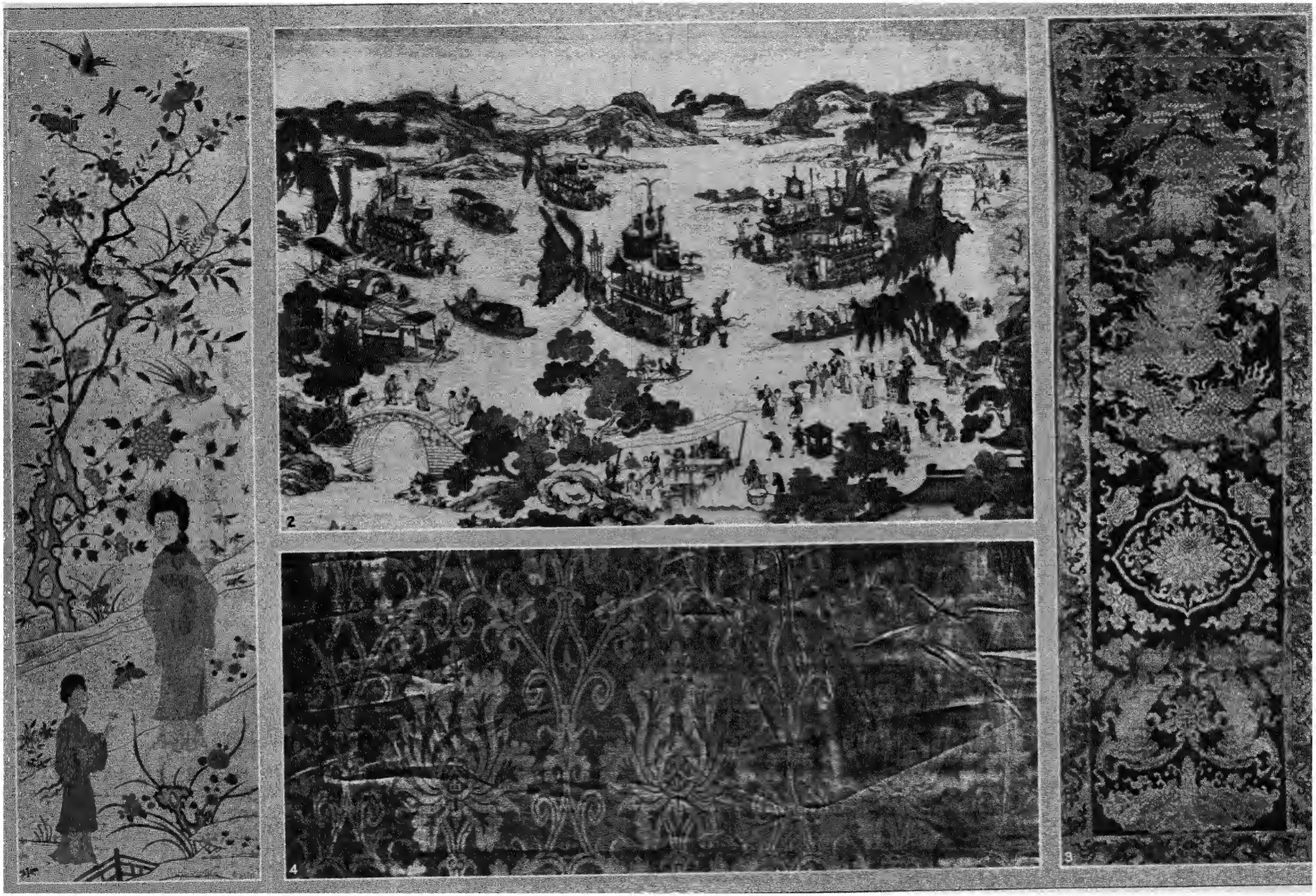
WOVEN BROCADE HANGING

A wall hanging of woven brocade of the Ming Dynasty, 15th century. This hanging, woven entirely in one piece, was originally made for the Winter Palace in the Province of Jehol, Mongolia



PORTUGUESE NEEDLEPOINT

Tapestry of early 18th century Portuguese needlepoint. The design, which is in the *gros point* stitch worked out with polychrome silk threads on a ground cloth of canvas, commemorates the return of Ferdinand Pinto, a Portuguese adventurer and traveller, from the East. The choice of an historical event for the subject of the design, as well as the brilliant colour and the scalloped border, is characteristic of Portuguese work of this period. The tapestry, owned by Quill Jones, is now in the Brooklyn Museum, New York



CHINESE TEXTILES

1. Early 18th century wall-hanging of white satin embroidered with colored silk
2. One of a series of four panels representing the Dragon Boat Festival in honor of Chu Yuan, statesman and poet, who was drowned in Milo River, 295 B.C. This panel is of embroidered silk, middle 18th century
3. Eighteenth century Chinese red velvet chair cover. The embroidery is done with gold threads on red satin background
4. Ming dynasty (1368–1644) woven damask. The character found in each flower, as well as the design and texture of the material, indicates the work is of Chinese origin

TEXTILES AND EMBROIDERIES

PHOTOGRAPHS, (1) HERBERT G. PONTING F.R.P.S., (2) BURTON HOLMES FROM EWING GALLOWAY, (3) PUBLISHERS PHOTO SERVICE

EMBROIDERERS AT WORK

1. Skilled Japanese embroiderers at work in Kyoto, Japan. They succeed in producing a product that will defy many destructive elements
2. Swiss embroiderers working in front of a shop in Lucerne, Switzerland
3. Hungarian woman displaying a sample of the beautiful embroidery characteristic of that country. Heavy thread is used to create many of the effects produced

Barbary and South America. The Venetians, too, carried their operations far afield. It was claimed for them that they studied to suit the colours and quality of their fabrics to the markets for which they were destined, both in Italy, and "all over the world."

The foundation of the silk-weaving industry in France in the 16th century, and its subsequent enormous development, challenged the Italian monopoly. Italian weavers were attracted to France. At Tours there were numbers of Genoese, and in the early days of the industry at Lyons there were many Genoese and Florentines Weaving was also carried on in other French towns, but during the 17th century the highly organized industry at Lyons gradually grew until it outstripped the Italians and reached that eminence which it has since maintained throughout Europe

Great Britain.—For many centuries Great Britain was provided with the silks it needed from abroad Henry VII., when he desired to give some vestments to Westminster Abbey, had specially woven for him at Florence at great cost some magnificent fabrics of red velvet and cloth of gold with a pattern of roses and portcullises. One of these vestments is still preserved at Stoneyhurst college (Plate I, fig 4).

In the 16th century much silk was worn in England, but very little was woven, and Italy was still the chief source of supply In the following century, in a speech from the throne James I urged mulberry-planting for rearing the silkworm It was tried, and foreign weavers were brought in. Silk culture did not prosper, on account of the late spring, but weaving went on, and there were already large numbers employed when the revocation of the edict of Nantes brought in many thousands more refugees connected with the silk industry Voltaire, who spent some years in England a generation later, speaks of an entire suburb of London (*i e*, Spitalfields) peopled with French manufacturers of silk. Others settled in Soho, Long Acre or Seven Dials. Weaving industries also grew up at Canterbury, Norwich, Sandwich and other provincial towns It was claimed that the Canterbury stuffs equalled any foreign silk.

During the 18th century the brocades of Spitalfields followed pretty closely the work of Lyons, and it is not always possible to distinguish between the two. Although gold and silver thread were made in the parish of St. Giles, Cripplegate, metal threads were not so freely used by the Spitalfields weavers, and patterns tended to be a little simpler The industry has now left Spitalfields, and subsequent work in East Anglia, though shrunken in output, still maintains the same high standard of craftsmanship and materials.

Persia and Turkey.—When Persia emerged again from alien rule early in the 16th century under the Safidian dynasty, a new era for the arts was inaugurated. The Shahs had their own establishments of craftsmen with a director-general, and overseers for the separate crafts. Some followed the movements of the court, others were settled on the royal estates and in convenient centres. The best materials were supplied, and there was no stint of labour or expense. Under such conditions, some of the most remarkable stuffs ever woven were done in Persia The most sumptuous velvets, with human figures, birds and trees, often on a gold ground, were made (Col Plate, fig 2). Brocades represented historical scenes, figures, landscapes, animals, birds and flowers The floral patterns of Persian stuffs are unsurpassed anywhere in the world. During the 18th century and subsequently, foreign intercourse has led in some degree to the adaptation of European patterns.

What is geographically classified as "Turkish" art is not the indigenous art of the once nomad Turkish tribes who ultimately overran Asia Minor and south-eastern Europe and there established a heterogeneous empire. It is the art of the conquered races under Turkish rule. Nevertheless there does gradually emerge, in those lands a unified art, largely under Persian influence, but not altogether unaffected by the relations of the Ottoman Porte with Italy (particularly with Venice) in the 16th and subsequent centuries. A brocade in the Lyons Museum, with a pattern of pairs of lions within roundels, in gold thread on a red silk ground, has an Arabic inscription giving the name of Kai Kubâd, the Seljuk Turk, sultan of Iconium (Konieh) in Asia Minor in the early years of the 14th century. This important stuff shows some affinities with Byzantine art. In the 16th century velvet brocades recalling the contemporary lobed or "Gothic" patterns of Italy but with a strong oriental bias, were woven in Turkey both for home use and for export

Embroidery.—Like all other crafts, embroidery had its origin in the daily needs of humanity. The problem how to join two edges of a fabric together must have arisen very early, and even a seam, as so many oriental embroideries show, may be treated decoratively Once the needle was invented, whether a sharp fish-bone, a thorn, a pointed stick, or a metal wire, the natural instinct to pass the limits of mere utility and to indulge in decoration would make itself felt. A good deal of what has been said above about woven patterns is applicable to embroideries. A few embroideries, mostly in wool, though gold thread occurs as well, were among the stuffs found in Greek graves in the Crimea (*see* above). One in particular, of the 4th century B.C., shows an Amazon on horseback. In later Roman times embroidery was practised very much in the same way as it is today, as examples from Egypt show

Perhaps the most sumptuous of all mediaeval embroideries is the imperial mantle at Vienna It is of red silk, with a lion springing upon a camel, worked in gold thread and silk and enriched with pearls and gems An Arabic inscription round the edge records that it was made at Palermo in Sicily in the year 1134. The design probably has reference to the capture of the island from the Arabs by the Normans, which had then recently taken place The imperial alb, also at Vienna, has a border of griffins in gold embroidery. An inscription in Latin and Arabic records that it was made at Palermo in 1181.

England was renowned for its embroidery ("opus anglicanum") in mediaeval times, and a number of remarkable English vestments are still preserved in England and on the Continent. Embroideries of Elizabethan times show much beauty in design (*see* DRESS) A strong oriental bias, due to trade with the East, is found in the 17th century. The great flowering trees worked in wools are copied from Indian designs. The 18th century maintained the standard of earlier times, and much has been done of late years to encourage this beautiful craft.

French mediaeval embroidery has much of the sweetness and grace that we should expect to find Later work has reflected the various influences which have moulded French art. Early Spanish work has Mohammedan characteristics. In later times, embroidery in the peninsula runs parallel with the Italian, but there is a tendency towards greater elaboration and brighter colours. The influence of Italy became widespread through its pattern-books for embroidery and lace-work, copies of which were carried to other countries and sometimes reproduced. In the Netherlands the work of the great schools of painting which arose in the 15th century is reflected in embroidery. The embroidery of Germany and Scandinavia is largely domestic in character. In the islands of the Aegean, peasant embroidery has reached a stage of development hardly matched on the continent of Europe. The embroideries are mostly in silk upon linen, for dress and domestic use Different islands have their own distinctive patterns.

In Turkey and Persia embroideries have followed a parallel course to woven fabrics, and similar motives are used A great deal of embroidery in silk and metal threads upon linen scarves and towels was done in Turkey during the 19th century. Much white-work has been done in Persia.

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(A F K.)

INDIA

Indian textiles have been famous from remote ages. Cotton was known to the Babylonians as *sindhu*, to the Greeks as *sindon*, and the natural inference as to its origin has been lately confirmed by the discovery at Mohenjo Daro, in the Sindh valley, of true cotton (*Gossypium*) fabric dating from the 3rd millennium B C. It was not until the 13th century that the plant was introduced into

southern Europe. Imitations of Indian cotton were first made in Manchester in the 17th century, but the imported material held its ground Numerous English names of cotton fabrics are of Indian origin. calico from Calicut, cramoisy from the *kermes* insect, chintz from Hindī *chint, cita,* meaning spotted or variegated, bandana from *bandhnā,* the process of tie-dyeing, shawl from Hindī *śālā.* From the most ancient times plain and decorated cottons of all sorts have been used in untailored lengths to form the principal elements of wearing apparel—*dhoti* or lower piece, *dupaṭṭā* or scarf, and *pagrī* or turban, and the *sārī* (draped robe) or *ghagrā* (skirt) worn by women Perhaps the most famous weaves are those of Dacca, including both decorated fabrics of some strength, and the filmy undyed muslins (*malmal*) known by such poetical names as "running water," "woven air," and "evening dew"; the last named may be woven of yarn so fine as to require 250 m of it to weigh a pound, and as much as Rs. 500 may be paid for a piece of plain muslin 10 yd in length by 1 in width. In many early Indian sculptures it is indicated that muslin garments are worn, but they are so thin and transparent, except where the folds or edges of the material appear, that the figures seem to be nude.

Silks are mentioned in the Indian epics, but these may have been imported from China Three varieties of silkworm are native in India (*tasar, muga,* and *eri*), but it is not certain that the true mulberry silkworm was ever cultivated there before its introduction by the East India company in the 17th century The main types manufactured are the plain, figured or shot material, satins chiné and brocade Typical of present day production are the brocaded silk gauzes of Benares

Woollen shawls and blankets are commonly met with in the Punjāb; but the most famous woollen textiles of India are the shawls (*Śālā*) and cloaks (*chogā*) of Kashmir Nothing of high quality has been produced for many years, but fine old examples are common both in Europe and America, and in the collections of Indian princes Kashmir shawls should be carefully distinguished from the machine-made Scotch imitations known as Paisley shawls, from the place of manufacture.

The Kashmir work is of two kinds, woven (*tili* or *kanikar*) and embroidered (*amlikar*); the wool used is the under fleece (*pashm*) of a goat The work is produced by a collaboration of at least four craftsmen, a designer, colour-designer, the man who plots the weave, and the actual weaver Whether woven or embroidered, a Kashmir shawl is almost always made of many small pieces, which are separately prepared and joined together; the joining is so skilfully done as to be almost imperceptible. The peculiar "Kashmir shawl pattern," "wind-blown cypress," "cone," or "flame" pattern, as it has been variously called, is known to the weavers as *būtā,* a term used throughout India to denote any floral motif in design The Rampur *chādar,* a square shawl, cream coloured, without ornament or with embroidery of the same colour, has generally a silk weft, and, still made in a good quality, is sometimes known as a ring-shawl, from the fact that the fineness of the texture makes it possible to draw the whole of such a shawl through a finger-ring. The best detailed accounts of the making of Kashmir shawls are in Moorecroft's *Travels,* and Watt's record of the Delhi exhibition of 1902–03 (*See* Bibliography)

Dyeing.—Coloured garments of wool and silk are often referred to in the epic period and in literature Some elaborate textile designs appear in the early reliefs, others in Gupta sculpture and the paintings of Ajantā, later on also in the paintings of the Gujarātī and Rājput and Mughal schools A *haṁsa lakṣaṇa* (goose pattern) is often referred to in the literature, appears in the paintings alluded to, and is still made in muslin brocade at Aurangābād. The most important Indian dyes are indigo (*nīl*), madder (Mañjiṣthā, "Manjeet") and *chaya* root Synthetic dyes have now come into general use

Indian dyes are applied in two ways, either to the warp and woof threads to be afterwards woven into self-coloured, patterned, or shot fabrics; or repeatedly to a finished textile, usually cotton, whenever it is washed, or a change of colour is desired. The most remarkable work of the latter kind may be studied in the elaborate zigzag designs of the turbans of Kota and Alwar; a fabric may even be double-dyed so as to appear of different colours back and front. For the various methods of applying a dye or dyes locally to produce a coloured design on a finished fabric, *see* below.

Block Printing and Painting.—These processes range in complication from simple printing in black on white from wood blocks, through combinations of block printing in many colours combined with dye painting, to work entirely dye-painted by hand, and with or without the use of a resist The technique is almost exclusively applied to cotton, and material for garments, bed covers, and hangings of all kinds is produced

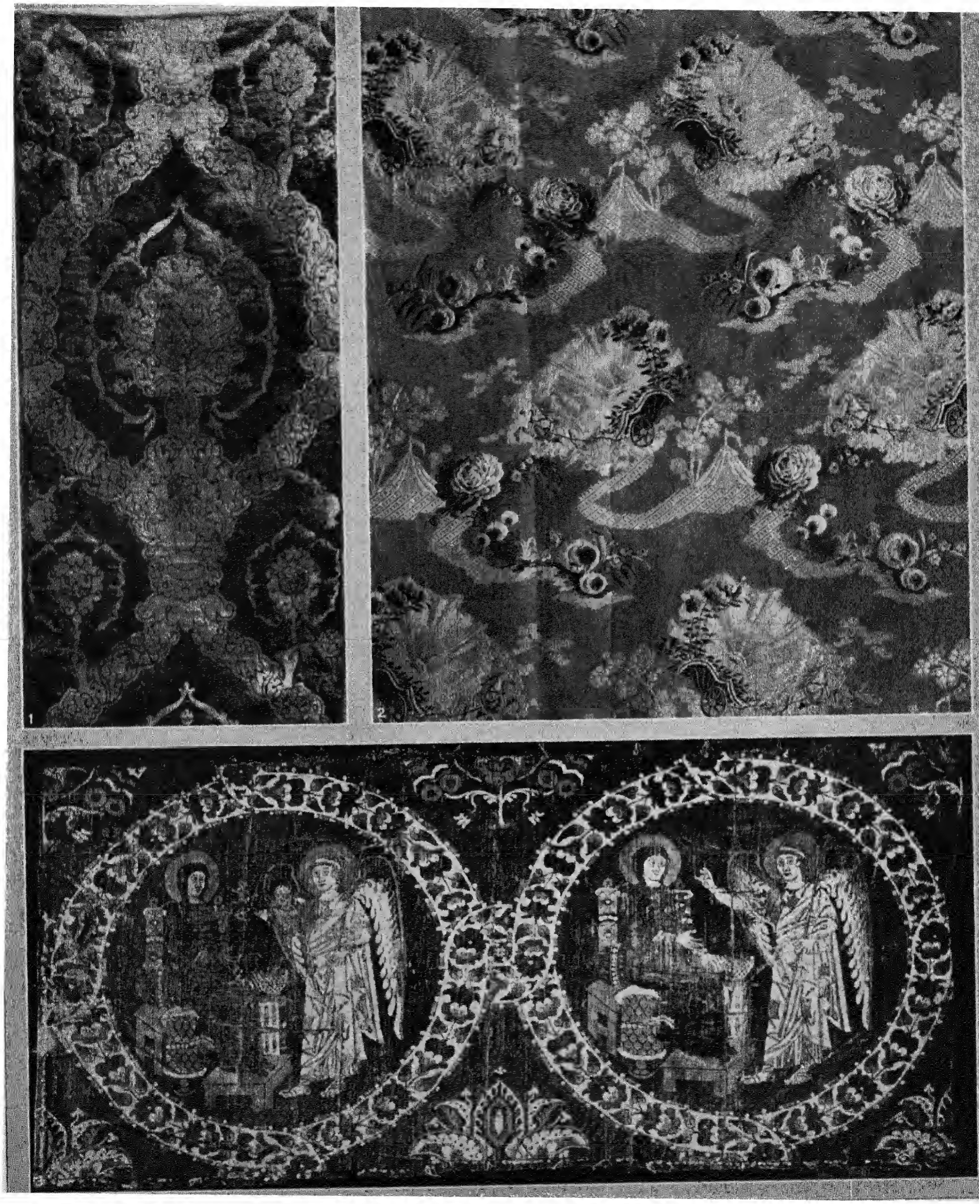
IMPRESSIONS OF 19TH CENTURY WOOD BLOCKS USED FOR STAMPING EMBROIDERY DESIGN (LEFT) AND FOR COLOUR PRINTING (RIGHT)

To give a very simple example of the process, a resist paste of lime and gum, or oil and beeswax, may be printed from wood blocks, the cloth is then dipped, and when the resist paste is subsequently removed, a white pattern on a coloured ground remains The art has reached its highest developments in Rajputana and Masulipatam The latter town, in the Madras presidency, has long manufactured printed and painted cottons both for local use and also in special designs for export to Persia on the one hand, and Siam on the other At Masulipatam the process is largely one of hand painting (*qalmdar*) with a brush or pencil (*qalm*) made of steel wires, with this brush a design is drawn in hot beeswax, which penetrates the material, and after dyeing, the wax is removed by boiling Although a different tool is used, this is essentially the process known in Java as *batik* (*q v*). In the case of a design of many colours, the process must be repeated for each colour The most noteworthy productions of Masulipatam and Kalahastri in the south are the well-known *palampores.* In design these are of two types; those of the *mihrāb* type, suitable for hangings, but essentially of the Mohammedan prayer mat type, and having the main element of the design consisting of a beautifully designed tree of life with birds and animals; and those representing mythological subjects, mainly intended for canopies to be used in Hindu temples.

Tinsel Printing and Painting.—In the "wax cloth" technique of Peshāwar a preparation (*roghan*) of oil just stiff enough to be drawn out into threads by the iron style which is used in making the design, is applied to the ground, then gold, silver powder or gold leaf is applied, and this naturally adheres only to the *roghan* As the *roghan* is often mixed with powdered lime to give it body, the resulting design stands a little above the general surface, and we have practically a form of *gesso.*

The most exquisite and delicate tinsel printing is done in Rajputana, largely on fine muslins intended for *pagris* or turbans Here glue, gum, or lac is first printed from a wood block, and then gold leaf pressed on to the surface Very often the gold is employed on a coloured design of floral motifs previously prepared. The technique is practised in other parts of India, but perhaps the most magnificent examples are the gold printed batiks of the island of Bali, known as *kain prada.*

The special and highly developed technique of tie-dyeing (*bandhnā, cunari*) is practised chiefly in Rajputana, Central India, Gujarāt, and in the island of Bali In this technique, a design is worked out, typically in spots, but also in squares or zigzags, by an elaborate process of tying up small portions of the cotton or silk fabric so tightly that the tied parts do not take up the



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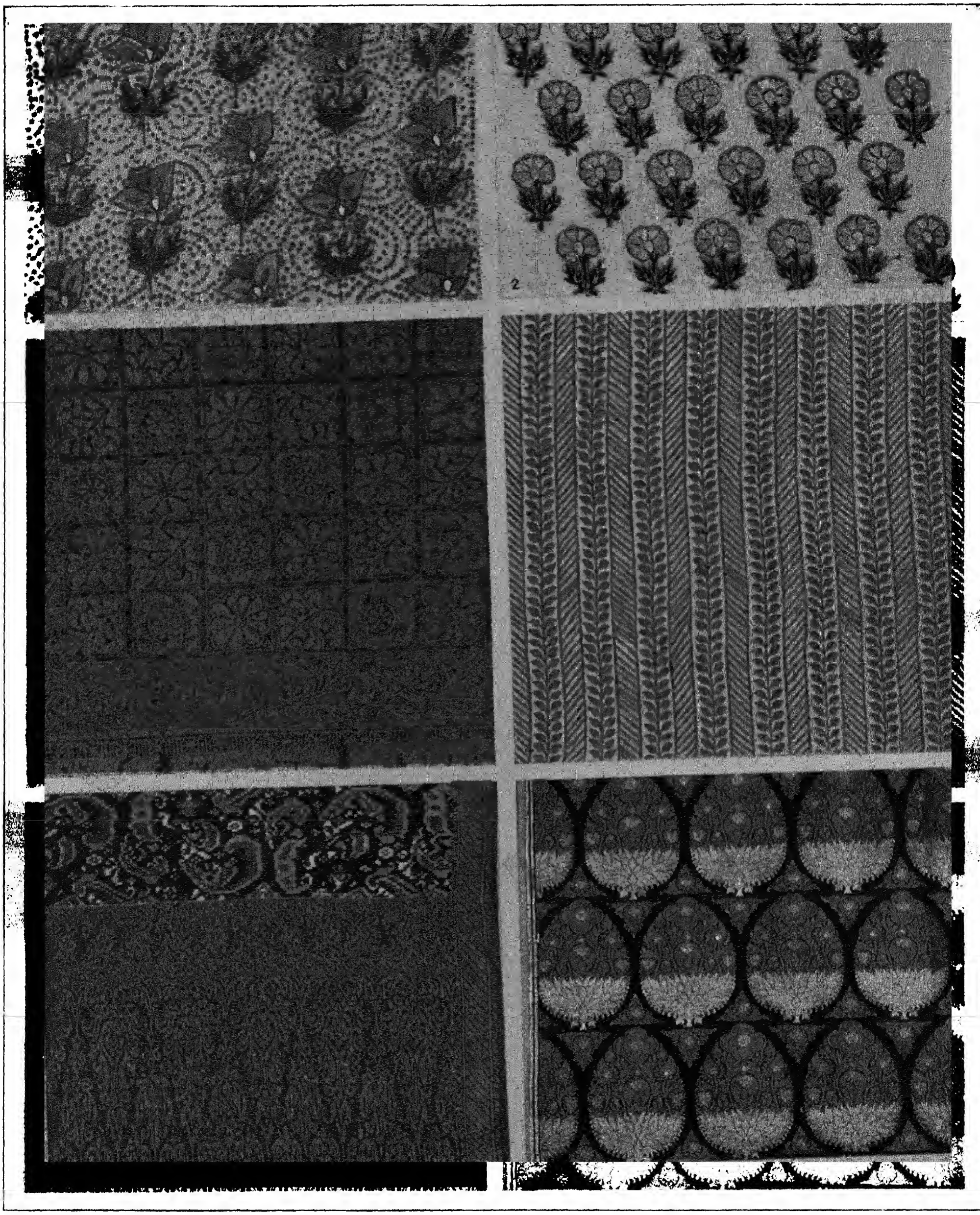
EUROPEAN AND PERSIAN SILKS AND VELVETS

1. Italian velvet brocade of the 16th century; Venetian red ground with design in gold thread
2. French "Le Char du Soleil" brocade made at Lyons about 1760, the design as reproduced is one-third actual size
3. Silk with Annunciation design, used as a cushion cover, one of the finest early silk stuffs; found in the *Cappella Sanctum Sanctorum*, Rome, 1903, now in the Vatican

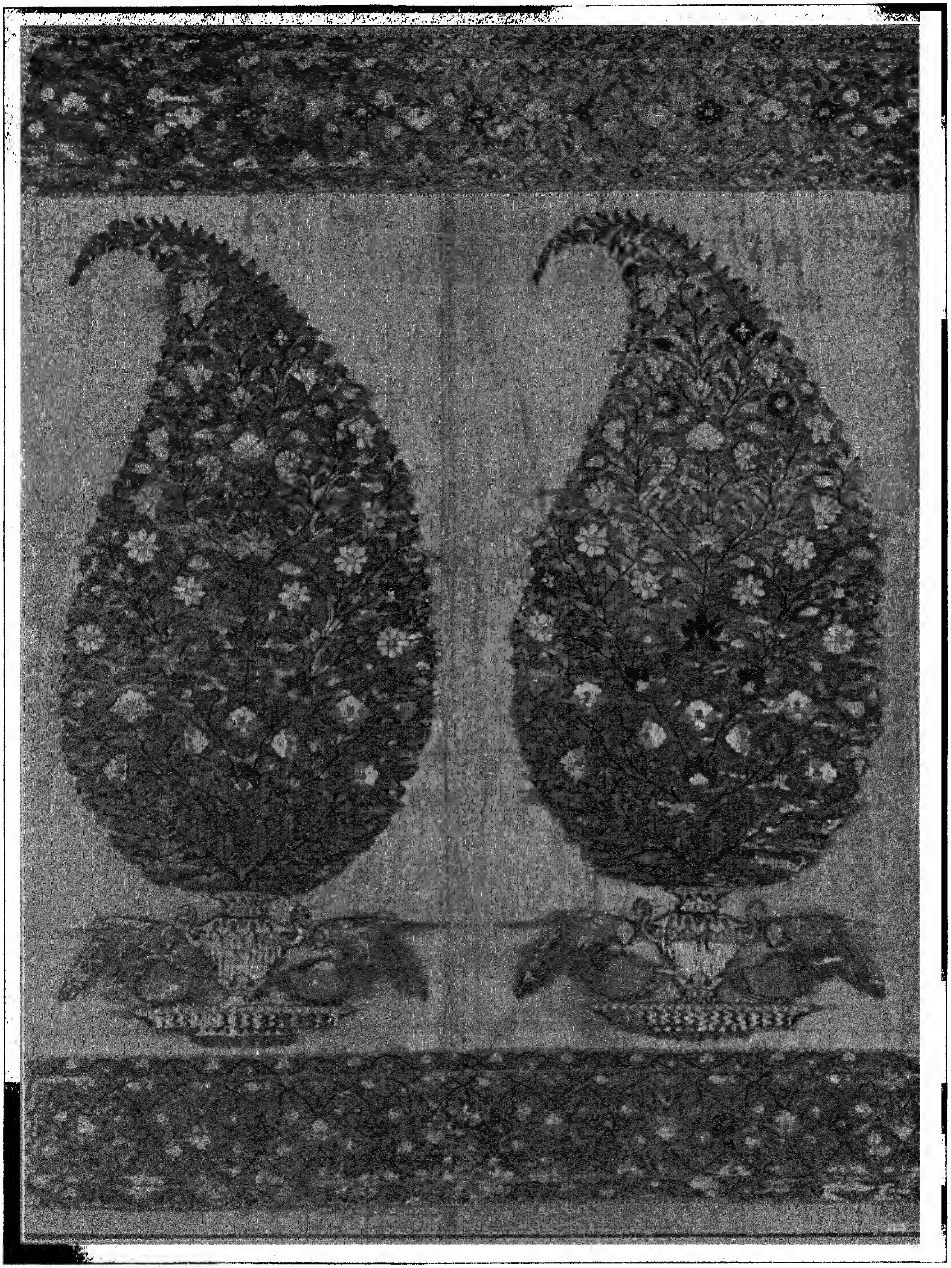


INDIAN AND INDONESIAN TEXTILES, 18TH AND 19TH CENTURIES

Above: Two fragments of turbans of embroidered muslin, Rajputana, India

Centre, Left: A garment piece of cotton batik with superposed design of stamped gold leaf (*kain prada*), from the island of Bali, east of Java. Right: Fragment of painted muslin, Rajputana, India

Below, Left: *Ikat* (chiné) silk sarong with gold brocade border, Sumatra. The threads are parti-dyed before weaving, and the design appears alike on both sides. Right: Typical gold brocade, (kinkhwab), Benares, India



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INDIAN BROCADE

Silk and gold brocade, part of the border of a sārī, 17th century, probably from Aurangabad. In the Museum of Fine Arts, Boston

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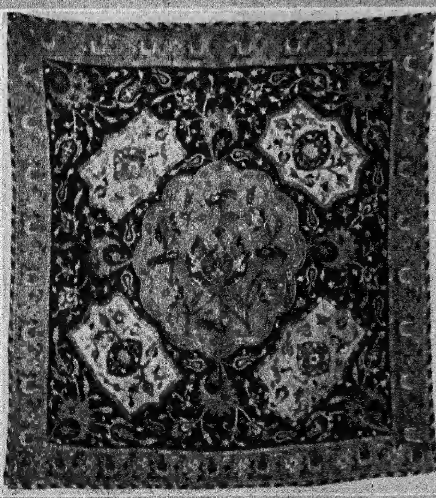

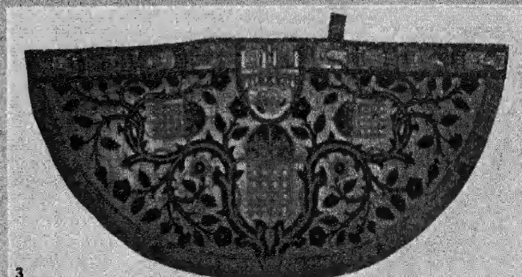

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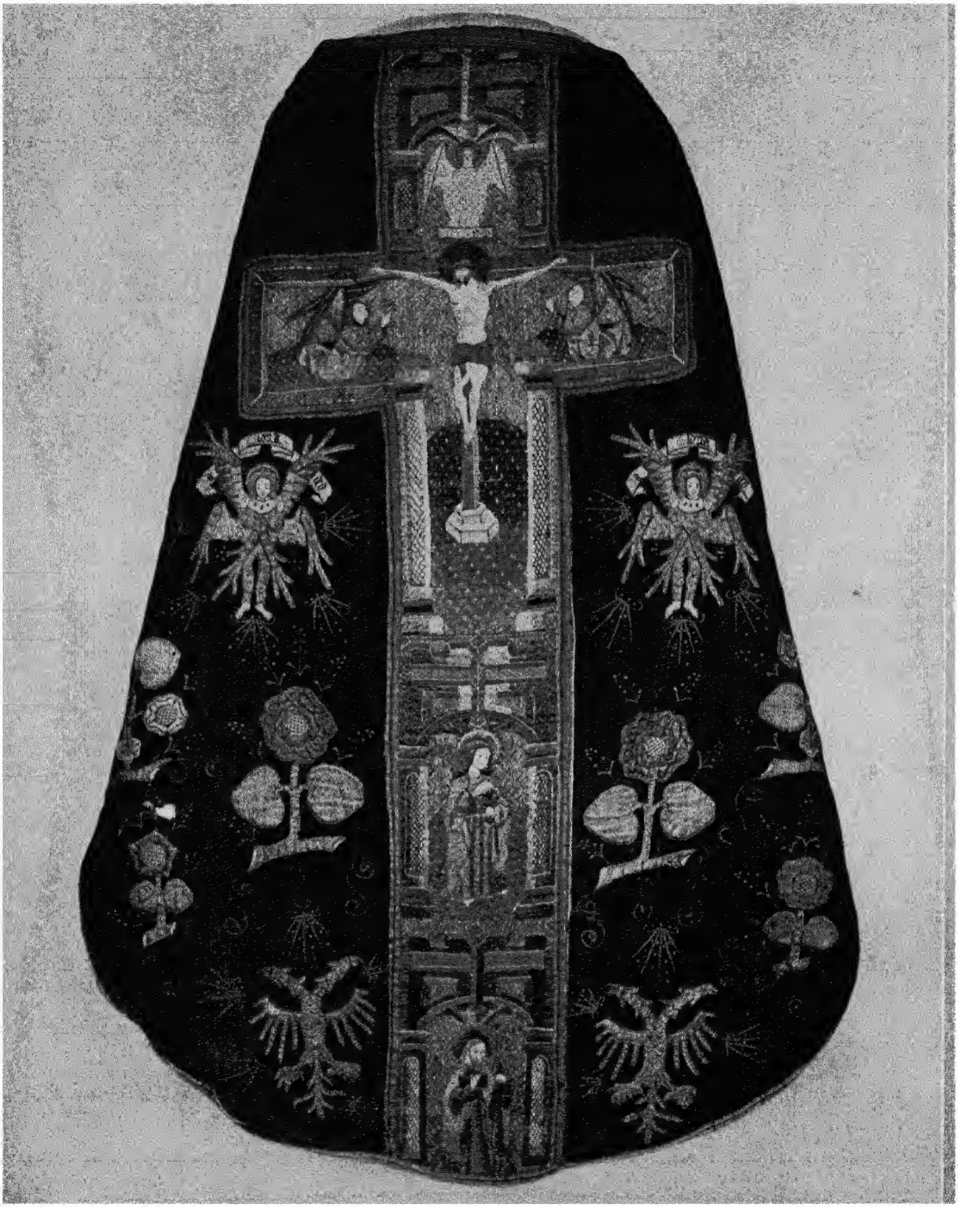
EUROPEAN AND NEAR EASTERN TEXTILES

1. Fragment of silk, about A.D. 960, from Khurasan, Persia, with representations of elephants and, in the border, camels. This piece, as illustrated, found in 1920 in the church of St. Josse-sur-Mer near Boulogne, is now in the Louvre
2. Persian embroidery with characteristic designs of birds and floral patterns
3. Cope of red velvet and cloth of gold, with a pattern of roses and portcullises. Woven at Florence as a vestment for Westminster Abbey during the reign of Henry VII. (1457–1509), it is now at Stonyhurst College, England
4. Detail of the border of an 18th-century Egyptian linen hanging, with floral embroidery in wool

TEXTILES AND EMBROIDERIES



EMBROIDERED CHASUBLE

Early 16th century chasuble of dark blue velvet, orphreys and ornaments embroidered on linen with silver gilt threads and coloured silks, 4'2" x 3'5". A chasuble is worn as the outer vestment of the celebrant at the Eucharist

colour when the fabric is dipped. The process must be repeated for every colour element in the design.

In the elaborate "Chiné" weaves (*paṭolas* and *ikats*) the characteristic feature is that the warp or woof threads, and often both, are individually and locally coloured by a tie-dyeing process before the warp is laid; the distribution of the colour on each thread is carefully calculated, so that the pattern will appear when the cloth is woven, without further manipulation. The term Chiné (Italian *alla Chinese*) is French, the fabrics having reached Europe from the East, but the technique is not Chinese. From the sporadic distribution of the method it may be inferred that it is a very ancient one, and perhaps of Indian origin. It extends to Turkey, and from Persia and Turkestan (Bokhara velvets and *dārāī* silks) through India (Gujarāt and the Dekkhan, but not in Ceylon) to the Malay peninsula (Tringannu), Sumatra, Java, Bali and Cambodia, and in a very simple form (*kasuri*) to Japan. Best known are the *paṭolas* (silk *sārīs* worn at weddings) of Gujarāt (Cambay and Baroda), under this name, the material has also been extensively exported to Java and Bali, where it is much prized. Very fine and elaborate examples in which both warp and woof threads are dyed reproduce animal and floral motifs. The same technique is employed in the preparation of striped *khañjarī mashrus*, mixed silk and cotton fabrics used by Muslim women and made in the Punjāb, Benares and at Ayyampet in the Tanjore district, mainly for the Haidarābād market. The gorgeous *ikats* of Sumatra are generally interwoven with gold thread. The double *ikats* of Tenganan in Bali are of cotton, and are used as coverings for temple offerings. Fine and large examples of cotton *ikats* are made in many other islands of the archipelago, the garments and shrouds from Sumba being the best. In Cambodia very beautiful silk *ikats*, known as *sampot hol*, are still made by traditional methods under the supervision of the Direction des Arts Cambodgiens at Phnom Pen.

Brocades.—These are textiles of silk in which the pattern is distinct from and supplementary to the weft, and thrown on its surface, small needle-like spools being thrust between the warp threads wherever the design requires; the term is generally used in connection with silk fabrics, but the method of weaving flowered muslins (*jamdānī*), the decorated cottons (*ctirili*) of Ceylon, and the *kanikar* type of Kashmir shawls is essentially the same. Silk brocades may be of pure silk (*amru*), or silk and cotton (*himru*) or interwoven with gold threat (*kimkhwāb*); these types pass into each other by gradual transitions, and the *kimkhwāb* ranges from types in which metal threads are very sparingly employed to pure cloth of gold or silver. Of pure silk brocades none is more beautiful than those of Surāt, which have floral sprays all over them and borders of conventional trees; the most exquisite of the *kimkhwābs* are those of Benares (already famous for its textiles before the Gupta period), Ahmadābād, and also Aurangābād.

The making of gold thread (*kalābatun*) for use in weaving and embroidery is still a flourishing industry, as much as 300,000 m per annum being produced in Delhi alone. This is a highly specialized craft. Silver gilt wire is first drawn through fine holes in an iron plate until no thicker than a hair, then beaten flat on an anvil, then twisted round a silk thread foundation.

Embroidery.—Only a very few of the most important types of Indian embroidery can be discussed. Embroidered garments and needles are mentioned already in Vedic texts, and although the use of untailored draped material is characteristic of Hindu culture, tailored garments have been in use from a remote period.

The *phūlkārīs* worn by Jāt women of the Punjāb and Rajputana are well known in Europe, they are used as hangings. These are executed in a darning stitch, done from the back, in white or yellow silk on coarse red cotton, in diapers or floral designs covering the whole ground; in good examples the stitches are very close and short, and the regularity of the design is secured by careful counting. Another type is carried out in cross stitch, with effects like those of European samplers.

Exquisite work in chain stitch is characteristic of the Punjāb, Rajputana, and Kach. In one type, known as *shīshadār*, and used in embroideries for many purposes, small pieces of mirror glass, manufactured at Karnak, are introduced into the design, and bound down by stitching round them. In the Punjāb, the embroidered floor coverings are especially admirable, in Jaipur, hangings and shield cushions; in Kāthiāwār (Kach), the brilliantly designed and coloured women's skirts and children's caps with the long flap hanging down behind. Perhaps the finest of all chain stitch embroidery is met with on the *kamarbands* of Murshidābād or Azamganj in Bengal. Excellent examples in a bolder style are to be found in the betel bags of Ceylon, where the elaborate binding stitches are also of great interest.

The beautiful *kasīda* embroidery of Dacca in Bengal is done in gold coloured *muga* silk in darn and satin stitch on muslins. Finer and more elaborate is the *chikān* work of Lucknow, done in white or cream cotton on muslin, often in combination with drawn thread work. Here the design is usually printed from a wood block in a colour that can be easily washed out, and the blocks used for this purpose should not be confused with those used for cotton printing with permanent dyes. Some of the work is characterized by the use of raised knots. The net embroidery, often spoken of as drawn thread, is really produced entirely by the needle, the strands of the fabric being pushed to one side by a kind of buttonholing, without the drawing of any threads, which is regarded as a slovenly imitation of the real process.

Heavy embroidery in raised gold thread is mainly applied to elephant trappings, palankeen canopies, and the like; but much is now made at Delhi in forms adapted to European requirements. Appliqué work is found in Ceylon and Burma, quilting all over northern India, goffering in various places. (*See* also LACE; FAN; WEAVING.)

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THE FAR EAST

Woven Fabrics of China.—The origin of silk-weaving (*see* WEAVING) in China is lost in the region of myth and legend, and nothing remains to show what the earliest stuffs were like. The oldest Chinese patterned stuffs known to exist were unearthed by Sir Aurel Stein in the Lop desert, Chinese Turkestan, in 1914. The site lay on the route opened out by the Chinese for the silk trade with western Asia in the 2nd century B.C., and replaced by an easier route in the 4th century A.D. The stuffs are attributed to the 1st century B.C., during the Han dynasty, and they are undoubtedly influenced by earlier traditions. The patterns of dragons, griffins, animals, birds, scrolls and diapers are archaic in form, though at the same time they have a remarkable resemblance to later work. The next Chinese dynasty especially associated with the output of artistic wares is the T'ang (A.D. 618–906). Considerable numbers of textiles attributed to this period have been preserved. The Chinese were then in contact with Persia both by land and sea, and this western intercourse is reflected in the art of the time. It is conspicuously seen in a silk banner said to have been used by the Japanese Prince Shotoku (A.D. 572–623), and now removed from Nara (the old imperial capital) to the Tokyo museum. The design is a typical Sassanian

hunting-scene, with the king on horseback attacking a lion; the manner of representation is, however, Chinese and Chinese characters are introduced. Many other silk weavings of this epoch are preserved in the royal treasure-house at Nara in Japan.

A characteristic type of Chinese weaving, done by the tapestry method in fine silks and gold thread, and known as k'o-ssu, is first met with under the T'ang dynasty. The specimens which have been found in the Gobi desert region differ remarkably little from those of modern times The same very fine silk warp is used, and the weft of bright coloured silk enhanced by the use of gold thread. On the other hand there can be no reasonable doubt that these examples woven more than a thousand years ago were the heirs of a far greater antiquity—perhaps assignable in its origin to the dim period when Chinese handicrafts first assumed a civilized form. The patterns are less archaic than those of the "Han" silks already mentioned, but they are similar in their scope —including dragons, symbolic "lions," phoenixes, and various animals, birds and flowers.

Under the Yuan dynasty, founded by a Mongolian conqueror about 1280, Marco Polo (besides other travellers from Europe) found his way across the Asiatic continent to China He speaks of the silk brocades woven in many parts of that country Numbers of Chinese silk and gold fabrics were brought to the West at that time and under the Ming dynasty which followed in the 14th century. Some are at Regensburg and Danzig and in other church treasuries of Europe Occasionally Arabic inscriptions are inwoven into these stuffs showing that they were intended for the use of a Mohammedan ruler of western Asia

With the arrival of the Portuguese at Canton in 1517 a new era begins for Chinese textiles. "Chinoiserie" soon came into vogue in Europe, and the trading ships of Portugal, Spain, England, France, Holland and other countries brought home vast quantities of Chinese textiles often made specially for export During this time the weaving of fine silk fabrics, uninfluenced in design by Western associations, went on as before. Dragons, phoenixes, clouds, waves and symbolical ornaments were reproduced on official garments, temple hangings and other stuffs. In China a landscape or a figure subject becomes a "pattern" almost as naturally as any other kind of ornamentation. Landscapes including rocks, rivers, boats, buildings, trees and figures were rendered by the tapestry-weaving process already described. A panel belonging to a series representing a popular commemorative festival held annually by the Chinese, is here reproduced (*see* Plate I.)

Woven Fabrics of Japan.—Textile art in Japan owes a great deal to the Chinese. The ancient royal treasure at Nara, already mentioned, contains some of the most remarkable early Chinese stuffs in existence. The inference that Japan was then very largely dependent upon the more ancient civilization of her neighbours for the richer sort of textiles is confirmed on more general grounds. In the early centuries of the Christian era large numbers of Chinese weavers settled in Japan. They usually worked under Japanese control, and they became distributed throughout the country.

In the year 1584 a Japanese embassy arrived in Europe, visiting Pope Gregory XIII. in Rome, and King Philip II in Spain. They brought with them silk weavings as presents, receiving in return velvets and brocades From this time onwards European influence may be discerned here and there in the textiles of Japan. But before the 17th century was well advanced, Japan closed her doors entirely to the foreigner, until in 1858 the country was reopened to European and American trade by Com Perry, U.S. Navy.

Japanese textile-design displays an acute perception of natural forms, seizing the salient features and transforming them with a light touch to the fabric. Ducks are shown floating on the rippling water, irises growing in the stream, fowls with their chicks (*see* Plate II), cranes on the wing; and with these are landscape effects —lakes and streams, clouds, pine trees, castles and bridges. Symbolic ornaments and small diaper patterns are also common. Different methods of ornamentation are frequently combined in one fabric. A silk stuff may have a woven pattern helped out by printing and completed with a few deft touches of embroidery.

(*See* LACE; INTERIOR DECORATION, ORIENTAL; FAR EASTERN ART; SCREENS, CHINESE AND JAPANESE; EASTERN DRESS)

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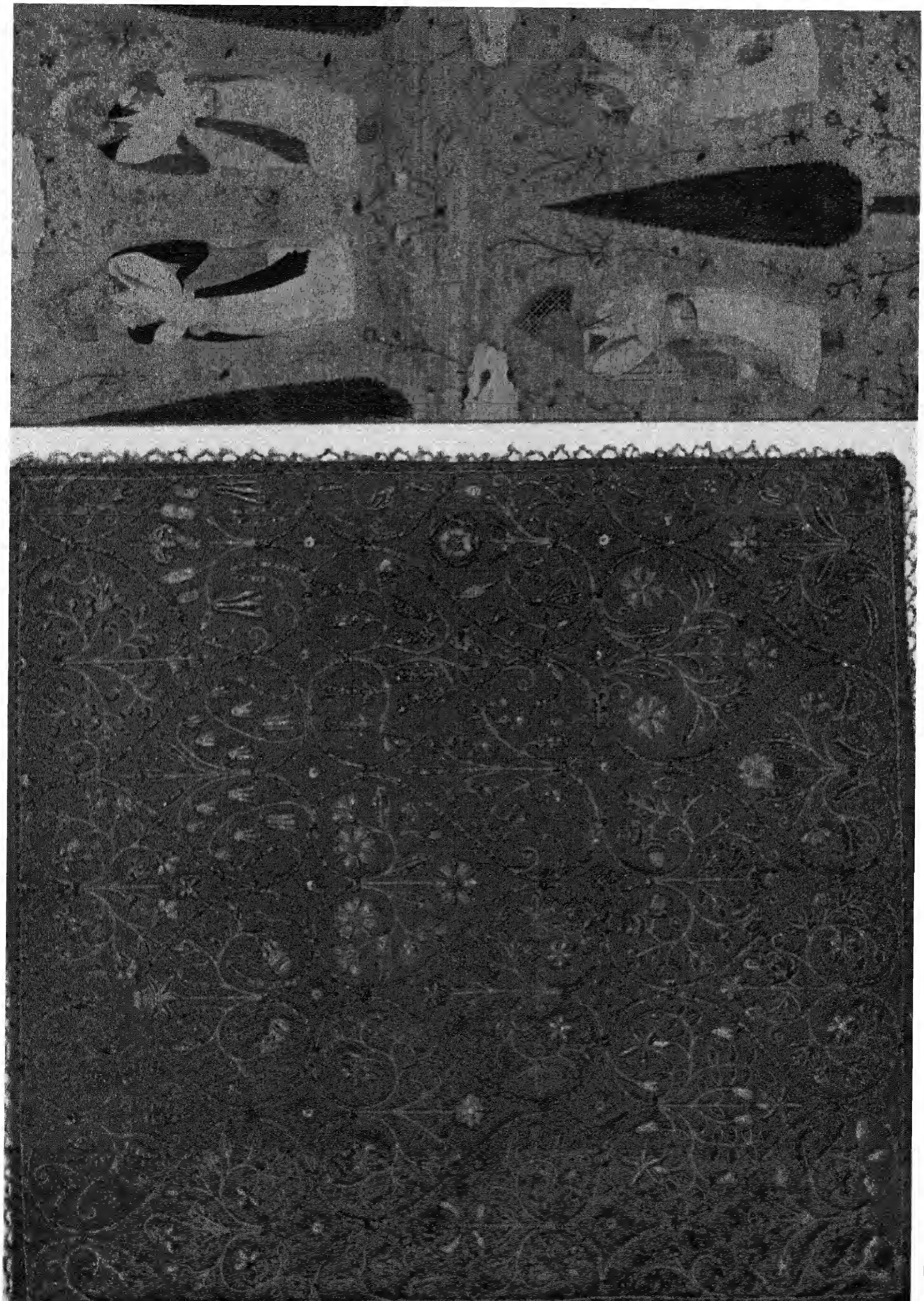
TEXTUAL CRITICISM, a general term given to the skilled and methodical application of human judgment to the settlement of *texts*. By a "text" is to be understood a document written in a language known, more or less, to the inquirer, and assumed to have a meaning which has been or can be ascertained. The aim of the "textual critic" may then be defined as the restoration of the text, as far as possible, to its original form, if by "original form" we understand the form intended by its author

Texts may be either *autographs* or they may be *transmitted* texts; these, again, being *immediate copies* of autographs or *copies of copies* to any degree

Autographs (which may be taken to include whatever, though not actually in the writing of its author, has been revised and attested by him) are not exempt from the operations of textual criticism Editors of journals remove the slips of the pens of their contributors; editors of books, nowadays usually in footnotes, the similar lapses of their authors With this branch of textual criticism, however, modern scholarship is not largely concerned Not so with *immediate copies* Textual criticism is called upon to repair the mischief done to *inscriptions* (texts inscribed upon stones) by weathering, maltreatment or the errors of the stone-cutter Any great collection, such as the *Corpus* of Latin inscriptions, will show at once its activity and ability in this direction

The chief field of textual criticism is elsewhere The texts of the older authors which have come down to us were written for the most part not on stone but on papyrus, parchment or other perishable material Of these several copies had to be made, both by way of prevention against the wear and tear of use and as a means of satisfying the desire of other persons than the original possessor to be acquainted with their contents Had the copies made of ancient writings been mechanical reproductions of the originals, such as the photographic facsimiles of modern times, there would have been little here for textual criticism to do The ancient texts have not come to us in this way, but through copies made by the human hand directed more or less by the human intelligence. Now a copy made thus can in no circumstances be a quite exact rendering of that from which it is copied or its *exemplar* A copy, *qua* copy, can never be the equal of the exemplar, and it may be much its inferior. This deterioration increases with the number of successive copyings Let us suppose that from a text which we will call "A" a copy has been made which we will call "B," and from this again a copy which we will call "C." If the copyist of "B" goes wrong once and the copyist of "C" twice in a hundred times, then, assuming that there is no coincidence or cancelling of errors, the relative correctness of the three texts, "A," "B," "C" will be 100 (absolute correctness), 99 and 97·02 If "C" had made his copy direct from "A," his percentage would have been 98 The importance of this must be borne in mind when we are dealing with *transmitted texts,* which have passed through many stages of copying.

The first step towards restoration of a text is the examination of the evidence upon which it is or is to be based. This begins with the investigation of its transmitted form For this we have usually to rely upon *manuscripts* (mss) By manuscripts (*q v*) we understand copies of the text made before the art of printing came into general use. These may be either *extant* or *non-extant* The evidence of extant manuscripts must be ascertained by *collation* To collate a manuscript is to observe and record everything in it which may be of use towards determining what stood in the source or the sources from which it is derived. A manuscript is not usually a clean or single piece of writing; it is commonly found to contain alterations by erasure, addition or substitution. Such alterations may be due to the writer or writers of the ms., called the *scribe* or *scribes*, or to some other person or persons (for there may be several) called *correctors* The relative importance of these corrections may be very different. Hence we must distinguish the different *hands* which have been at work on the manuscript. Account must also be taken of the number of lines



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM

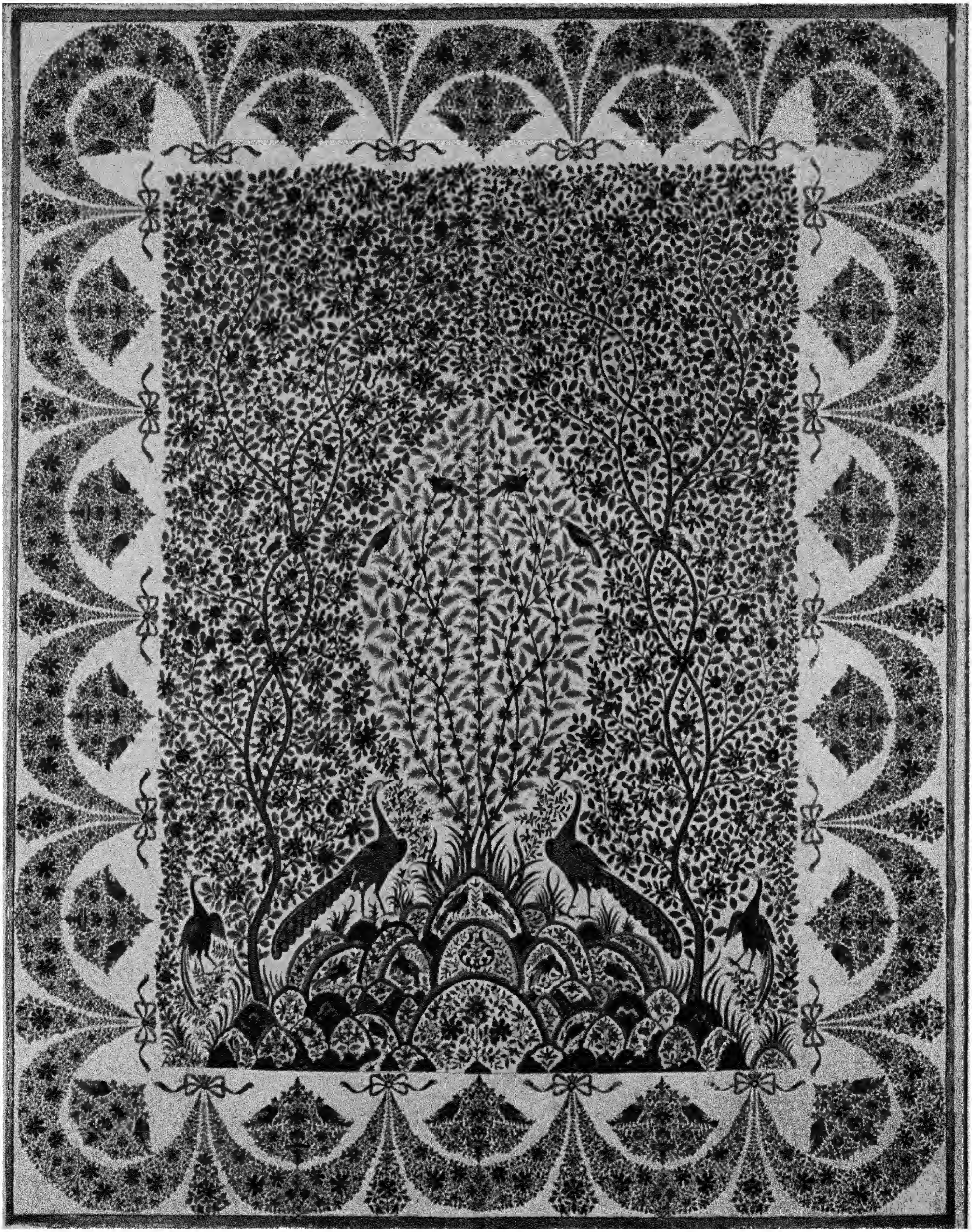
EXAMPLES OF ENGLISH AND PERSIAN EMBROIDERY

1. Satin cover with embroidery in gold thread and silk. English, late 16th century
2. Velvet brocade panel on a gold thread ground. A courtier in a garden. Persian, late 16th century

PERSIAN EMBROIDERED HANGING OF THE 19TH CENTURY

Hanging for a niche. Field, olive brown; spandrels, white; broad border, dark blue; three narrow borders, red; grounds, white and blue; all woven separately and sewed together. The decoration consists of many coloured pieces of woollen cloth set into the ground, outlined and connected to form patterns by chain stitching in silk thread. It is backed with printed cotton. Size: 75 in. x 50 in.

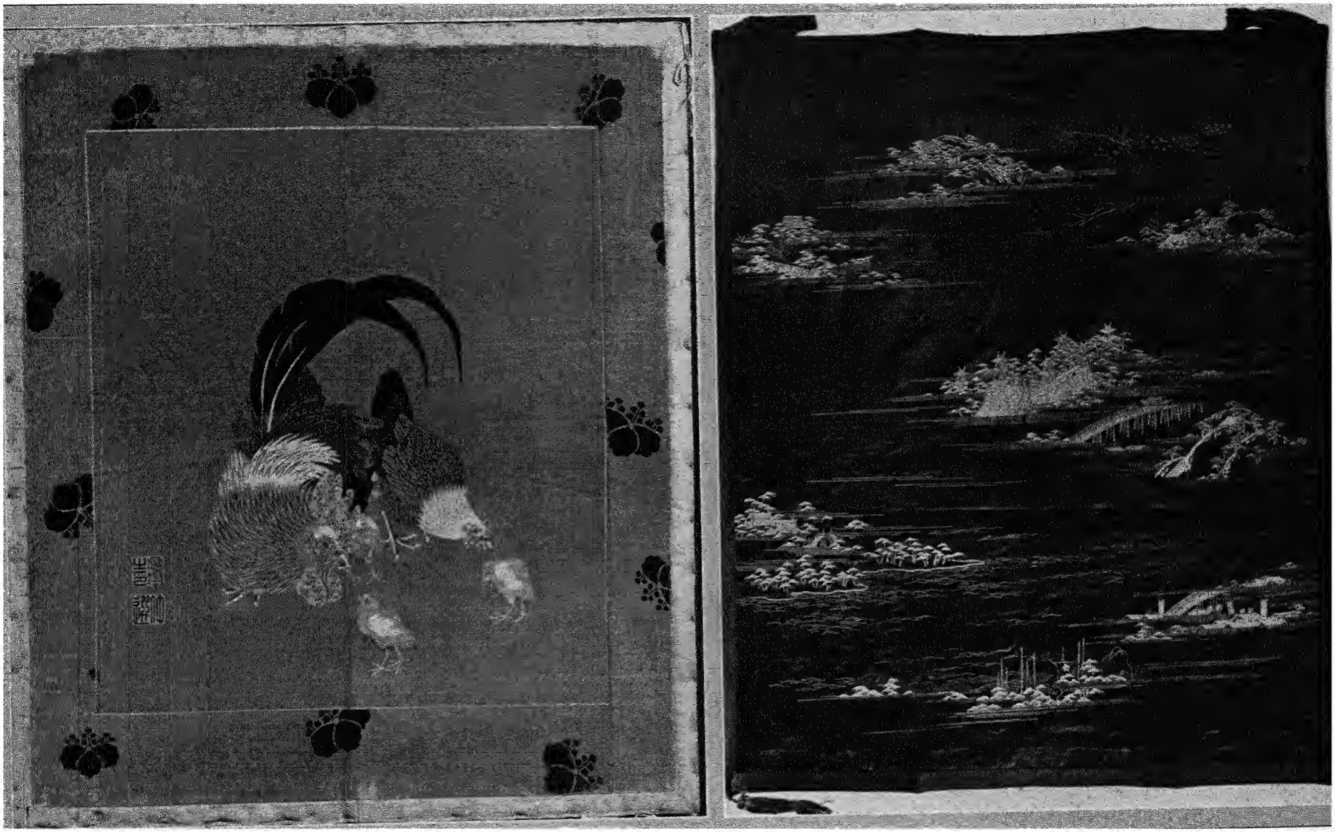
TEXTILES AND EMBROIDERIES



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, LONDON

INDIAN PALAMPORE OR BED-COVER

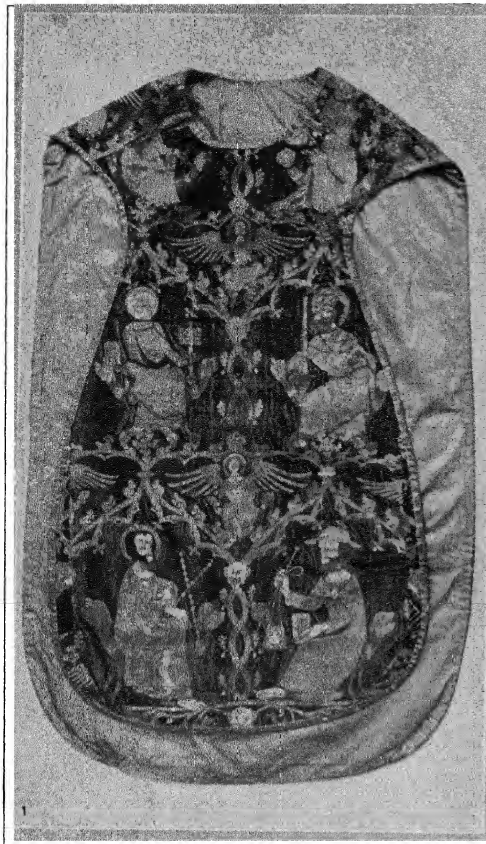
Palampore of elaborate design with peacocks and various geometrical figures. Indian palampores are usually of a heavy type of material and are extensively used in India for bed coverings



JAPANESE COVERS

1. Japanese cut and uncut velvet; fowls with their chicks; the plumage rendered in cut and uncut pile, 19th century
2. Embroidered satin cover of the type usually used for covering a ceremonial present. Japanese landscapes are used in this design, 19th century

TEXTILES AND EMBROIDERIES



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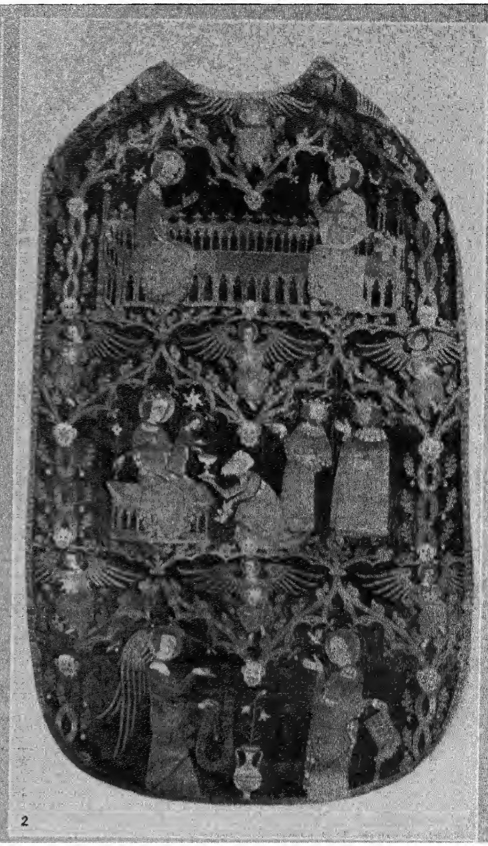

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BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, NEW YORK

ENGLISH EMBROIDERY

1. Front view of an English embroidered chasuble of opus anglicanum of the first decade of the XIV. century, with figures of apostles under arcading
2. Back view of the same chasuble with scenes from the life of the Virgin—the chasuble which is embroidered in gold thread and silk on red velvet has been made from a cope

in each page, the number of pages in each quire, of gaps or lacunae in the manuscript, and so forth. The work cannot be considered complete till all the extant manuscripts have been collated or at least examined When this is done we shall have the materials for pronouncing a judgment upon the text as *directly transmitted*. Perhaps there is only one extant MS. of the text, as in the case of the *Mimes* of Herodas and the *Annals* and *Histories* of Tacitus Then this part of our work is done. But often we have to take account of a number of MSS whose respective claims to attention we must determine. In the first place we shall discard all MSS derived by copying *from other extant MSS* If a MS is immediately or ultimately derived by copying from another MS, it cannot tell us anything that we do not know already if this copied MS is known to us But how can we tell that a MS is so derived? It must be later than the other MS, *and* the similarity between them must be such as to permit of no other explanation In the absence of explicit dates the relative age of MSS is often hard to determine, hence the criterion of unmistakable resemblance is one of especial importance. If the MSS agree in singular though trivial mistakes, if they omit, apparently without motive, words and passages which other MSS preserve, we shall be safe in pronouncing that there exists a close bond of connexion between them; and if one of them shows errors which, though strange in themselves, are quite intelligible when we see what stands in the other, then we conclude that the second is that from which the first is derived For the proper consideration of such points a personal examination, *autopsy*, of the MSS or of facsimiles of them, is often indispensable It was thought at one time that a MS of the Latin poet Propertius at Naples (*Neap* 268) might have independent value as an authority for the text. But its claims were disposed of when (amongst other facts) it was observed that at book iv 8, 3, the MS with which it most closely agreed (F, No 36, 49 in the Laurentian Library) had a gap at the beginning of the line and only the end words "vetus est tutela draconis," with the marginal note "*non potuit legi* in exemplari hoc quod deficit," ("what is missing could not be read in the original") and that *Neap.* 268 gives the line as follows, "*non potuit legi* vetus est tutela draconis"

Accident apart, *identity of reading implies identity of sources.* The source of a transmitted reading may undoubtedly be the author's autograph; but if not, then it is some MS in the line of transmission The peculiar resemblances of two MSS, though not sufficient to warrant the derivation of either from the other, may be sufficient to establish some connexion between them. From the axiom which has just been cited it follows that this connexion can be due only to community of source, and we thus arrive at the idea of *families of MSS* Suppose that a text is preserved in seven MSS, A, B, C, D, E, F, G If we find that of these A stands apart, showing no great similarity to any of the other six, while B, C, D on the one side, and E, F, G on the other, much resemble each other though differing considerably from the rest, we may express this by saying that B, C, D form a "family" descended from a hypothetical common "ancestor" which we may call X, and E, F, G another "family" descended from a hypothetical "ancestor" which we may call Y. The readings of X which can be deduced from considering the agreements in B, C, D will be of higher antiquity and of greater external authority than any of the readings in B, C, D taken singly. And similarly for the readings of Y and those of E, F, G Nor shall we stop here; but we shall further compare the readings of X and Y with each other and with those of A, and thus deduce the readings of a still more remote ancestor which we may call Z. Z will be the *archetype* of all our existing MSS., and we may embody our results in a *pedigree* of manuscripts with Z as the first ancestor.

If we have done our work properly, the texts that we arrive at for X and for Y will be freer from error than the texts of the separate members of the families B, C and D, and E, F, G respectively, and that of Z freer from error than that authenticated by any existing MS.

The procedure, however, is by no means always so simple. That a text may be improved by the comparison of different MSS. is not a modern discovery. It has long been known, and the knowledge has led to the production of what are known as *conflated manuscripts* or *Misch-codices*. These are MSS. produced by "crossing" or "intermixture." In the following stemma M and N are "mixed" or "conflated" MSS, being formed by the blending of readings from the "pure" or "unmixed" codices A, B and D, E respectively. Intermixture may take place to any extent; and the more of it there has been, the more difficult does it become to trace the transmission of a text. Whether crossing improves a given text or not depends ultimately on the knowledge and the judgment of the crosser; and these will vary indefinitely

Non-extant Manuscripts.—Some of the most valuable of ancient MSS. have disappeared since their discovery in modern times When this has happened we have to rely upon mere copies, many times of inferior quality, or upon the information which old scholars have given us respecting them In this case what we have are not "collations," for the art of collation was not understood till the 19th century, but selections or "excerpts" of readings which we have reason to fear are often imperfect and erroneous Further, it must not be assumed that all readings which are cited as being "*ex vetustis codicibus*" ("from ancient MSS.") are necessarily from older or better MSS. than we now possess, or indeed from MSS. at all. Scholars since the Renaissance have not always been above inventing codices to obtain currency for their own conjectures. The codices of Bosius (1535–80) are just as imaginary as the "old plays" which appear as the source of so many of the quotations that head the chapters of the Waverley novels, and suspicion rests on Barth, Lambinus and others.

Some texts and portions of texts of ancient writers are now known only from printed books. The metrical treatise of Terentianus is now preserved in the *editio princeps* (1497) alone. All known MSS of Silius Italicus have a considerable gap in the 8th book, first filled up on the authority of Jac. Constantius (1503), and not printed with the rest of the poem till the edition of Aldus (1523). By the methodical employment of these means we shall arrive at a text different from any existing one. It will not be the best one, possible or existing, nor necessarily even a good one. But it will be *the most ancient one* according to the *direct line of transmission,* and the purest in the sense of being the freest from traceable errors of copying and unauthorized improvements.

The invention of printing has naturally limited the province of textual criticism, and modified its operations. The writer's autograph, if it is preserved after it has been through the hands of the printer, has seldom more than an antiquarian value. As a source for the text it is superseded by the printed edition, and if there is more than one, then by the latest printed edition which has been revised in proof by the author, or, in certain cases, by his representative; and the task of the textual critic is restricted to the detection of "misprints," in other words, of errors which the compositor (the modern analogue to the scribe) has made in "setting up" the manuscript, and which have escaped the notice of the proof-reader and the author or his representative. If, however, this revision has been neglected or incompetently performed, the number of such mistakes may be considerable.

Another question with which the textual critic of modern authors must be prepared to deal is the relative importance of different editions, each of which may have a *prima facie* claim to be considered authentic. Thus Shakespearian criticism must decide between the evidence of the first folio and the quartos; the critic of Shelley's poems must consider what weight is to be attached to the readings in the posthumous edition by Mrs. Shelley, and in unpublished transcripts of various poems. Where there is great or complicated divergence between the editions, as in the case of Marlowe's *Faustus,* the production of a resultant text which may be relied upon to represent the ultimate intention of the author is well-nigh impossible For the bettering of the *transmitted text* we can call in aids of a partial or subsidiary character which are known in general as *testimonia.* Such are *anthologies* or collections of extracts. The oldest authority for an epithalamium of Catullus (62) is an anthology at Paris written in the 9th century. *Translations* from one language into another may help to fix the reading of the original, or this again that of the translation. In

Shelley's *Prometheus Unbound,* ii. 5, 54:

> Child of Light! thy limbs are burning
> Through the vest which seems to hide them

"limbs" is supported against "lips" (ed. i.) by *membre* in the Italian prose version made by Shelley himself; and similarly in l. 52 "looks" (not "locks") by the rendering *sguardi*. In *direct quotations,* either of passages or single words, and either with or without the author's name, we must be sure that the writer is quoting exactly. *Parodies,* discreetly used, may prove of service in restoring the form of what is parodied or this in restoring the parody. So also *obvious imitations,* especially in a highly imitative literature such as Latin poetry.

The support which a reading gains from the evidence of the directly transmitted text *and* from the auxiliary testimonia may be called its *documental probability*. To restore a text from the documental evidence available we must know and weigh the causes which tend to vitiate this evidence in its various kinds. We shall speak first of those which affect the *direct* transmission of texts. These are either external or internal.

External.—A text may become illegible through damp or constant thumbing; portions of it may be torn away; if it is in book form, leaves or whole quires may be detached and either lost or misplaced. When this has taken place on a considerable scale, the critic is helpless, but minor injuries may sometimes be traced and remedied. The weakest parts of a MS. book were the outer margins; hence the beginnings and the ends of lines, whether of verse or prose, were especially liable to injury. It obviously makes a difference upon which side of a leaf, whether on the verso or the recto, a line was written. Hence the determination of the paging of the "archetype" or parent MS. (as was done for the archetype of Lucretius by Lachmann) has more than a merely antiquarian value. In ancient classical MSS. the first letters of poems in verse and paragraphs in prose usually, and the initial letters of lines in verse occasionally, were written separately and by another person than the scribe (who was called the *rubricator*), and therefore were apt to be omitted. Other external circumstances may prejudicially affect a text. The copy from which Shelley's *Julian and Maddalo* was printed was written on very narrow paper, and the punctuation marks at the ends of the lines were frequently omitted.

Internal.—These errors arise from the default of the scribe or copyist, and, in the case of printed books, the compositor. (For the convenience of the general reader these errors have been illustrated as far as possible from English authors and especially from the poems of Shelley [ed. Hutchinson].) They are very numerous. They may be roughly arranged according to the degree in which the volition of the copyist is absent or present, as involuntary or mechanical, semi-voluntary and voluntary, or again as they affect single signs (letters, figures or symbols), words, lines, or even larger units such as sentences or paragraphs.

Simple Errors of the Eye.—(*a*) Confusions of letters. These are very numerous, and different in different scripts or styles of writing (*see* PALAEOGRAPHY). Thus the Roman letters *E* and *F* are liable to be confused in capital script, but not in cursive *e, f; C, G,* in capitals; *c, e* in the cursive writing called Caroline minuscule, *c, t,* in the angular cursive of the 13th century and later. Texts which have had a long history will often show by the letter-confusions which they exhibit that they have passed through several distinct stages of copying. It is to be observed that two different styles of writing are often found in the same manuscript, the difference being utilized for the purposes of distinction. Thus in Greek cursive MSS. notes were often written in uncials. (*b*) Omissions of letters. (*c*) Shiftings of letters, sometimes by syllables. This is very common in half intelligent or half mechanical copying. In printing we get the disarrangement of type which is known as "pie." (*d*) Confusions of symbols and abbreviations.

(*a*) Examples of confusion of capital letters from Shelley's poems are: *Prometheus,* i. 553, "*M*ark that outcry of despair" for "*H*ark", *Hellas,* 472, "*H*old each to the other in loud mockery" for "*T*old." Of cursive letters: *Marenghi,* 130, "the *dim* ocean" for "the *dun* ocean", *Letter to Maria Gisborne* 126, seq.:

> above
> One chasm of Heaven smiles like the *age* of Love
> On the unquiet world

for "*eye.*" (*b*) *Translations from Goethe's Faust,* sc. ii. 165, "eye" for "ey*ne*" (in spite of the rhyme with 163). (*c*) *Prometheus,* iv. 575, "Neither to change, nor f*la*tter, nor repent," for "f*al*ter." In Latin MSS. we often find a mere jumble of letters. (*d*) Confusion of words through abbreviations is very common in ancient MSS., where they were much employed. At a famous place in the doxology of I. Timothy iii. 16, the MSS. vary between ὅς (or ὅ) and Θεός. In uncial writing OC (ὅς) might easily be miswritten or altered to ΘC (Θεός) or vice versa.

Loss of Letters, Syllables, Words or Lines, through Similarity of Writing: Homoeography.—When similar letters or groups of letters stand next to each other, one of these is liable to be omitted. This is the simplest case and is called *haplography*. An example is Shelley's *Cenci,* v. 4, 136, "whose love *was* [*as*] a bond to all our loves." Similarity operates differently if the similar groups stand in different lines of the exemplar. Then the copyist's eye is apt to slip from the first of two similarly written groups to the second; and he will thus omit all that is between.

Omissions through Simple Negligence.—Groups of letters, words, syllables and lines are often omitted without any contributory cause. Short words or such as are not necessary to the sense are especially prone thus to disappear.

Examples of this are, Shelley's *Prometheus,* iii. i, 70,

> No refuge! No appeal!
> Sink with me [then],

Cenci i. i, 26,

> Respited [me] from Hell! So may the Devil
> Respite their souls from Heaven!

Repetitions: Dittography.—Letters, groups of letters, words and lines may be written twice (or even oftener) instead of once. Other repetitions of words already written and anticipations of words yet to be written are also found, through the scribe's eye wandering into the preceding or the following context. Wherever the word or group of words repeated is not the one that he has just copied loss is liable to occur. *Dittography* is common enough in manuscripts, but is usually detected in reading proofs. In the sole MS. of Cicero's treatise *De Republica,* 2, 33, 57, *secutus* appears as *secututus secutus.* Other kinds of repetition are Shelley's *Witch of Atlas,* 611 *seq.:*

> Like one asleep in a green hermitage,
> With gentle *sleep* about its eye-lids playing

(*sleep* for *smiles* has come from the previous line).

Confusions of Words.—Words are not only changed through confusion of single letters or abbreviations, but also through general resemblance or (a semi-voluntary change) through similarity of meaning. Shelley, *Prometheus,* ii. 2, 53 "There s*t*reams a plume-uplifting wind" for "steams." In Shelley's lines, "When the lamp is shattered," vv. 5–6,

> When the lute is broken,
> Sweet *tones* are remembered not

the printed edition had "notes" for "tones." In Mrs Gaskell's *Cranford,* ch. xiv. (near the end), "The lunch—a hot savoury mutton-chop, and a little of the cold *loin* sliced and fried—was now brought in" is the reading of most if not all the editions; but *loin* should be "lion," the reference being to the pudding, "a lion with currant eyes," described earlier in the chapter.

The same character frequently attaches to *transpositions of words and parts of words.* The copyist does not as a general rule consciously intend a change, but he falls into one through the influence of dominant associations. He substitutes an order of words which, in respect of syntax, metre or rhythm is more familiar to him.

Faulty Divisions of Words.—These will generally imply an exemplar in which the words were without any division or without a sufficient one. Under this head we may class errors which arise from the omission or the insertion of such marks as the apostrophe and the hyphen. Examples of *wrong division* of words are Chaucer's *House of Fame,* iii. 1,975, "Of good or misgovernement"

which should be "mis (*i e*, bad) governement"; Shelley's *Prometheus*, iii. 2, 22, "Round many peopled continents" for "many-peopled," *ib* 26, "the light laden moon" for "light-laden" With this we may class *faulty division of sentences.* Wrong punctuation is a common error and usually easy to correct As an example of mispunctuation we may take Shelley's *Triumph of Life,* 188 seqq.:

> "If thou can'st, forbear
> To join the dance, which I had well forborne"
> Said the grim Feature of my thought "Aware
> I will unfold"

for

> said the grim Feature (of my thought aware)
> "I will unfold."

Grammatical Assimilations.—These are often purely mechanical errors, but they may be semi-voluntary or even voluntary, the copyist desiring to set the syntax right, as for example in Shelley's *Mask of Anarchy,* 280 seq

> the daily strife
> With common wants and common cares
> Which *sow* the human heart with tares,

for *"sows"*

Insertions (or Omissions) of Seemingly Unimportant Words.—These, inasmuch as they must often import some judgment on the sense of the passage copied, will be frequently semi-voluntary if not voluntary Examples are Shelley, *Prometheus,* iii 1, 5 "The soul of man like [*an*] unextinguished fire" So in *Triumph of Life,* 265

> Whom from the flock of conquerors
> Fame singled *out* for her thunder-bearing minion,

"out" seems to be due to the compositor

False Recollections.—The passage which a copyist is reproducing may suggest to him something else and he will write down what is thus in his mind instead of what is before his eyes There is a noteworthy instance in Horace, *Odes,* iii 18, 11 seqq

> festus in pratis vacat otioso
> cum bove *pagus*

where some MSS give "pardus," a reminiscence of Isaiah xi 6, "The *leopard* (*pardus*) shall lie down with the kid"

Incorporation of Marginalia.—The copyist may erroneously suppose that something written in the margin, between the lines or at the top or the foot of the page which he is copying, is intended to be placed in the text The words so incorporated may appear side by side with the genuine reading or they may expel it In Horace, *Odes,* iii 27, 47, "amati cornua *monstri*" (of the bull which carried off Europa), more than one MS has "cornua *tauri,*" an explanation of *monstri* The celebrated passage about the three heavenly witnesses inserted in the Epistle of St John (v. 2) seems to have been originally a comment explanatory of the text.

Transpositions of Lines and Passages.—This kind of transposition is really arrested loss An accidental omission is discovered, and the person responsible, or another, places what is omitted in the margin, at the foot of the page or in some other part of the text, usually adding a mark to show where it ought to have been The next copyist may easily overlook this sign and thus the passage may be permanently displaced

Interpolation.—This is the deliberate alteration of an exemplar by way of substitution, addition or omission, but when it takes the particular form of omission it is naturally very hard to detect Interpolation then always has a motive The most frequent motive is the removal of some difficulty in the sense, expression or metre of the text, and especially obvious gaps or corruptions which the interpolator endeavours to fill or to heal Fraudulent interpolation, whether the fraud be pious or otherwise, does occur, but is comparatively rare The removal or the mitigation of objectionable matter is also occasionally found Interpolation is then a voluntary alteration, but in practice it is often hard to distinguish from other changes.

The usual character of scribes' alterations is well illustrated by a passage in Bacon's *Advancement of Learning,* II xix, "for these critics have often presumed that that which they understand not is false set down as the Priest that where he found it written of St. Paul *Demissus est per sportam* (Acts ix 25) mended his book, and made it *Demissus est per portam,* because *sporta* was an hard word, and out of his reading" Shelley in *Triumph of Life,* 201 seq, wrote

> And if the spark with which Heaven lit my spirit
> Had been with proper *nutriment* supplied,

but the printed editions made it "sentiment"

Deliberate alteration is sometimes due to disapproval of what stands in the text or even to less creditable reasons There is an old and seemingly trustworthy tradition that some lines in Homer's "Catalogue of the Ships," *Iliad,* ii 553–556 and 558, were introduced there to gratify the vanity or ambition of the Athenians Insertions of this or of a similar character may be of almost any length, from a few words to a whole chapter or a complete poem Literary forgery has never set any bounds to itself, and the history of every literature will supply examples of entire works being foisted upon authors and personages of repute

Special Conditions Conducing to Corruption.—The chief of these is strangeness or difficulty in the matter to be copied Proper names, technical expressions, quotations from foreign languages, and frequent change of subject, are all likely to cause difficulty to a scribe and error in his work Careful and continuous regard to the various kinds of errors and defaults that are found in transcription will enable us to judge whether a reading which it is suggested stood in the archetype of our text is likely to have been corrupted to the reading, or readings, which stand in the extant manuscripts or editions If it is, we say of this reading that it is *transcriptionally probable*

Some precautions must be observed First we must rule out any proposal which assumes confusions of letters and abbreviations which are not attested for the particular tradition Secondly, since different scribes are prone to different kinds of error, we must ever bear in mind the particular failings of the scribes responsible for the transmission of our text as these failings are revealed in the *apparatus criticus* Maxims of criticism to which we may here refer are that "harder readings are better than easier" and that "the shorter reading is generally the truer" The first maxim is indisputable, provided we understand by "harder" *harder to the scribe,* and by "easier" *easier to the scribe* The characteristic of scribes' emendations or interpolations is that they are superficial Their mark is that at the time of their making they "combine the appearance of improvement with the absence of its reality" (Westcott and Hort, *New Testament,* i. p 27) The second maxim refers to the well known fact that accretions from marginalia, etc, lengthen and also weaken a text

The virtues of a scribe are *honesty* and *care* (or in a single word *fidelity*) and *intelligence* But it is rare to find these combined in a very high degree, and out of them we can least easily dispense with fidelity Paradoxical as it may seem, the mechanical corruptions of a stupid but faithful copyist may tell us more than the intelligent copyings of a less faithful one At certain epochs in the transmission of literature systematic efforts have been made to improve the transmitted texts, and these efforts have naturally been accompanied by a good deal of emendation both successful and unsuccessful Such an epoch was the revival of Latin and Greek learning in the 15th century, and a modern scholar would for that reason naturally prefer to have a manuscript to work on which was written immediately before this epoch to one which was written immediately after it. The fidelity of a scribe has to be judged chiefly by *internal* tests, and these are best applied to his work in passages where there is no reasonable doubt of the correctness of the transmitted text. But there are two tests of a more objective character that may be used—orthography, and indication of lacunae or other faults in his exemplar. A scribe who preserves in his spelling the traces of a bygone age is probably trustworthy If faithful in small things, he is likely to be faithful in great A scribe again who scrupulously records the presence of a lacuna or illegibility in what he is copying, inspires us with confidence in the rest of his work.

As regards the use of *testimonia*, it may be observed to begin with that their value must depend on the trustworthiness of the texts of the writers from whom they are taken, and further upon that of the text used by the translator, the excerptor or the quoter, about which we can know nothing for certain, though we may sometimes make probable inferences. In the case of quotations we must allow for failures of memory. Many times in the course of his investigations the critic will be confronted with problems which cannot be resolved by considerations of transcriptional or documental probability.

This leads us to consider *intrinsic probability*. By this is meant the likelihood that the writer of our text would at the time of writing have written, or not have written, a particular thing. Two questions which may be separated, though they are not entirely distinct, are here involved What was the meaning of the writer? And how did he express it? The sense may be clear though the words may no longer be determinable. A reading may be impugned on a number of grounds: that it gives no sense or an inappropriate sense; that it involves a usage or an idiom not current at the assumed time of writing, or foreign to the reputed author, or to the style in which he then was writing; that it involves some metrical or rhythmical anomaly; or that the connexion of thought which it produces is incoherent or disorderly. These charges cannot be played off against each other It is no answer to the objection that a reading in some Roman poet makes nonsense to say that its Latinity is perfect or its metre excellent. But they may reinforce each other, and to such corroboration great weight must be assigned

To set the meaning of a passage in a foreign language before us we must frequently have recourse to *translation*. But this method of representation is a very imperfect one, we may easily impose on ourselves and others by strained and ambiguous renderings. A more subtle danger to which we are especially liable in the case of a dead language is that of our acquiescing in a sense which satisfies us but which would not have satisfied the ancient writer. Above all we must avoid applying our own standards of taste, style and morality to the judgment of the text before us The textual critic has no concern with what the writer ought to have thought or said; his business is solely with what he did say or think or might have said or thought Among the legitimate reasons for suspecting the correctness of a text are patent contradictions in a passage or its immediate neighbourhood, proved and inexplicable deviations from the standards for forms, constructions and usages (mere rarity or singularity is not enough), weak and purposeless repetitions of a word (if there is no reason for attributing these to the writer), violations of the laws of metre and rhythm as observed by the author, obvious breaks in the thought (incoherence) or disorderly sequence in the same (double or multiple incoherence) Where the critic has ascertained the earliest form of a reading in his text, he will apply to it the tests of intrinsic probability No part of a text can be considered exempt from this scrutiny, though for a very large part of it, it may be dispensed with

After every such critical examination four conclusions are possible—acceptance, doubt, rejection, or alteration. In other words, a critic may deliberately pronounce that what stands in the text represents what the author wrote or might well have written, that it is doubtful whether it does, that it certainly does not, or, in the last event, that it may be replaced with certainty by something that does In the three first cases his judgment will be governed by considerations of intrinsic probability alone: but in the last it must regard transcriptional probability as well No alteration of a text, or *emendation*, is entitled to approval unless, in addition to providing the sense and diction required, it also presents a reading which the evidence furnished by the tradition shows might not improbably have been corrupted to what stands in the text. These tests, and these alone, are emendations bound to satisfy; but others are often tacitly imposed upon them. Of this the transposition of lines is the most notable example. This kind of change is troublesome to estimate and inconvenient to adopt, as it involves placing passages where we are not accustomed to look for them, but to the question, did the author write the passage here or there? the matter of *our* trouble or inconvenience is wholly irrelevant. There is, however, one class of cases in which no conclusion may be drawn, documental and intrinsic probability both failing us. This is where the alternative readings, neither of which can have come from the other, have equal external support and equal intrinsic merit. Isolated discrepancies of this kind may be due to some accident to our text at a period now beyond our power to trace. Numerous and striking discrepancies may be due to the fact that there was more than one edition or recension of it in early times, or to the author's leaving his work in such a condition that such discrepancies must inevitably gain currency In the case of dramas, different acting editions will give rise to them.

Up to this point all schools of textual criticism are theoretically at least in accord But here begins a divergence which has done more than anything else to discredit the study with the outside world. It emerges because in all judgments on textual matters it is presupposed that they will be acted upon, that a reading accepted will remain in the text, a rejected one obelized, enclosed between brackets or removed, and in this last case something else substituted in its place. Now the "conservative" critic's chief concern is for the safety of the traditional and by preference the transmitted text He urges very rightly that if alteration is carried beyond a certain point it cuts away its own foundation, and so all certainty is destroyed His objective is the minimum of change. And as the need of making a text compels some sort of decision in every case, the "doubtful" readings of the tradition, some of which on the evidence would be doubtfully accepted and others doubtfully rejected, will all appear with the accepteds in the text As to alterations (emendations) that are less than certain, his attitude is clearly if somewhat crudely expressed in the dictum that it is better to leave in the text "what, if not the original reading, is at least the remains of it" The corresponding thesis of the opposite school would be that it is better to present to the reader something which the author might have written than something which he could not: or, in other words, that "stopgaps" should be preferred to débris

An editor of a corrupt and disputed text may reasonably adopt either of two methods of procedure. He may present the text in the purest form which the external evidence warrants, and place all plausible suggestions for its improvement in notes or appendices The text will be faithful but unreadable, and his work will be that of an honest man but of a textual antiquarian, not a textual critic, since he declines the duty of "the restoration of the text, as far as possible, to its original form." By the other method the editor will provide all necessary information about the evidence for the text in the notes of his critical apparatus; but in the text itself he will give whatever in each case is supported by the balance of the probabilities Each and every case he will decide on its own merits and without reference to decisions upon the other cases not now before him Special consideration will be paid to "doubtful" readings, which will be distinguished in his work as "doubtfully accepted" or "doubtfully rejected." Legitimate doubt arises when the evidence *pro et contra* of documental and intrinsic probability is equal, or nearly equal, or when documental probability points strongly to one side and intrinsic probability to another Illegitimate doubt is the uncertainty of the doubter as to whether he has examined the whole of the evidence Such doubt is much more frequently felt than acknowledged, and its effect upon critical work is highly injurious. On the one hand, it is apt to take refuge in an uncritical acceptance of the traditional readings, and on the other hand to produce a crop of hesitant and mutually destructive conjectures which a reader naturally resents as a needless waste of his time

The so-called "conservative text" is neither an antiquarian's text nor a critic's text, but a compromise between the two. When it is conscientiously obtained, it is arrived at by handicapping, more or less heavily, intrinsic probability as compared with documental probability, or by raising the minimum of probability which shall qualify a reading for admission into the text until it is in agreement with the notions of the editor. Both of these procedures are arbitrary in their principle, and liable to be erratic

in their application. The text will suffer whichever course is adopted, and it will suffer the more the more conservative is the editor, as may easily be shown Thus, if we suppose that of two editors of equal competence "A" requires a probability of four-fifths to admit a reading into his text and "B" a probability of three-fifths only, then in all the cases in which the probability lies between these two fractions "B" will be right seven times to "A's" three, while outside these limits there will be no difference between them.

Many persons appear to suppose that decisions upon doubtful points can be avoided by the expedient of leaving the traditional reading in possession of the text The rule is a simple one and easy to apply But owing to the constitution of the human mind it has consequences which possibly they have not contemplated The great works of classical literature are not studied as pathological specimens, and they will be studied the less the more they contain to repel and disquiet the reader If a corruption is left in a text when something might be substituted which would at least, as a "stopgap," give the sort of sense required, then one of two things must happen Either the sense of the passage is blotted out for the reader and the conservation of the corruption is tantamount to the expunging of the rest of the sentence, or else he will obtain the required sense by distorting the meaning of the other constituents of the context until they furnish it So far so good. the requisite sense has been obtained, but the price has now to be paid And the price is that the reader's perception of the signification of the word or words so wrested is dimmed and impaired, and his power of discriminating and understanding them when he meets them again is shot with doubt and error.

It is a weakness of conservative critics to extol interpretation (or exegesis) at the expense of emendation Some have even ventured to say that the successful defence of a passage in a text is a greater service than its successful correction This is not true. The service to the text is the same, what was previously dark being now made clear But the emendation deserves the higher praise as being in most instances the more difficult achievement The fault of the opposite school, on the other hand, is to disparage interpretation and to regard correction as the proper field of a scholar and gentleman This bias is reflected in the maxim that "correction should precede interpretation," which is no more than a half-truth For emendation must inevitably fail unless it express the meaning which the proper interpretation of the passage has shown to be required Further, a corrector may propose the right word with the wrong meaning. Yet the custom is to give the credit of the emendation to him, and not to a successor who has seen what the right sense was and that this was the only word to express it, whereas the first scholar blundered once if not twice, first assigning the wrong sense to the passage and then selecting what (in most cases) would be the wrong word to express it. The proper course would be not to mention the first conjecturer or to mention him only for his error

One of the most vexed questions of textual criticism, and one which divides scholars more perhaps than any other, is the question to what extent admitted imperfections and inconsistencies may properly be left in a text as due to the default of an author rather than of a scribe or compositor. No universal rule is here attainable. Each case must be considered on its merits; and the critic's procedure must of necessity be "eclectic"—an epithet often used with a tinge of reproach, the ground for which it is not easy to discover Two general considerations may be indicated. If the autograph of a work is not accessible, there is no means of distinguishing between the involuntary errors of a scribe and the involuntary errors—"slips of pen"—of an author For these are in fact only scribe's mistakes, the author being his own amanuensis

Passing over this class we come to one about which there may frequently be serious doubt. What is clearly erroneous or faulty may as clearly be intended, and therefore *not* to be removed by the critic. In Chaucer's "Miller's Tale" (3,451, 3,457) *astromie* is used for *astronomie,* and *Noe* and *Noel* (Christmas) confused, "Nowélis flood" (3,451, 3,457), because the speaker is an illiterate carpenter In the "Prologue" to the "Parson's Tale" (10) there is, on the other hand, a mistake of Chaucer's own, which no judicious critic would think of removing, the constellation Libra being said to be "*the moon's* exaltation" when it should be *Saturn's*. But this error in an astrological detail would not warrant us in assigning to the poet the blunder about Jacob and Laban in the same tale (*see* above) Much depends on the precision with which an error can be corrected: wherever there are more plausible ways than one of doing this, the faulty reading must be allowed to remain Collateral as well as direct evidence must be obtained If there is a number of instances where there is faultiness which is hard to remove, it is probable that the evil lies too deep for emendation The author's own carelessness may be to blame, or, as in the case of Virgil and Lucan, he may not have been allowed to put the finishing touches to his work

Certain lapses from grammatical correctness and metrical regularity that we find in the poems of Shelley are undoubtedly due to the author, though the number of these has been reduced (as Mr Buxton Forman has pointed out) with our improved knowledge of the sources of the text Among such lapses we may instance *Prince Athanase* (287),

> The shadow of thy moving wings *imbue*
> Its deserts and its mountains;

"To a Skylark" (80), "Thou lovest—but ne'er *knew* love's sad satiety" The solecism in the Preface to the *Adonais,* "My known repugnance to the narrow principles of taste on which several of his earlier compositions were modelled *prove* at least that I am an impartial judge," would probably have been corrected by the poet if his attention had been called to it, but the two first ones, with others, cannot be thus regarded. We may detect occasional laxity also in his handling of his verse Lines are left unrhymed, or the same word is used in place of another rhyming word

Authority, as already hinted, has properly no place in textual criticism For his facts a textual critic may, and often must, be beholden to others but never for his opinions It adds nothing to the evidence for a reading that it has been approved by a Lachmann or a Madvig or rejected by a Stoeber or a Carutti· and an appeal to names on any such question confuses issues and deters inquiry But inasmuch as there are many persons, including most makers of school editions, who prudently and modestly desire a better road to truth than their own investigations can discover and think thus to find it, it will not be amiss to observe on the one hand that the concurrence of a succession of editors in a reading is no proof and often no presumption either that their agreement is independent or that their reading is right, and on the other that, though independence may generally be granted to coinciding emendations of different scholars, yet from the general constitution of the human mind it is likely that not a few of these will be coincidences in error rather than in truth

As time goes on, textual criticism will have less and less to do In the old texts its work will have been performed so far as it is performable What is left will be an obstinate remainder of difficulties for which there is no solution or only too many. In the newer texts, on the other hand, as experience has already shown, it will have from the outset but a very contracted field

(J P P)

THĀʻALIBĪ [Abu Mansur ʻAbd ul-Malik ibn Mahommed ibn Ismaʻīl uth-Thaʻālibī] (961–1038), Arabian philologist, was born in Nīshāpūr. His most famous work is the *Kitāb Yatīmat ud-Dahr,* on the poets of his own and earlier times, containing valuable extracts (Damascus, 4 vols, 1887) Another work, the *Kitāb Fiqh ul-Lugha,* is lexicographical, the words being arranged in classes It has been published at Paris (1861), Cairo (1867), and Beirūt (1885, incomplete).

For his other works *see* C Brockelmann's *Geschichte der Arabischen Literatur,* vol i. (Weimar, 1898), pp. 284–286

THACKERAY, WILLIAM MAKEPEACE (1811–1863), English novelist, only son of Richmond and Anne Thackeray (whose maiden name was Becher), was born at Calcutta on the 18th of July 1811 His father and grandfather (W R Thackeray) had been Indian civil servants His mother was nineteen

at the date of his birth, was left a widow in 1816, and married Major Henry Carmichael Smyth in 1818. Thackeray went to school in Hampshire, Chiswick, and in 1822 to Charterhouse, still on its ancient site near Smithfield In 1828 he left school to join his mother and her husband at Larkbeare in Devon, near Ottery St Mary, which is the "Clavering St Mary," as Exeter and Sidmouth are the "Chatteris" and "Baymouth" of *Pendennis*.

In February 1829 Thackeray went to Trinity College, Cambridge, and contributed lines on "Timbuctoo," the subject for the Prize Poem (the prize for which was won by Tennyson), to a little paper called *The Snob* James Spedding, Monckton Milnes (Lord Houghton), Edward FitzGerald, and W. H. Thompson (afterwards Master of Trinity) were among his friends. In 1830 he left Cambridge without taking a degree. A visit to Weimar bore fruit in the sketches of life at a small German court which appear in *FitzBoodle's Confessions* and in *Vanity Fair.* In G. H. Lewes's *Life of Goethe* is a letter containing Thackeray's impressions of the German poet On his return to England in 1831 he entered the Middle Temple, and found material for some capital scenes in *Pendennis.* In 1832 he inherited a sum which, according to Trollope, amounted to about five hundred a year. The money was soon lost—some in an Indian bank, some at play and some in two newspapers, *The National Standard* and *The Constitutional.* In *Lovel the Widower* these two papers are indicated under one name as *The Museum,* in connection with which Honeyman and Sherrick of *The Newcomes* are briefly brought in. Thackeray's adventures at play were utilized on three occasions, in "A Caution to Travellers" (*The Paris Sketch-Book*), in the first of the Deuceace narrations (*The Memoirs of Mr. C. J Yellowplush*), and in *Pendennis*, vol. ii chap. v., in a story told to Captain Strong by "Colonel Altamont."

About 1834 Thackeray settled in Paris to study art seriously. He had, like Clive in *The Newcomes,* shown early talent as a caricaturist His pencil was at its best technically in such fantastic work as is found in the initial letters of chapters, and in those drawings made for the amusement of child friends which were the origin of *The Rose and the Ring*

In 1836 Thackeray married Isabella, daughter of Colonel Matthew Shawe. There were three daughters born of the marriage, one dying in infancy The eldest daughter, Anne Isabella married in 1877 (Sir) Richmond Ritchie, of the India Office. She inherited literary talent from her father and wrote several charming works of fiction, notably *Miss Angel* (1875), and subsequently edited Thackeray's works and published some volumes of criticism and reminiscences The younger daughter, Harriet Marian, married (Sir) Leslie Stephen in 1867 and died in 1875. Mrs. Thackeray, to quote Trollope, "became ill and her mind failed her," in 1840, and he "became as it were a widower to the end of his days", she did not die till 1892

In 1837 Thackeray came to London, and became a regular contributor to *Fraser's Magazine* In this in 1841 appeared *The History of Mr Samuel Titmarsh and the Great Hoggarty Diamond,* a work filled with the wit, humour, satire, pathos, which found a more ordered if not a fresher expression in his later works. The characters are full of life; the book is crammed with honest fun, and for pure pathos, the death of the child stands in the company of very few such scenes in English fiction, but *The Great Hoggarty Diamond,* had to be cut short at the bidding of the editor. In 1840 came out *The Paris Sketch-Book*, much of which had been written and published at an earlier date In 1838 Thackeray had begun, in *Fraser, The Yellowplush Papers,* with their strange touches of humour, satire, tragedy, and their fantastic spelling; and this was followed by *Catherine,* a strong story, founded closely on the career of a criminal named Catherine Hayes, and intended to counteract the then growing practice of making ruffians and harlots prominent characters in fiction When *Pendennis* was coming out in serial form (1850) another Catherine Hayes, an Irish singer and famous *prima donna,* was much before the public. Thackeray, thinking of the former and oblivious of the latter Catherine Hayes, caused a great outcry in the Irish press by coupling the name with that of a recently notorious murderer. He afterwards suppressed the passage but the incident is of interest because it explains the initial letter drawn by Thackeray for chap. xv., vol. ii., of *Pendennis.* The drawing is in itself highly comic, but must seem quite meaningless without the key. There soon followed *Fitz-Boodle's Confessions and Professions,* and the *Shabby Genteel Story,* a work interrupted by Thackeray's domestic affliction and afterwards republished as an introduction to *The Adventures of Philip,* which took up the course of the original story many years after the supposed date of its catastrophe. In 1843 also came out the *Irish Sketch-Book,* and in 1844 the account of the journey *From Cornhill to Grand Cairo,* in which was included the excellent poem of "The White Squall." In 1844 there began in *Fraser* the *Memoirs of Barry Lyndon,* called in the magazine "The Luck of Barry Lyndon, a Romance of the Last Century." His latter career is founded on that of Andrew Robinson Stoney Bowes, who married the widow of John, 9th earl of Strathmore.

Thackeray became a contributor to *Punch* within the first year of its existence. John Leech, who was one of the earliest contributors, had been at Charterhouse with Thackeray and the two men were friends through life He made his first hit with *Jeames's Diary,* begun in November 1845, and may be said to have established his reputation by the *Snob Papers* (1846), now known as *The Book of Snobs. "Punch's Prize Novelists,"* another series which Thackeray contributed to the paper, contain some brilliant parodies of Edward Bulwer-Lytton, Lever, Disraeli and others. Owing to differences in political opinion, his connection with *Punch* ended in 1851 Minor but admirable works of the same period are *Legend of the Rhine* (a burlesque of Dumas's *Othon l'Archer*), in George Cruikshank's *Table Book,* edited by Gilbert À Beckett, *Cox's Diary* (on which has been founded a well-known Dutch comedy, *Janus Tulp*), and *The Fatal Boots. Rebecca and Rowena* towers over every other burlesque of the kind. Its taste, its wit, its pathos, its humour, are unmatchable; and it contains some fine songs of a particular sort In 1846 was published, by Messrs. Bradbury and Evans, the first of twenty-four numbers of *Vanity Fair*, the work which placed Thackeray as a novelist of the first rank It was completed in 1848, when Thackeray was thirty-seven years old The charge of cynicism Thackeray has himself met at the end of the eighth chapter, in a passage which is the best commentary on the author's method.

Another accusation brought against the book was that the colours were laid on too thick, in the sense that the villains were too villainous, the good people too goody-goody, the best answer to that can be found by anyone who chooses to read the work with care Osborne is meant to be a poor enough creature, and one whose poorness of character is developed as he allows bad influences to tell upon his vanity and folly The good in him comes out in the beautiful passage describing his farewell to Amelia on the eve of Waterloo, in which passage may be also found a sufficient answer to the statement that Amelia is insipid and uninteresting. So with the companion picture of Rawdon Crawley's farewell to Becky Sharp: who that reads it can resist sympathy, in spite of Rawdon's vices and shady shifts for a living, with his simple bravery and devotion to his wife? As for Becky, there is certainly not much to be said in her defence We know that she thought she would have found it easy to be good if she had been rich, and we know also what happened when Rawdon surprised her alone with Lord Steyne How "she admired her husband, strong, brave and victorious " This admiration is the capital touch in a scene as powerful as any Thackeray ever wrote. The supreme art in the treatment of the character of the brilliant adventuress that Becky was, makes the reader feel her attractiveness, though he knows her evil qualities.

Vanity Fair was followed by *Pendennis, Esmond* and *The Newcomes,* which appeared respectively in 1850, 1852 and 1854. *Esmond* is perhaps Thackeray's capital work. It is undoubtedly one of the greatest of English historical novels. The insolent beauty Beatrix reappears in the *Virginians* as the jaded, worldly, and not unkindly Baroness.

In 1851 Thackeray had written *The English Humourists of the Eighteenth Century,* delivered as a series of lectures at Willis's Rooms in the same year, and re-delivered in the United States in

1852 and 1853, as was afterwards the series called *The Four Georges*. In 1854 was published that delightful burlesque, *The Rose and the Ring*. In 1857 Thackeray stood unsuccessfully as a parliamentary candidate for Oxford and in the same year appeared the first number of *The Virginians*, a sequel to *Esmond*. The last number came out in 1859, and in the same year Thackeray undertook the editorship of the *Cornhill Magazine*. This was a task which, as readers of his *Roundabout Paper* "Thorns in the Cushion" will remember, the kindliness and sensitiveness of his disposition made irksome to him, and he resigned the editorship in April 1862, though he continued to write for the magazine until he died In the *Cornhill* appeared *Lovel the Widower*, previously written, with different names for some of the personages, in dramatic form, *The Adventures of Philip* (1861–62); the *Roundabout Papers*, some of his best essays, and (1860–63) the story, unhappily never finished, called *Denis Duval* Among the *Roundabout Papers* is one differing in form from the rest, called "The Notch on the Axe—a Story à la Mode," an almost perfect specimen of the author's genius for burlesque story-telling *The Adventures of Philip* is in the nature of a sequel to *A Shabby Genteel Story*, contains scenes which rank with Thackeray's best work, there are fine sketches of journalistic, artistic and diplomatic life, but Philip himself is impossible, the character is not drawn at all *Denis Duval*, which reached only three numbers, promised to be a first-rate work in the *Esmond* manner The author died while it was in progress, on Dec 24, 1863 He was buried in Kensal Green, and a bust by Marochetti was put up to his memory in Westminster Abbey

The grace and the apparent spontaneity of Thackeray's verses are beyond question Some of the more serious efforts, such as "The Chronicle of the Drum" (1841), are full of power and instinct with true poetic feeling Both the half-humorous, half-pathetic ballads and the wholly extravagant ones must be classed with the best work in that kind, and the translations from Béranger are as good as verse translations can be, for Thackeray had the true poetic instinct

The books of reference that can be best commended to the student of Thackeray's life and works are Merivale and Marzials' *Life of Thackeray* (1891), R H Shepherd, *Bibliography of Thackeray* (1880), C P Johnson, *The Early Writings of Thackeray* (1888), Charles Whibley's *Thackeray* (1905), a critical commentary, the edition of Thackeray's Works with biographical introductions (1897–1900), by his daughter, Lady Ritchie, the *Life of Thackeray* ("English Men of Letters Series," 1899) by Anthony Trollope Trollope showed in his own Autobiography far more appreciation of Thackeray's great qualities than is apparent in the Life *Letters of W M Thackeray and Edward Fitz-gerald* (1912), Rt Hon Sir A C Lyall, *Studies in Literature and History* (1915), Trowbridge Hall, *Illustrated Catalogue of 1st Editions* (New York 1921); E B Chancellor, *The London of Thackeray* (1923); Anne Thackeray Ritchie, *Letters, with 42 additional letters of W M. Thackeray* (1924), ed by her daughter, H Ritchie.

THAÏS, a Greek courtesan, who lived during the time of Alexander the Great She accompanied him on his Asiatic campaign, and is chiefly known from the story which represents her as having persuaded the conqueror to set fire to the city of Persepolis This anecdote forms the subject of Dryden's *Ode to Saint Cecilia's Day*. But its authenticity is doubtful, since it is based upon the authority of Cleitarchus, one of the least trustworthy of the historians of Alexander Thaïs subsequently became the wife of Ptolemy Lagus, king of Egypt

See Diod Sic xvii 72; Plutarch, *Alexander*, 38; Athenaeus xiii. 576, 585, Quintus Curtius v. 7.

THALE, a town in the Prussian province of Saxony, situated at the northern foot of the Harz Mountains, 8 m. S W. of Quedlinburg by rail, at the entrance to the gorge of the Bode. Pop. (1923) 13,743 It is largely frequented as a summer resort and for its saline springs It is a manufacturing centre, its chief products being tin wares and tiles, and it has iron foundries, sawmills and lignite mines

THALER, a silver coin formerly circulating in North Germany. When the mark was first introduced in 1871, all other silver coins were withdrawn from circulation, but the thaler was of such outstanding importance that this course proved impossible It was thus enacted that the thaler should remain unlimited legal tender at three marks per thaler This system lasted till 1908.

THALES OF MILETUS (640–546 B C), Greek physical philosopher, son of Examyus and Cleobuline, is said to have been of Phoenician extraction, but was more probably a native Milesian of noble birth Thales was certainly a Greek and not a Phoenician. He was chief of the seven "wise men" of Greece; and in later times amongst the ancients his fame was remarkable This name (σοφός) was given on account of practical ability, and Thales had been occupied with civil affairs The advice which he gave to his fellow-countrymen "before Ionia was ruined"—"that the Ionians should constitute one general council in Teos, as the most central of the twelve cities, and that the remaining cities should nevertheless be governed as independent states" (Herod i. 170) —is noteworthy. The appellation "wise man" was conferred on him not only for his political sagacity, but also for his scientific eminence (Plut *Solon*, c 3)

He became famous by his prediction of the eclipse of the sun of May 28, 585 B C. Herodotus's account of it (i 74) contains two statements —(1) the fact that the eclipse did actually take place during a battle between the Medes and the Lydians, that it was a total eclipse, that it caused a cessation of hostilities and led to a lasting peace between the contending nations; (2) that Thales had foretold the eclipse to the Ionians, and fixed the year in which it actually did take place Various dates—ranging from 625 B C to 583 B C—have been assigned by different chronologists to this eclipse; but, since the investigations of Airy[1], Hind[2], and Zech[3], the date determined by them (May 28, 585 B C) has been generally accepted (for later authorities *see* ECLIPSE and ASTRONOMY) This date agrees nearly with that given by Pliny

Thales's fame amongst the ancients must have been largely due to this achievement Thales seems to have left no works (but *see* Diog Laer. i. 23) Many anecdotes are related of him, from some of which it would appear that he was engaged in trade (Plutarch, *Solon, c.* 2) Of the fact that Thales visited Egypt, and there became acquainted with geometry, there is abundant evidence Hieronymus of Rhodes (ap Diog Laër i 27) says, "he never had any teacher except during the time when he went to Egypt and associated with the priests "[4]

But the important feature of Thales's work was that he founded the geometry of lines, which was essentially abstract in its character. The Egyptian priests only had the geometry of surfaces, a sketch of that of solids, *i e*, a geometry consisting of some simple quadratures and elementary cubatures, obtained empirically Thales introduced *abstract* geometry, the object of which is to establish precise relations between the different parts of a figure, so that some of them could be definitely found by means of others This was a phenomenon quite new in the world

The following discoveries in geometry are attributed to Thales —(1) the circle is bisected by its diameter (Procl *op cit* p 157), (2) the angles at the base of an isosceles triangle are equal (*Id* p. 250); (3) when two straight lines intersect the vertically opposite angles are equal (*Id* p 299); (4) the angle in a semicircle is a right angle[5], (5) the theorem Euclid i 26 (Eudemus, Procl *op cit* p 352) Two applications to practical problems are also attributed to him —(1) the determination of the distance of a ship at sea; (2) the determination of the height of a pyramid by means of the length of its shadow the shadow was measured at the hour of the day when a man's shadow is the same length as himself[6] According to Plutarch (*Sept Sap Conviv* 2), Thales must have known Euclid vi 4, but without the restriction as to the hour of the day Further, we learn that he perfected the

[1] "On the Eclipses of Agathocles, Thales and Xerxes," *Phil Trans* vol cxliii, p. 179 *seq*, 1853.

[2] *Athenaeum*, p 919, 1852

[3] *Astronomische Untersuchungen der wichtigeren Finsternisse*, etc, p. 57, 1853.

[4] *Cf.* Pamphila and the spurious letter from Thales to Pherecydes, ap Diog Laer; Proclus, *In primum Euclidis Elementorum Librum Commentarii*, ed Friedlein, p 65; Pliny, *H N* xxxvi 12; Iamblichus, *In Vit. Pythag* 12; Plutarch, *Sept. Sap Conviv* 2, *De Iside*, 10, and *Plac* i 3, 1

[5] This is unquestionably the meaning of the statement of Pamphila (temp Nero), ap Diog Laër i 24, that he was the first person to describe a right-angled triangle in a circle

[6] Hieronymus of Rhodes (Diog. Laër i. 27) and Pliny (*N H* xxxvi 12).

theory of the scalene triangle and the theory of lines[1]. Proclus in his summary of the history of geometry before Euclid, says that Thales introduced geometry into Greece from Egypt, and communicated the beginnings of many propositions to his successors.

From these indications it is difficult to determine what Thales brought from Egypt and what he himself discovered. This difficulty has, however, been lessened since the translation and publication of the papyrus Rhind by Eisenlohr[2]; and we can deduce certain facts from it [1] Thales must have known the theorem that the sum of the three angles of a triangle are equal to two right angles. This inference is made from theorems (4) and (2). We know from Proclus, on the authority of Eudemus, that Euclid i. 32 was first proved in a general way by the Pythagoreans; but, on the other hand, we learn from Geminus that the ancient geometers discovered the equality to two right angles in each kind of triangle —equilateral isosceles, and scalene (Apoll *Conica*, ed. Halleius, p. 9); and the geometers older than the Pythagoreans can only have been Thales and his school The theorem was probably arrived at by induction, and may have been suggested by the contemplation of floors or walls covered with regular triangular, square or hexagonal tiles. [2] We see also in the theorem (4) the first trace of the conception of geometrical loci, which we, therefore, attribute to Thales. It was in this manner that this remarkable property of the circle, with which, in fact, abstract geometry was inaugurated, presented itself to the imagination of Dante:—

> "O se del mezzo cerchio far si puote
> Triangol si, ch'un retto non avesse"—*Par.* c. xiii. 101.

[3] Thales discovered the theorem that the sides of equiangular triangles are proportional. This theorem was probably made use of also in his determination of the distance of a ship at sea.

Let us now consider the importance of the work of Thales. I. In a scientific point of view: (*a*) by his two theorems he founded the geometry of lines, which has ever since remained the principal part of geometry; (*b*) he may be considered to have laid the foundation of algebra, for his first theorem establishes an equation in the true sense of the word, while the second institutes a proportion[3]. II. In a philosophic point of view; we see that in these two theorems of Thales the first type of a natural law, *i. e.*, the expression of a fixed dependence between different quantities, or, in another form, the disentanglement of constancy in the midst of variety—has decisively arisen[4]. III Lastly, in a practical point of view: Thales furnished the first example of an application of theoretical geometry to practice[5], and laid the foundation of the methods of measurement of heights and distances.

As to the astronomical knowledge of Thales we have the following notices:—(1) besides the prediction of the solar eclipse, Eudemus attributes to him the discovery that the circuit of the sun between the solstices is not always uniform[6]; (2) he called the last day of the month the thirtieth (Diog Laër. i 24); (3) he divided the year into 365 days (*Id.* i. 27), (4) he determined the diameter of the sun to be the 720th part of the zodiac[7]; (5) he remarked on the constellation of the Lesser Bear and instructed his countrymen to steer by it [as nearer the pole] instead of the Great Bear (Callimachus ap Diog Laër i 23, *cf.* Aratus, *Phaenomena*, v. 36 *seq*). Other discoveries in astronomy are attributed to Thales but on doubtful authorities He did not know, for example, that "the earth is spherical," as is erroneously stated by Plutarch (*Placita*, iii. 10); on the contrary, he conceived it to be a flat disk The doctrine of the sphericity of the earth, for which the researches of Anaximander had prepared the way, was in fact one of the great discoveries of Pythagoras, was taught by Parmenides, who was connected with the Pythagoreans, and remained for a long time the exclusive property of the Italian schools. (*See* Schiaparelli, I Precursori de Copernico nell' Antichità, 1873.)

Philosophy.—Whilst in virtue of his political sagacity and intellectual eminence Thales held a place in the traditional list of the wise men, on the strength of the disinterested love of knowledge which appeared in his physical speculations he was accounted as a "philosopher" (φιλόσοφος). Thales's "philosophy" is usually summed up in the dogma "water is the principle, or the element, of things"; but, as the technical terms "principle" (ἀρχή) and "element" (στοιχεῖον) had not yet come into use, it may be conjectured that the phrase "all things are water" (πάντα ὕδωρ ἐστί) more exactly represents his teaching. Writings bearing his name were extant in antiquity; but as Aristotle, when he speaks of Thales's doctrine, always depends upon tradition, the writings were probably forgeries.

From Aristotle we learn (1) that Thales found in water the origin of things; (2) that he conceived the earth to float upon a sea of the elemental fluid; (3) that he supposed all things to be full of gods; (4) that in virtue of the attraction exercised by the magnet he attributed to it a soul. Here our information ends Aristotle's suggestion that Thales was led to his fundamental dogma by observation of the part which moisture plays in the production and the maintenance of life, and Simplicius's, that the impressibility and the binding power of water were perhaps also in his thoughts, are by admission purely conjectural Simplicius's further suggestion that Thales conceived the element to be modified by thinning and thickening is plainly inconsistent with the statement of Theophrastus that the hypothesis in question was peculiar to Anaximenes The assertion preserved by Stobaeus that Thales recognized, together with the material element, "water," "mind," which penetrates it and sets it in motion, is refuted by the precise testimony of Aristotle, who declares that the early physicists did not distinguish the moving cause from the material cause, and that before Hermotimus and Anaxagoras no one postulated a creative intelligence

It would seem, then, that Thales sought amid the variety of things a single material cause; that he found such a cause in one of the forms of matter most familiar to him, namely, water, and accordingly regarded the world and all that it contains as water variously metamorphosed; and that he asked himself no questions about the manner of its transformation

The doctrine of Thales was interpreted and developed by Anaximander, Anaximenes, and Heraclitus. The Eleatic Parmenides (*q v*), noted that, when Thales and his successors attributed to the supposed element changing qualities, they became pluralists; they therefore required that the superficial variety of nature should be strictly distinguished from its fundamental unity Hence, whereas Thales and his successors had confounded the One, the element, and the Many, its modifications, the One and the Not-One or Many became with Parmenides matters for separate investigation In this way two lines of inquiry originated On the one hand Empedocles and Anaxagoras, abandoning the pursuit of the One, gave themselves to the scientific study of the Many; on the other Zeno, abandoning the pursuit of the Many, gave himself to the dialectical study of the One. Both successions were doomed to failure; and the result was a scepticism from which the thought of Greece did not emerge until Plato, returning to Parmenides, declared the study of the One and the Many, jointly regarded, to be the true office of philosophy. Thus, meagre and futile as the doctrine of Thales was, all the Greek schools, with the solitary exception of that of Pythagoras, took their origin from it. Not in name only, but also in fact, Thales, the first of the Ionian physicists, was the founder of the philosophy of Greece.

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[1] Diogenes Laërtius (i. 25).

[2] *Ein mathematisches Handbuch der alten Aegypter* (Leipzig, 1877).

[3] Auguste Comte, *Système de Politique Positive*, iii., pp. 297, 300.

[4] P Laffitte, *Les Grands Types de l'Humanité*, vol ii., p. 292.

[5] *Ibid*, p 294.

[6] Theonis Smyrnaei Platonici *Liber de Astronomia*, ed. Th. H. Martin, p 324 (Paris, 1849). *Cf.* Diog Laër i. 24.

[7] This is the received interpretation of the passage in Diogenes Laërtius, i 24 (*see* Wolf, *Gesch. der Astron.*, p. 169), where σεληναῖον is probably a scribe's error for ζῳδιακοῦ. *Cf* Apuleius, *Florida*, v. 18, who attributes to Thales, then old, the discovery: "quotiens sol magnitudine sua circulum quem permeat metiatur."

of Greek philosophy mentioned *s.v.* PARMENIDES. A. B. Krische, *Forschungen*, pp. 34–42 (Gottingen, 1840). (H. JN.; X.)

THALLIUM, a metallic chemical element, discovered in 1861 by Sir William Crookes, who, during a spectroscopic examination of the flue-dust produced in the roasting of seleniferous pyrites occurring at Tilkerode in the Harz, observed a green line foreign to all then known spectra. He concluded that the mineral contained a new element, to which he gave the name of thallium, from θαλλός, a green twig. Crookes presumed that his thallium was something of the order of sulphur, selenium or tellurium; but Lamy, who anticipated him in isolating the new element, found it to be a metal. (Symbol Tl, atomic number 81, atomic weight 204·3.)

Chemical Character.—The chemical character of thallium presents striking peculiarities. Dumas once called it the "*Ornithorhynchus paradoxus* of metals" As an elementary substance, it is very similar in its physical properties to lead; it resembles lead chemically inasmuch as it forms an almost insoluble chloride and an insoluble iodide. But the hydroxide of thallium, in most of its properties, comes very close to the alkali metals, it is strongly basic, forms an insoluble chloroplatinate (platinichloride), and an alum strikingly similar to the corresponding potassium compounds. Yet, unlike potassium or lead, it forms a feebly basic sesquioxide similar to manganic oxide, Mn_2O_3

Traces of thallium exist in many kinds of pyrites, as used for vitriol-making The only known mineral of which it forms an essential component is the rare mineral crookesite of Skrikerum, Sweden, which, according to Nordenskiöld, contains 33·3% of selenium, 45·8% of copper, 3 7% of silver, and 17 2% of thallium. The best raw materials for the preparation of thallium are the flue-dusts produced industrially in the roasting of thalliferous pyrites and the "chamber muds" accumulating in vitriol-chambers worked with such pyrites, in both it is frequently associated with selenium The flue-dusts may contain 0·5–3·5% of thallium, but usually do not exceed the lower value

For the extraction of the metal from chamber mud, the latter is boiled with water, which extracts thallium as sulphate From the filtered solution the thallium is precipitated as chloride by addition of hydrochloric acid, along with more or less of lead chloride The mixed chlorides are boiled down to dryness with sulphuric acid to convert them into sulphates, which are then separated by boiling water, which dissolves only the thallium salt. From the filtered solution the thallium is recovered, as such, by pure metallic zinc, or by electrolysis The (approximately pure) metallic sponge obtained is washed, made compact by compression, fused in a porcelain crucible in an atmosphere of hydrogen, and cast into sticks.

Metallic Thallium.—Metallic thallium is bluish white; it is extremely soft and almost devoid of tenacity and elasticity. Its specific gravity is 11·86 It fuses at 302° C; at about 1,300° it boils and can be distilled in hydrogen gas. Its vapour density corresponds to monatomic molecules Its salts colour the Bunsen flame a bright green. When heated in air it is readily oxidized, with the formation of a reddish or violet vapour. When exposed to the air it becomes quickly covered with a film of oxide; the tarnished metal when plunged into water reassumes its metallic lustre, the oxide film being quickly dissolved. When kept in contact with water and air it is gradually converted into hydroxide, TlOH It decomposes water at a red heat, liberating hydrogen and being itself converted into the hydroxide. It is readily soluble in nitric and sulphuric acids, but less so in hydrochloric. It does not combine with hydrogen, but unites directly with the halogens.

Salts.—Thallium forms two series of salts: thallous, in which the metal is univalent; and thallic, in which it is trivalent The thallic salts are, however, much less stable than the thallous. In the thallous series many analogies with lead compounds are observed; in the thallic some resemblance to aluminium and gold.

Thallous hydroxide, TlOH, is most conveniently prepared by decomposing the solution of the sulphate with baryta water. It crystallizes from its solution in long yellow needles, TlOH or $TlOH+H_2O$, which dissolve readily in water, forming an intensely alkaline solution, which acts as a caustic and greedily absorbs carbonic acid from the atmosphere. Unlike the alkalis, it readily loses its water at 100° C and even at the ordinary temperature, to form the oxide Tl_2O, which is black or black-violet *Thallic oxide,* Tl_2O_3, is formed when the metal is heated in air or oxygen at 500–700°, by the action of hydrogen peroxide upon alkaline solutions of thallous salts, or by heating thallous nitrate. It decomposes into thallous oxide and oxygen above 800° The corresponding hydroxide, TlO·OH, is very unstable. A thallothallic oxide, $Tl_2O{\cdot}Tl_2O_3$ or TlO, is also known

Thallous chloride, TlCl, is readily obtained from the solution of any thallous salt, by the addition of hydrochloric acid, as a white precipitate similar in appearance to silver chloride, like which it turns violet in the light and fuses below redness into a (yellow) liquid which freezes into a horn-like flexible mass. It is also formed when the metal is burnt in chlorine. One part of the precipitated chloride dissolves at 0° C in 500 parts of water, and in 40 parts at 100° C. It is less soluble in dilute hydrochloric acid. *Thallous iodide,* TlI, similarly obtained as a yellow precipitate, requires 16,000 parts of cold water for its solution. The yellow crystals melt at 190°, and when cooled assume a red colour, which changes to the original yellow on standing *Thallous bromide,* TlBr, is a light yellow crystalline powder; it is formed analogously to the chloride. *Thallous perchlorate,* $TlClO_4$, and *periodate,* $TlIO_4$, are interesting inasmuch as they, together with several other thallous salts, are isomorphous with the corresponding potassium salts

Thallous carbonate, Tl_2CO_3, more nearly resembles the lithium compound than any other ordinary carbonate It is produced by the exposure of thallous hydrate to carbon dioxide, and therefore is obtained when the moist metal is exposed to the air It forms resplendent monoclinic prisms, soluble in water, The bicarbonate is not known.

Thallous sulphate, Tl_2SO_4, forms rhombic prisms soluble in water, which melt at a red heat with decomposition, sulphur dioxide being evolved It unites with aluminium, chromium and iron sulphates to form "alums" (*q v*) It also forms double salts of the type $Tl_2SO_4(Mg, Fe\ or\ Zn)SO_4\,6H_2O$. *Thallous sulphide,* Tl_2S, is obtained as a black precipitate by passing sulphuretted hydrogen into a thallous solution. It is insoluble in water and in the alkalis, but readily dissolves in the mineral acids.

Thallous nitrate, $TlNO_3$, is obtained as white, rhombic prisms by crystallizing a solution of the metal, oxide, carbonate, etc., in nitric acid Various thallous phosphates are known, *e.g,* $Tl_2HPO_4{\cdot}H_2O$, TlH_2PO_4, Tl_3PO_4, $Tl_4P_2O_7$, etc, they bear a close resemblance to the corresponding phosphates of the alkali metals

Thallic chloride, $TlCl_3$, is obtained by heating the monochloride with chlorine under pressure, or by saturating a suspension of the monochloride in water with chlorine, when anhydrous it is a crystalline mass which melts at 24°. It forms several double salts, *e g,* with hydrochloric acid and the alkaline chlorides. The chlorine is not completely precipitated by silver nitrate in nitric acid solution, the ionization apparently not proceeding to all the chlorine atoms. The mixed chlorides $TlCl{\cdot}TlCl_3$ and $3TlCl{\cdot}TlCl_3$ are also produced by the regulated action of chlorine on the monochloride. *Thallic iodide,* TlI_3, is interesting on account of its isomorphism with rubidium and caesium tri-iodides, a resemblance which suggests the formula $TlI(I_2)$ for the salt, but T. M Lowry and A. J Berry (1928) have shown that it does not give the reactions of a thallous salt, and, when dissolved in methyl alcohol, it behaves as a binary electrolyte, *i e,* as $(TlI_2)I$ or as $Tl[TlI_6]$. *Thallic sulphate,* $Tl_2(SO_4)_3{\cdot}7H_2O(?)$, and *thallic nitrate,* $Tl(NO_3)_3{\cdot}3H_2O$, are obtained as colourless crystals on the evaporation of a solution of the oxide in the corresponding acid The sulphate decomposes into sulphuric acid and the trioxide on warming with water, and differs from aluminium sulphate in not forming alums.

Thallium salts are used in the manufacture of certain optical glasses on account of the high refractive index conferred on the glass. They are all poisonous, having an action somewhat resembling that of lead salts, and are said to have a pronounced depilatory action, but this has also been denied.

Thallous acetylacetone, $C_5H_7O_2Tl$, prepared from an alcoholic solution of acetylacetone and the hydroxide, is of interest On the application of thallium compounds to organic syntheses, *see* R C. Menzies, *J Chem. Soc*, 1924, *et seq.*

Analysis.—All thallium compounds volatile or liable to dissociation at the temperature of the flame of a Bunsen lamp impart to such flame an intense green colour. The spectrum contains a bright green of wave-length 5.351. From solutions containing it as thallous salt the metal is easily precipitated as chloride, iodide, or chloroplatinate by the corresponding reagents Sulphuretted hydrogen, in the presence of free mineral acid, gives no precipitate, sulphide of ammonium, from neutral solutions, precipitates Tl_2S as a dark brown or black precipitate, insoluble in excess of reagent. Thallic salts are easily reduced to thallous by means of solution of sulphurous acid, and thus rendered amenable to the above reactions Thallous chloride can be titrated by potassium iodate in moderately concentrated hydrochloric acid solution.

THALWEG, a land-form term adopted into general usage for the continuous line drawn through the lowest points of a river's valley from its source to its mouth The concave curve thus drawn shows the natural direction of a watercourse.

THAMES, the chief river of England, rising in several small streams among the Cotswold Hills in Gloucestershire Its source is generally held to be at Thames Head, in the parish of Coates, 3 m west of Cirencester, but claims have also been advanced on behalf of the Seven Springs, the head waters of the river Churn, 5 m. south of Cheltenham The length of the river from Thames Head Bridge to London Bridge is 161¼ m and from London Bridge to the Nore, 47¾ m, a total of 209 m. The width at Oxford is about 150 ft, at Teddington 250 ft, at London Bridge 750 ft, at Gravesend 2,100 ft, and between Sheerness and Shoeburyness, immediately above the Nore, 5½ m The height of Thames Head above sea-level is 356 ft, Seven Springs 700 ft., and Lechlade 237 ft. and the average fall below Lechlade is 20 in per mile The Thames forms the boundary between the following counties along its course. Gloucestershire and Wiltshire, Gloucestershire and Berkshire, Oxfordshire and Berkshire, Buckinghamshire and Berkshire, Middlesex and Surrey, and finally, at its estuary, Essex and Kent In the succeeding paragraph the bracketed figures indicate the distance in miles above London Bridge.

The upper course lies through a broad valley. The scenery is rural and pleasant, the course of the river winding. Before reaching Oxford the stream swings north, east and south to encircle the wooded hills of Wytham and Cumnor, which overlook the city from the west The Windrush joins from the north (left) at New Bridge (126¾), the Evenlode near Eynsham (119), and the Cherwell at Oxford (112). Between Lechlade and Oxford the main channel sends off many narrow branches; the waters of the Windrush are similarly distributed, and the branches in the neighbourhood of Oxford form the picturesque "backwaters" The river then passes the pleasant woods of Nuneham, and at Abingdon (103½) receives the Ock from the Vale of White Horse, at Dorchester (95¼) the Thame (left), and it then passes Wallingford (90¾) and Goring (85) The river now bends eastward, and breaches the chalk hills, dividing the Chilterns from the downs of Berkshire From this point as far as Taplow the southern slopes of the Chilterns descend closely upon the river, they are finely wooded, and the scenery is peculiarly beautiful At Pangbourne (80¾) the Thames receives the Pang (right), and at Reading (74½) the Kennet (right) After passing Reading it bends northward to Henley (65), eastwards past Great Marlow (57) to Bourne End (54), and southwards to Taplow and Maidenhead (49¾), receiving the Loddon (right) near Shiplake above Henley Winding in a south-easterly direction, it passes Eton and Windsor (43½), Datchet (41½), Staines (36), Chertsey (32), Shepperton (30) and Sunbury (26½), receiving the Coln (left) at Staines, and the Wey (right) near Shepperton. Flowing past Hampton Court, opposite to which it receives the Mole (right), and past Kingston (20½), it reaches Teddington (18¾). Passing Richmond (16) and Kew the river flows through London and its suburbs for a distance of about 25 m, till it has passed Woolwich. Gravesend, the principal town below Woolwich, is 26½ m. from London Bridge. The estuary may be taken to extend to the North Foreland of Kent. In the tideway the principal affluents of the Thames are the Brent at Brentford, the Wandle at Wandsworth, the Ravensbourne at Deptford, the Lea at Blackwall, the Darent just below Erith, and the Ingrebourne at Rainham, besides the Medway.

The basin of the Thames is of a composite character. Thus, the upper portion of the system, above the gap at Goring, is a basin in itself, defined on the west and south by the Cotswold and White Horse Hills and on the east and north by the Chilterns and the uplands of Northamptonshire. But there are several points at which its division from other river basins is only marked by a very low parting Thus a well-marked depression in the Cotswolds brings the head of the (Gloucestershire) Coln, one of the head-streams of the Thames, very close to that of the Isborne, a tributary of the upper Avon; the parting between the head-streams of the Thames and the Bristol Avon sinks at one point, near Malmesbury, below 300 ft.; and head-streams of the Great Ouse rise little more than two miles from, and only some 300 ft above, the middle valley of the Cherwell The White Horse Hills and the Chilterns strike right across the Thames basin, but almost their entire drainage from either flank lies within it, and similarly a great part of the low-lying Weald, though marked off from the rest of the basin by the North Downs, drains into it through these hills Further, the Kennet continues upward the line of the main valley below the Goring gap, and the Cherwell that of the main valley above it The basin thus presents interesting problems The existence of wide valleys where the small upper waters of the Cherwell, Evanlode and Coln now flow, the occurrence of waterborne deposits in their beds from the north-west of England and from Wales, and the fact that the Thames, like its lower southern tributaries which pierce the North Downs, has been able to maintain a deep valley through the chalk elevation at Goring, are considered to point to the former existence of a much larger river, in the system of which were included the upper waters of the present Severn, Dee and other rivers of the west The question, in fact, involves that of the development of a large part of the hydrography of England

Tamesis and Isis.—The Thames about Oxford is often called the Isis. Caesar (*De Bell. Gall.* v. 11) says that at the time of his invasion of Britain it was called Tamesis In the first statute passed for improving the navigation of the river near Oxford (21 Jac I) it is called the river of Thames, and it was only in a statute of George II. (1751) that the word Isis appears The flow of the Thames varies greatly, according to the season of the year In very dry summers the flow at Teddington has been known to fall as low as 200,000,000 gal per day and as high as 20,000,000,000 gal. in a rainy season Flooding of the surrounding country is not uncommon, and it becomes a serious menace to the low-lying parts of London, where the river is tidal, when flooding coincides with high spring tides. The importance of storage reservoirs is manifest under such conditions of flow, especially bearing in mind the ever increasing needs of the London district The water-supply of London is considered under that heading; it may be noted here that the Thames forms its chief source of supply, but apart from this the corporation of Oxford and two companies in the Staines district have powers to draw water from the river

Throughout the whole of the Thames watershed, and especially in the 3,800 sq m above the intakes of the water companies (at Hampton or in the vicinity), the Thames Conservancy has enforced the requirements of parliament that no sewage or other pollution shall be allowed to pass into the Thames, or any water communicating with it. The Thames is navigable for rowing-boats as far upwards as Cricklade and for barges as far as Lechlade At Inglesham, three-quarters of a mile above Lechlade, the Thames and Severn canal has its junction with the Thames. Barges drawing 3 ft 6 in can now, even in the summer season, navigate from London to Inglesham.

Construction of Locks.—In 1771 an act of parliament was passed authorizing the construction of pound locks on the Thames above Maidenhead Bridge. In pursuance of the powers thus granted, the Thames Commissioners of that day caused locks

to be built at various points above Maidenhead, and between 1810 and 1815 the Corporation of London carried out river works on the same lines as far down the river as Teddington. The works as subsequently maintained by the Thames Conservancy ensure an efficient head of water during the drier seasons of the year, and facilitate the escape of winter floods. The number of locks is 47, including four navigation weirs above Oxford The uppermost lock is St John's, below Lechlade, the lowest is Richmond

The canals in use communicating with the Thames, are the Thames and Severn canal, the Oxford canal, the Kennet and Avon canal from Reading to the Bristol Avon, the Grand Junction at Brentford, the Regent's canal at Limehouse, and the Grand Surrey canal at Rotherhithe. A short canal connects Gravesend with Higham Navigation is also carried on by the Medway to Tonbridge, on the lower parts of the Darent, Cray and Wey. The Woking, Aldershot and Basingstoke canal joins the Wey, but is little used The Wilts and Berks canal, joining the Thames at Abingdon, is disused By means of the Grand Junction and Oxford canals especially, constant communication is maintained between the Thames and the great industrial centres of England The trade on the upper Thames is steady, though not extensive The vast trade on the estuary, which lies within the bounds of the port of London, as well as the bridges over the river in the London area, is considered under LONDON The utility of the river is great in the opportunities for exercise and recreation which it affords to the public, especially to Londoners Rowing boats, sailing boats and motor boats ply its waters There are fixed prices for the passage of the locks During the season regattas take place, of which the Henley Royal Regatta is pre-eminent The Oxford and Cambridge boat-race from Putney to Mortlake on the tideway, the summer eights and the "torpids" at Oxford University, and the school races at Eton and Radley should also be mentioned

In 1857 the Thames Conservancy Board was established Its powers were increased and its constitution varied in 1864, 1866 and 1894, but the creation of the Port of London Authority (*see* LONDON) limited its jurisdiction Fish are abundant, especially coarse fish such as pike, perch, roach, dace and barbel Of trout there are many fine specimens, especially at the weirs The right of the public to take fish freely from the river has been frequently under dispute and to-day fisheries are under the regulation of by-laws made by the Thames Conservancy, which apply to the riparian owners as well as to the public generally These by-laws are carried into effect by officers of the conservators, assisted by the river-keepers of the various fishing associations The principal associations are those at Oxford, Reading, Henley, Maidenhead and Windsor, and the Thames Angling Preservation Society, whose district is from Staines to Brentford

THANA, a town and district in British India, in the Northern division of Bombay The town is on the west of the Salsette creek or Thana river, just where the Great Indian Peninsula railway crosses to the mainland, 21 m from Bombay city, of which it is now practically a suburb Pop (1921) 22,639.

The DISTRICT OF THANA has an area of 3,434 sq m It extends along the coast and is confined between the Western Ghats on the east and the sea on the west, while on the north it is bounded by the Portuguese territory of Damaun and by Surat district, and on the south by Bombay suburban district The district is well watered and wooded, and, except in the north-east, is a low-lying rice tract broken by hills. Most of the hills were once fortified, but the forts built on them are now dilapidated and useless The only rivers of any importance are the Vaitarna and the Ulhas, the former being navigable for a distance of about 20 m from its mouth; the latter is also navigable in parts for small craft There are no lakes; but the Vehar and the Tulsi, formed artificially, supply Bombay city with water. In 1921 the population was 759,916. The staple crop is rice. Fishing supports many of the people, and the forests yield timber and other produce. Salt is manufactured by evaporation along the coast

The territory comprised in the district of Thana (apart from Salsette island, which was acquired in 1782) formed part of the dominions of the peshwa, and was annexed by the British in 1818 on the overthrow of Baji Rao.

THANESAR, an ancient town of British India, in Karnal district of the Punjab, on the river Saraswati. pop (1921) 4,226 As the centre of the tract called Kurukshetra in the Mahabharata it has always been a holy place. The bathing-fair held here on the occasion of a solar eclipse is said to be attended by half a million pilgrims

THANET, ISLE OF, the extreme north-eastern corner of Kent, England, insulated by the two branches of the river Stour, and forming one of the eight parliamentary divisions of the county Pop (1921) 112,597 Its name is said to be derived from Saxon *tene,* a beacon or fire (probably from the number of watch-fires existing on this easily ravaged coast), and numerous remains of Saxon occupation have been found, as at Osengal near Ramsgate. Thanet is roughly oblong in form. its extreme measurements being about 8 m from E to W., and 5 m from N to S The branches of the Stour dividing near Sarre take the place of the former Wantsume, a sea-passage which had diminished in breadth to half a mile in the time of Augustine The Wantsume was guarded by the Roman strongholds of *Regulbium* (Reculver) in the north and *Rutupiae* (Richborough) in the south, and was crossed by ferries at Sarre and Wade With the drying up of this channel and the closing of Sandwich harbour in the 16th century, the present marshlands or level to the south and west of the isle were left The sea-face of Thanet consists mainly of bold slopes or sheer cliffs, and the eastern extremity is the fine chalk headland of the North Foreland with a lighthouse Containing the popular seaside resorts of Ramsgate, Broadstairs, Margate and Westgate, Thanet is served by the S R , and Minster is a junction station of the lines to Ramsgate and Sandwich respectively

THANKSGIVING DAY, in the United States, the last Thursday in November, annually set apart for thanksgiving by proclamation of the president and of the governors of the various States The day is observed with religious services in the churches, and, especially in New England, as an occasion for family reunion The Pilgrims set apart a day for thanksgiving at Plymouth immediately after their first harvest, in 1621; the Massachusetts Bay Colony for the first time in 1630, and frequently thereafter until about 1680, when it became an annual festival in that colony, and Connecticut as early as 1639 and annually after 1647, except in 1675 The Dutch in New Netherland appointed a day for giving thanks in 1644 and occasionally thereafter During the Revolutionary War the Continental Congress appointed one or more thanksgiving days each year, except in 1777 President Washington appointed a day of thanksgiving (Thursday, Nov 26) in 1789, and appointed another in 1795 President Madison, in response to resolutions of Congress set apart a day for thanksgiving at the close of the War of 1812 By 1858 proclamations appointing a day of thanksgiving were issued by the governors of 25 States and 2 Territories President Lincoln appointed the last Thursday of Nov 1864, and each president has followed his example

See F B Hough, *Proclamations for Thanksgiving* (Albany, 1858), W. D Love, *The Fast and Thanksgiving Days of New England* (1895), E H Hughes, *Thanksgiving Sermons* (1924); A G Lloyd, *Thanksgiving School Programs* (1927), Van Buren and Bemis, *Thanksgiving Day in Modern History* (1928), L C Van Derveer, *Thanksgiving Plays and Ways* (1927)

THANN, a town of France, capital of an arrondissement in the department of Haut-Rhin, on the Thur, 16 m by rail N W of Mulhouse Pop. (1926) 6,376 In the course of the World War Thann was taken by the French in 1914, and was bombarded from time to time The fine Gothic church of St Theobald (1351) escaped serious injury, it has a tower (1450–1516) with a beautiful spire Above the town are the ruins of the castle of Engelburg, destroyed by Turenne in 1675 Thann is the seat of a subprefect It has a stone quarry, metal-foundries and manufactories of chemical products, machinery and textiles

THAPSACUS (Tiphsah, modern Kalat Dibse, also called for a short time Amphipolis), formerly an important crossing place on the Euphrates (*q.v.*), about 8 miles below Meskene in 36° N. 38° E. The city seems to have stood on the right bank and on the direct line to Syria. It was used as a centre from which to measure distances by Eratosthenes The earlier crossing place

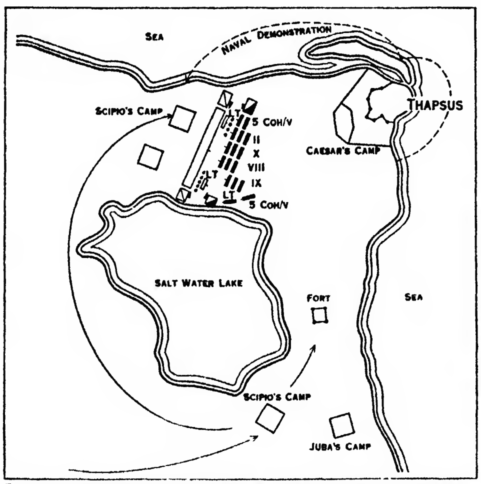
seems to have been higher up the river, but Xenophon, who reports that it was a large prosperous city, forded his army here, and by the time of Alexander there was a bridge of boats.

THAPSUS, a low peninsula, now known as Magnisi, joined by a narrow isthmus to the mainland of Sicily, about 7 m. N N.W of Syracuse. The Athenians used it as a naval station in their attack on Syracuse early in 414 B C A number of tombs contained objects belonging to a transitional stage between the second and third Sicel period, attributable roughly to 1000–900 B C, with a proportion of Mycenean importations

See Orsi in *Monumenti dei Lincei* (1897), vi 89–150

THAPSUS, BATTLE OF (47 B C) After his victory at Pharsalus Julius Caesar followed Pompey to Egypt, where the Pompeians accumulated a large army and were joined by Juba, king of Numidia A battle was fought at Ruspina in which Caesar was almost overwhelmed, after which he moved to Veita and besieged it, withdrew on account of lack of supplies, and, in order to compel Scipio to battle, marched on Thapsus, an ancient city of North Africa in the province of Byzacium (the modern province of Tunis), on the coast more than 100 m north of Carthage Thapsus contained large military stores, was strongly garrisoned and blockaded by Caesar's fleet On Feb. 4, 47 B C. he arrived before the city, and immediately besieged it This drove Scipio into action, for he at once advanced on Thapsus and threw up two entrenched camps, one for his own men and the other for Juba's eight miles south of the city

The manoeuvres which now followed were controlled by a salt water lake, the modern Sebka di Moknine, which lies to the south-west of Thapsus Caesar had entirely surrounded the town, but Scipio considered that it was still possible to relieve it from the south. Caesar had foreseen the likelihood of this move, and had built a strong fort in the centre of the strip of land which separates the eastern margin of the lake from the sea When Scipio ad-



PLAN OF THE BATTLE OF THAPSUS, FEB 47 B C, WHEN JULIUS CAESAR ANNIHILATED THE FORCES OF SCIPIO, FATHER-IN-LAW OF POMPEY THE GREAT

vanced he struck this fort, and being unable to take it turned back and decided to march round the lake and force the northern approach to the city This he did, and constructed two camps north of the lake Though Caesar would have preferred to defer battle until he had taken Thapsus, he now determined to attack Scipio before he had finished his entrenchments. Leaving Asprenas, the pro-consul and two legions to carry on the siege, with the rest of his force he marched against Scipio One half of his fleet he left to continue the blockade, and the other he ordered to sail down the coast, and make a demonstration against Scipio's rear Placing his left on the coast, Scipio drew up his army in three lines with his elephants and light troops in front of his right and left wings, his Numidian cavalry on the left, and the rest of his cavalry and light troops on the right. Advancing on him, Caesar also extended his army into three lines with the II. and X. legions on the right, the VIII and IX. on the left, and five legions in the centre His flanks he covered by five chosen cohorts supported by archers, slingers and cavalry.

As Scipio's camp was but half dug, Caesar's men wished to advance at once Caesar, however, was not over anxious to precipitate the battle because he was largely outnumbered by the Numidian cavalry Whilst he hesitated, the X. legion suddenly sounded the charge which was repeated all down the line. The archers and slingers soon overwhelmed Scipio's elephants with their arrows and stones, driving them back on their own line, where they not only demoralized the infantry but scattered the left wing horse The infantry lines then clinched, fighting each other until sunset, when Scipio's right wing became demoralized This affected the centre, and soon the entire line broke and sought refuge in the half-completed camp, which was speedily captured by a double envelopment of Caesar's wings. Scipio's force was annihilated in an awful slaughter of which Mommsen writes "If the hydra with which they fought always put forth new energies, if the army was hurried from Italy to Spain, from Spain to Macedonia, from Macedonia to Africa, and if the repose ever more eagerly longed for never came, the soldier sought, and not wholly without cause, the reason of this state of things in the unseasonable clemency of Caesar." Fifty thousand corpses were strewn over the battlefield of Thapsus, and among them were several Caesarian officers known as opponents to the new monarchy

In this battle neither strategy nor tactics are remarkable, but what is so is the insubordination of the men, and their growing sense of mastership in the new order which Caesar was creating He wished to found an Empire, and aimed at a complete victory, constantly taking tremendous risks and ignoring the units The soldiers wanted peace, so that they could return to their homes and families At Thapsus a battle was begun between the will of Caesar and the desires of his men, it was slow and progressive, and did not end until Alaric had sacked Rome *See* PHARSALUS. (bibl)

(J F. C F)

THAR AND PARKAR, a district of British India in the Sind province of Bombay Area, 13,636 sq m. Pop. (1921) 396,331 The district is divided into two portions The western part, called the "Pat," is watered by the Eastern Nara canals and the Jamras canal, which constitute the water-systems of the district, and the presence of water has created a quantity of jungle and marsh, the other part, called the "Thar," is a desert tract of rolling sand-hills, running north-east and south-west, composed of a fine but slightly coherent sand To the south-east of Thar is Parkar, where there are ranges of rocky hills, rising to 350 ft above the surrounding level, and open plains of stiff clay This portion contains the ruins of several old temples The principal crops are millets, rice, wheat, oil-seeds and cotton Mirpur Khas (*q v.*) is the administrative headquarters of the district The town lies on the Jodhpur-Bikanes metre-gauge line which connects it with Hyderabad and Rajputana A feeder line runs north from Mirpur Khas to Khadro, and another south to Jhudo. (*See* also INDIAN DESERT.)

THARAUD, JEROME (1874–), French man of letters, was born on March 18, 1874, at Saint-Junien, Haute Vienne, and educated at the collège Sainte-Barbe and the *Ecole normale supérieure* He became a lecturer at the University of Budapest In collaboration with his brother Jean (1877–), he gained the prix Goncourt in 1908, and the *grand prix de littérature* at the French Academy in 1920 The brothers are joint authors (J.-J. Tharaud) of all their works. They excel in the art of story-telling

Their works include, *Dingley, l'illustre écrivain* (1902); *Bar-Cochebas* (1907); *La Maîtresse Servante* (1910); *La Bataille à Scutari d'Albanie* (6th ed., 1913); *La Tragédie de Ravaillac* (1913); *La Vie et la Mort de Déroulède* (1914); *L'Ombre de la Croix* (1917); *Un Royaume de Dieu* (1920); *Quand Israël est roi* (1921); *Rendezvous espagnols* (1925); *La Rose de Saron* (1927) *See* J Bonnerot, *Jérôme*

et Jean Tharaud, leur oeuvre (1927).

THARGELIA. A Greek festival bearing signs of very high antiquity; in historical times part of the cult of Apollo, but quite possibly, indeed probably, older than its arrival in Greece. The name is derived from *θάργηλος*, which signifies an offering of some sort (exact nature and etymology quite uncertain) used at the festival. In Attica, it was held on the 6th and 7th of the month Thargelion, to which it gave its name, the latter date (towards the end of May) was supposed to be Apollo's birthday. On the 6th, certainly at Athens and probably elsewhere, two persons known as *pharmakoi* (magical people, "medicine-men"), who had been chosen for their ugliness, were beaten with plants of a magically purifying value, including squills, being thus filled with good magic, they were led through the city, presents of food being made to them. In classical times they seem to have been regarded chiefly as scapegoats, and some pretence was made of stoning or burning them to death; it is, however, fairly clear that this was not their only significance In Attica they were called *σύβακχοι*; their connection with Apollo is simply that he is the great god of purifications. They occur elsewhere in Ionian ritual

On the 7th, sundry holy things, very likely including an *εἰρεσιώνα* (*see* PYANOPSIA), were carried in procession, and an important musical festival with prizes for the best chorus, was held in honour of Apollo, this is the only rite which we can definitely say is Apolline, and not taken over from some still earlier ceremony It is noteworthy that on the 6th an offering of a ram was made to *Demeter Chloe.* The principal part of the festival was therefore agricultural; as already suggested, Apollo perhaps took it over because it was in part purificatory; it certainly has no intimate relation to his worship.

BIBLIOGRAPHY—*See* A. Mommsen, *Feste der Stadt Athen,* p. 468 *et seq.* (1898); M P. Nilsson, *Griechische Feste,* p. 105 (1906); L. R. Farnell, *Cults of the Greek States,* vol iv. p 267 *et seq.* (1907). For the pharmakoi *see* V Gebhard, *Die Pharmakoi in Ionien und die Sybakchoi in Athen* (Amberg, 1926; bibl)

THARRAWADDY, a town and district in the Pegu division of Burma. The town has a station on the railway, 68 m N W from Rangoon Pop. (1921), 3,625 The district has an area of 2,863 sq m The Pegu Yoma range separates it from Toungoo district, and forms the water-parting between the rivers Irrawaddy and Sittang; there are also many small elevations The Irrawaddy is the principal navigable river Teak forests and fuel reserves, cover more than a quarter of the whole area Among the wild animals found in the mountains are elephant, bison and various kinds of feathered game. The rainfall ranges from about 60 to 90 inches. Pop (1921), 492,429, showing an increase of 59,109 in the decade The railway runs through the centre of the district, with ten stations The chief towns are Letpadan (9,901), Gyobingauk (7,666), Zigôn (6,916); Thonzè (6,594); Nattalin (4,898) and Minhla (3,829) The staple crop is rice. The history of the district is identical with that of Henzada (*q.v.*). Tharrawaddy was formed in 1878 out of that portion of Henzada lying east of the Irrawaddy.

THARROS, an ancient town of Sardinia, situated on the west coast, on the narrow sandy isthmus of a peninsula at the north extremity of the Gulf of Oristano, now marked by the tower of S. Giovanni di Sinis. It was 12 m W of Othoca (Oristano) by the coast road, which went on northward to Cornus, and thence to Turris Libisonis. It was of Phoenician origin, but continued to exist in Roman times. It was destroyed by the Saracens in the 11th century. In the necropolis to the south of Tharros many Phoenician tombs have been excavated; they are rectangular or square chambers cut in the rock, measuring from 6 to 9 ft each way Some 3 m to the north is the church of S. Salvatore, with underground rock-cut chambers below it with walls decorated with pre-Christian paintings.

THASOS, an island in the north of the Aegean Sea, off the coast of Thrace and the plain of the river Nestus (Turk. *Kara-Su*). Herodotus (ii. 44. vi. 44–8.) tells of an early Phoenician settlement, of gold mines, and of a temple of Heracles: Thasus, son of Phoenix, gave his name to the island. In 720 or 708 B.C. Thasos received a Greek colony from Paros In a war between the Parian colonists and the Saians, a Thracian tribe, the poet Archilochus threw away his shield. The Greeks owned gold mines also on the mainland From these sources the Thasians drew annual revenues of 200 or even 300 talents. After the capture of Miletus (494 B.C.) Histiaeus, the Ionian leader, laid siege to Thasos The attack failed, but the Thasians built war ships and strengthened their fortifications This excited the suspicions of the Persians, and Darius compelled them to disarm After the defeat of Xerxes they joined the Delian confederacy, but, on account of a difference about the mines and marts on the mainland, they revolted. The Athenians, after a siege of two years, compelled the Thasians in 463 to destroy their walls, surrender their ships, pay an indemnity and an annual contribution (in 449 this was 2½ talents, from 445 about 30 talents), and resign their mainland possessions In 411 B C, during the oligarchical revolution at Athens, Thasos again revolted and received a Lacedaemonian governor, but in 407 the partisans of Lacedaemon were expelled, and the Athenians under Thrasybulus were admitted After the battle of Aegospotami (405 B C), Thasos again fell into the hands of the Lacedaemonians under Lysander who formed a decarchy there, but the Athenians must have recovered it, for it formed one of the subjects of dispute between them and Philip II of Macedonia In the dispute between Philip V and the Romans, Thasos submitted to Philip, but received its freedom after Cynoscephalae (197 B C). After a period of Latin occupation in the 13th century it was captured by the Turks in 1462; it was given by the Sultan Mahmud II to Mehemet Ali (*see* MOHAMMED ALI) of Egypt, and remains the property of the Khedive The capital stood on the N coast, and had two harbours The highest mountain, Ipsario, is 3,428 ft high. Besides its gold, the wine, nuts and marble of Thasos were well known.

The population, 8,000, is distributed in ten villages, mostly at some distance from the sea: for the island suffered from pirates The people are Greek Christians, and do not differ in appearance from the inhabitants of the other Greek islands

For a description of the island and its remains of antiquity, *see* A. Conze, *Reise auf den Inseln des thrakischen Meeres* (Hanover, 1860), for inscriptions *see Inscr Gr* xii 8, the island is fully described by J. ff. Baker-Penoyre in *Journal Hell. Stud.* xxix. (1909).

THATÔN, a town and district in the Tenasserim division of Burma The town is situated below a hill range, 10 m from the sea It was formerly the capital of the Talaing kingdom and a sea-port Pop. (1921), 15,091. The district has an area of 4,831 sq m.; pop (1921) 471,100 The railway from Pegu to Martaban passes through this district Another urban centre in the district is Kyaikto (7,168 in 1921).

THAXTER, ROLAND (1858–), American botanist, was born in Newton, Mass, on Aug 28, 1858, the son of Levi Lincoln Thaxter and Celia Laighton Thaxter (*q v*). He graduated in 1882 from Harvard university, from which he received the degree of doctor of philosophy in 1888. He served as assistant in biology at Harvard from 1886 to 1888, and from 1888 to 1897 as mycologist at the Connecticut agricultural experimental station He was assistant professor of cryptogamic botany at Harvard from 1891 to 1901 and professor from 1901 until 1919, when he became professor emeritus In 1907 he was appointed American editor of the English publication *Annals of Botany* In 1909 he served as president of the Botanical Society of America, and in 1912 was elected member of the National Academy of Sciences

THAYER, ABBOTT HANDERSON (1849–1921), American artist, was born at Boston, Mass., Aug. 12, 1849. He was a pupil of J L. Gérôme at the École des Beaux Arts, Paris, and became a member of the Society of American Artists (1879), of the National Academy of Design (1901), and of the Royal Academy of San Luca, Rome. As a painter of portraits, landscapes, animals and the ideal figure, he won high rank among American artists

Thayer is also well known as a naturalist. He developed a theory of "protective coloration" in animals (*see* COLOURS OF ANIMALS), which has attracted considerable attention among naturalists. According to this theory, "animals are painted by

nature darkest on those parts which tend to be most lighted by the sky's light, and vice versa," and the earth-brown of the upper parts, bathed in skylight, equals the skylight colour of the belly, bathed in earth-yellow and shadow During the World War he worked in England on the development of camouflage. He died at Dublin (N H), May 29, 1921.

See his article, "The Law which underlies Protective Coloration," in the *Annual Report* of the Smithsonian Institution for 1897 (1898), and *Concealing Coloration in the Animal Kingdom* (1910), a summary of his discoveries, by his son, Gerald H Thayer.

THAYER, WILLIAM ROSCOE (1859–1923), American writer, was born in Boston (Mass) on Jan. 16, 1859 After travel abroad with a private tutor, he graduated at Harvard in 1881 He was assistant editor of the Philadelphia *Evening Bulletin,* 1882–85, and then returned to Harvard for advanced study. He was editor of the *Harvard Graduates' Magazine,* 1892–1915. In 1903, at the International Historical Congress at Rome, he represented both Harvard university and the American Historical Association, as also in 1906 at the Italian Historical Congress in Milan He was for almost ten years a member of the Harvard board of overseers In 1918 he was elected president of the American Historical Association and was awarded numerous other scholarly honours He died at Cambridge (Mass) on Sept 7, 1923. Thayer was best known for his works on Italian history, especially *The Dawn of Italian Independence,* (1893), *A Short History of Venice* (1905), and *The Life and Times of Cavour* (1911) His other works include: *Italica* (1908), *The Life and Letters of John Hay* (1915); *Theodore Roosevelt—An Intimate Biography* (1919), *Volleys from a Non-Combatant* (1919); *The Art of Biography* (1920), and *George Washington* (1922) His *Letters* (1926) were edited by C D Hazen.

THAYETMYO, a town and district in the Magwe division of Burma The town is situated on the right bank of the Irrawaddy, opposite Allanmyo Pop (1921) 10,768 The cantonment is no longer used, and the population and importance of Thayetmyo have tended to decrease with the rise of Allanmyo (11,219 in 1921) on the opposite bank of the Irrawaddy There is a special industry of silver work.

The district has an area of 4,750 sq m ; pop (1921) 255,406 The rainfall ranges between 30 and 50 inches On the west is the Arakan Yoma range, and on the east the Pegu Yomas; and the face of the country, where it does not rise into mountains, is everywhere broken by low ranges of hills, many of which are somewhat barren. The chief river is the Irrawaddy, which traverses Thayetmyo from north to south Products are rice, cotton, ground nuts, oil-seeds and tobacco; cutch is also abundant, and he manufacture of the dye-stuff is carried on extensively

THEAL, GEORGE McCALL (1837–1919), British historiographer, was born in Canada in 1837, and became a schoolmaster in Cape Colony in 1858 He developed an interest in the natives and in the history of the country, and after settling a dispute with the Gaika Kafirs on behalf of the Government (1877), joined the Cape Civil Service, in the Native Department. He was also appointed keeper of the archives, and in 1891 was made colonial historiographer, a position which he held until 1905 In 1895 he was commissioned by Cecil Rhodes, then prime minister of Cape Colony, to go to Europe, where he stayed several years examining the Portuguese, Dutch and British archives His research brought to light a mass of unknown or forgotten documents of high value. He died at Wynberg, Cape Province, on April 17, 1919

He published a *History of South Africa (1486–1872)* (5 vols. 1888–93) official *Records of South East Africa* (9 vols. 1898, etc), *Records of Cape Colony, 1793–1827* (36 vols 1897, etc), *The Beginning of South African History* (1902), and many other works, some in Dutch

THEATRE, a building or place furnished with seats and provided with a stage upon which plays or dramatic spectacles are performed; a playhouse In treating fully the various aspects of he theatre, the following sections are presented in this article: (A) Architecture (1) *Development,* (2) *Modern Exteriors and Interiors,* (3) *General Planning,* (4) *Modern Theory of Design;* (B) Direction and Production: (1) *Modern Tendencies,* (2) *Direction and Acting,* (3) *The Actor,* (4) *Theory of Modern Production* (X.)

ARCHITECTURE

DEVELOPMENT

In considering the form of the modern theatre building, its physical aspect, and in tracing the origins and development of that form from the earliest known theatres of Europe, the investigator does well to keep constantly in mind the basic meaning of the word "theatre" From the Greek *θεασθαι*, it means roughly "a place for seeing" In a short survey of the subject it is not necessary to mention pre-Greek theatres, beyond saying that there is no known connection between those of earlier civilizations and the playhouse with which the history of drama in the Western world is generally supposed to start—the theatre of Dionysus at Athens.

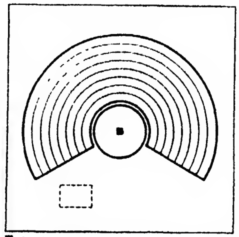


FIG 1—PLAN OF GREEK THEATRE OF EARLIEST TYPE

Greek Theatre.—The first Greek theatres, according to those who have studied the subject most thoroughly, were little more than marked-out dancing-circles, each around an altar, at the foot of hillsides on which spectators stood or sat From this natural form the first *built* theatres took their main outlines a circle or *orchestra* (ὀρχήστρα) for the chorus and actor or actors, and rising tiers of wooden seats, built against a hillside for the spectators These seats extended usually around two-thirds or more of the orchestra, since at this time dancing or movement was more important than acting, and there was no stage for the spectators to face The type of the first built theatres is shown in fig 1 It should be kept in mind, however, that in no period were any two Greek theatres exactly alike, and exceptions to this general type were common

Taking the theatre of Dionysus as an example, one notes that the temple of Dionysus Eleuthereus appeared in relation to the theatre approximately as indicated in the diagram (all within the precinct sacred to Dionysus on the south-eastern side of the Acropolis) One conjecture is that the architectural form of this 6th century temple helped to determine the shape of the stage building which was later to be added at the edge of the circle opposite the seats But the more widely accepted theory is that out of necessity a hut or tent (σκηνή) was added at the edge of the orchestra as a retiring-room for the actors, for changes of costume, etc ; and that the stage building was in all later ages an elaboration of this rude shelter—dressed, in the Greek period, with those beautiful architectural forms with which the Athenians adorned all their important structures.

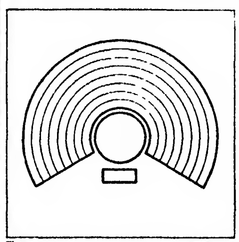


FIG 2—THE THREE-PART THEATRE ARRANGEMENT OF SEATS, ORCHESTRA AND SKENE

Just when this *skene* became truly a stage building, with definite and studied relationship to orchestra and auditorium, is a matter of conjecture As a step in the development of the larger theatre form, we may think of the three parts of the theatre as developing gradually into a set arrangement as shown in fig 2.

Here one sees the accretion of the three features that characterized theatre building through many succeeding centuries: (1) θέατρον, or auditorium; (2) orchestra; and (3) scene, names which persist even to-day. But at this time players appeared only in the orchestra, the scene remaining an architectural background to the action and a practical retiring-house for the actors, structurally separated from the auditorium, by entrances or runways, called παραδοι (Lat. *parodi*).

Such was the theatre form when the 5th century B C dawned, and such it remained, with only slight changes, in all probability, during the period of Aeschylus, Sophocles and Euripides. The architectural features and the height of the *skene* are still only to be conjectured, though recently excavated foundations at Athens indicate clearly the plan and limits of an early stage building, wider than the dancing circle and with ends projecting forward toward the auditorium.

Archaeologists have waged one of their bitterest battles over the question as to when the raised stage made its first appearance, but in the "high" period of Greek drama it is now almost unanimously agreed that there was no platform stage The theatre at Athens had taken this general form, with probably a portico at the front of the scene building, between the *paraskenia* (fig 3).

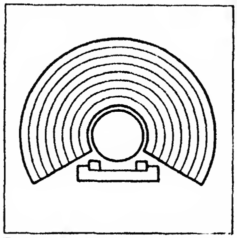


FIG 3—PORTICO ADDED TO FRONT OF SCENE BUILDING

In Greece the theatres were regularly built in hillside hollows, thus avoiding any need to build supporting framework for the tiers of seats, except perhaps at the ends of the "rings" The auditorium was broken by up-and-down aisles with steps, into a number of wedge-shaped "segments" of seats, and sometimes by one or more lateral aisles

The student of later forms may profitably transfer his attention to a point beyond the controversy about the introduction of the raised stage to that time when there was, without doubt, an auxiliary platform for acting The next well-differentiated type of theatre is that in which the stage building is characterized by a high narrow platform on the audience side, called at times the *proskenion* (from which our "proscenium" is derived), and at others the *logeion* or "place for speaking" As acting has become more and more important, the *skene* has developed into a combined architectural background and platform for lifting the actor into clearer view (fig 4) It is to be noted here that the typical Greek separation of auditorium and scene building still exists, although acting now is divided between the orchestra and a stage in our later sense Through the late Greek and the so-called Greek-Roman periods, the narrow *logeion* doubtless went through a gradual widening process

Roman Theatre.—The existing ruins of Roman theatres give absolute evidence regarding the arrangement of the Roman stage and auditorium The two heretofore separate buildings have now been pushed together to form one structure, which is not placed as in Greek times against a hillside hollow, but is erected as a free-standing building supported by arch construction; the orchestra has been contracted to a half-circle, and is now added to the seating space; and all the acting is done on a platform stage, behind which the greatly enlarged *skene* and *paraskenia* rise, with rich architectural ornamentation, to a considerable height The type plan is shown in fig 5. A special type of theatre with wooden platform stage, for comedies, as shown in many extant vase paintings, is disregarded here as having little or no influence on the traditional or persisting form of theatre

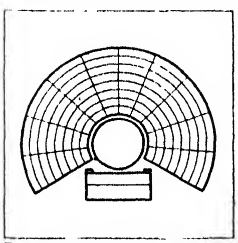


FIG 4—A PLATFORM ADDED AS PART OF THE SKENE

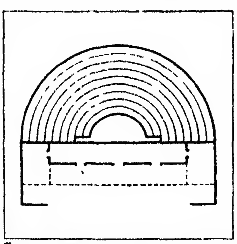


FIG 5—PLAN OF TYPICAL ROMAN THEATRE AS A STRUCTURAL UNIT

In the Roman theatres there were no built-in facilities for scene changing, and it may be assumed that in general there was no painted scenery and no effort to indicate change of locality though elaborate "stage machinery" for trick effects, apparitions, etc, is described by contemporary writers In general, the architecture of the stage wall was the "scene" This wall was regularly pierced by five doorways, three at the back and one in each of the *paraskenia* The large centre door was the "palace entrance" (S CHE)

The larger of the two theatres at Pompeii dates from the Hellenistic period but was thrice reconstructed and it is not clear to what date we are to assign the low stage of Roman pattern Probably it belongs to the earliest period of the Roman colony at Pompeii founded by Sulla 80 B C The theatre of Pompeii is said by Plutarch to have been copied from that of Mytilene which suggests that the Roman theatre was derived from a late Greek model and this is made probably by the existence of transitional forms

During the Republican period the erection of permanent theatres with seats for the spectators was thought to savour of Greek luxury and to be unworthy of the stern simplicity of Roman citizens Thus in 154 B C Scipio Nasica induced the senate to demolish the first stone theatre which had been begun by C Cassius Longinus Even in 55 B.C when Pompey began the theatre of which remains still exist in Rome he thought it wise to place a shrine to Venus Victrix at the top of the cavea, as a sort of excuse for having stone seats below it—the seats in theory serving as steps to reach the temple This theatre which was completed in 52 B C is spoken of by Vitruvius as "the stone theatre" *par excellence:* it is said by Pliny to have held 40,000 people, but Huelsen has shown that this statement was exaggerated and estimates the number of spectators at between 9,000 and 10,000 It was also used as an amphitheatre for the bloody shows in which the Romans took greater pleasure than in the intellectual enjoyments of the drama At its inauguration 500 lions and 20 elephants were killed by gladiators Near it two other theatres were erected, one begun by Julius Caesar and finished by Augustus in 13 B C under the name of his nephew Marcellus and another built about the same date by Cornelius Balbus Little remains of the latter, but the ruins of the theatre of Marcellus are among the most imposing which now exist in ancient Rome

A long account is given by Pliny of a most magnificent temporary theatre built by the aedile M Aemilius Scaurus in 58 B C It is said to have held the incredible number of 80,000 people and was a work of most costly splendour. Still less credible is the account which Pliny gives (H N xxxvi 116) of two wooden theatres built by C Curio in 50 B C which were made to revolve on pivots so that the two together could form an amphitheatre in the afternoon after having been used as two separate theatres in the morning.

All Roman provincial towns of any importance possessed at least one theatre and many of these are partly preserved Covered theatres were sometimes built, whether on account of climatic conditions (as at Aosta) or more commonly for musical performances These latter were generally called *Odea* (a place for singing) The best preserved is the Odeum of Herodes Atticus, at the south-west angle of the Athenian Acropolis, which has a semicircular orchestra It was built in the reign of Hadrian by Herodes Atticus Its cavea which is excavated in the rock, held about 6,000 people, it was connected with the great Dionysiac theatre by a long and lofty porticus or stoa of which considerable remains still exist, probably a late restoration of the stoa built by Eumenes II of Pergamum It was also a common practice to build a small covered theatre in the neighbourhood of an open one, where performances might take place in bad weather. We have an example of this in Pompeii The Romans used scenery and stage effects of more elaboration than did the Greeks Vitruvius (iii. 7) mentions three sorts of movable scenery—(1) for the tragic drama, facades with columns representing public buildings, (2) for comic plays, private houses with practicable windows and balconies such as are shown on Graeco-Roman vases of the latest type, with

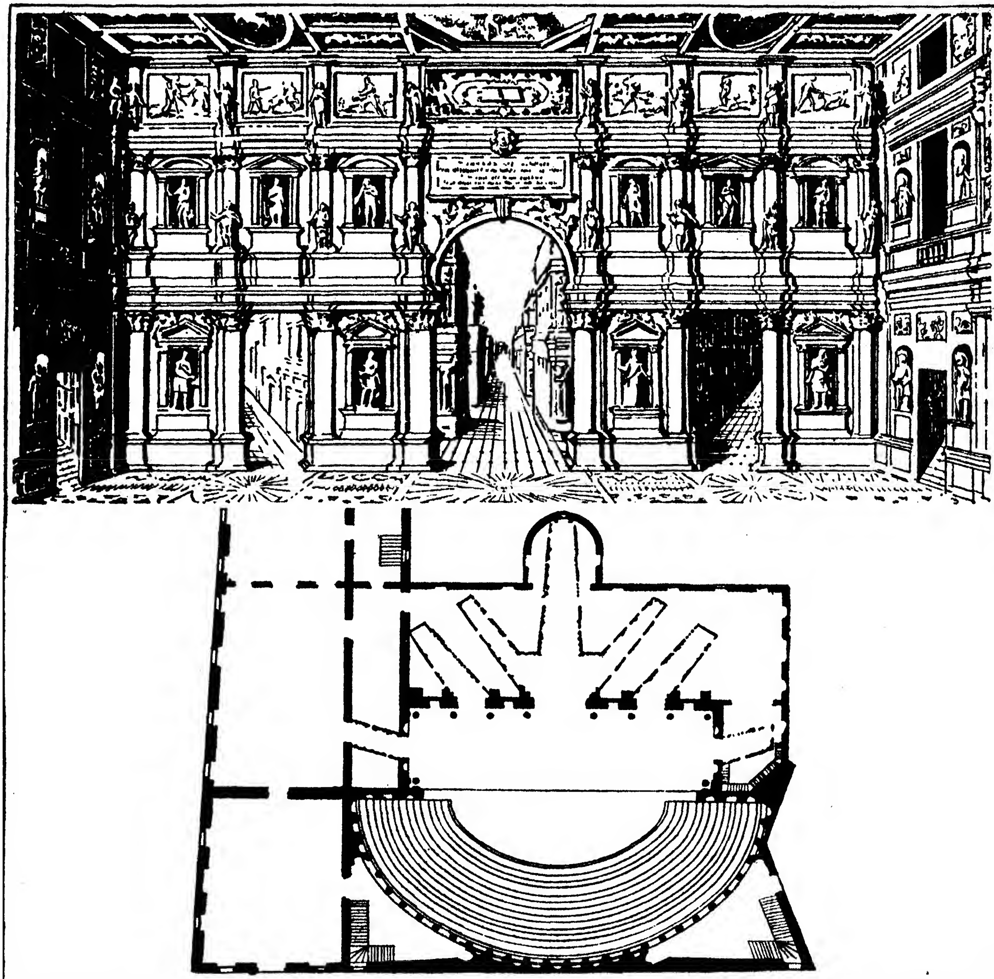


FIG. 6.—PLAN AND STAGE WALL OF THE THEATRE OF THE OLYMPIAN ACADEMY, VICENZA, ITALY; SOMETIMES CALLED THE PALLADIAN THEATRE AFTER ITS FAMOUS ARCHITECT, ANDREA PALLADIO (1518–1580). IT PRESERVES THE ROMAN FORM WITH THE FIVE CLASSIC DOORWAYS AND PROVIDES FOR INTRODUCING SCENERY (NOT AS YET CHANGEABLE)

aintings of burlesque parodies of mythological stories, and (3) or the satyric drama, rustic scenes, with mountains, caverns and rees. (X.)

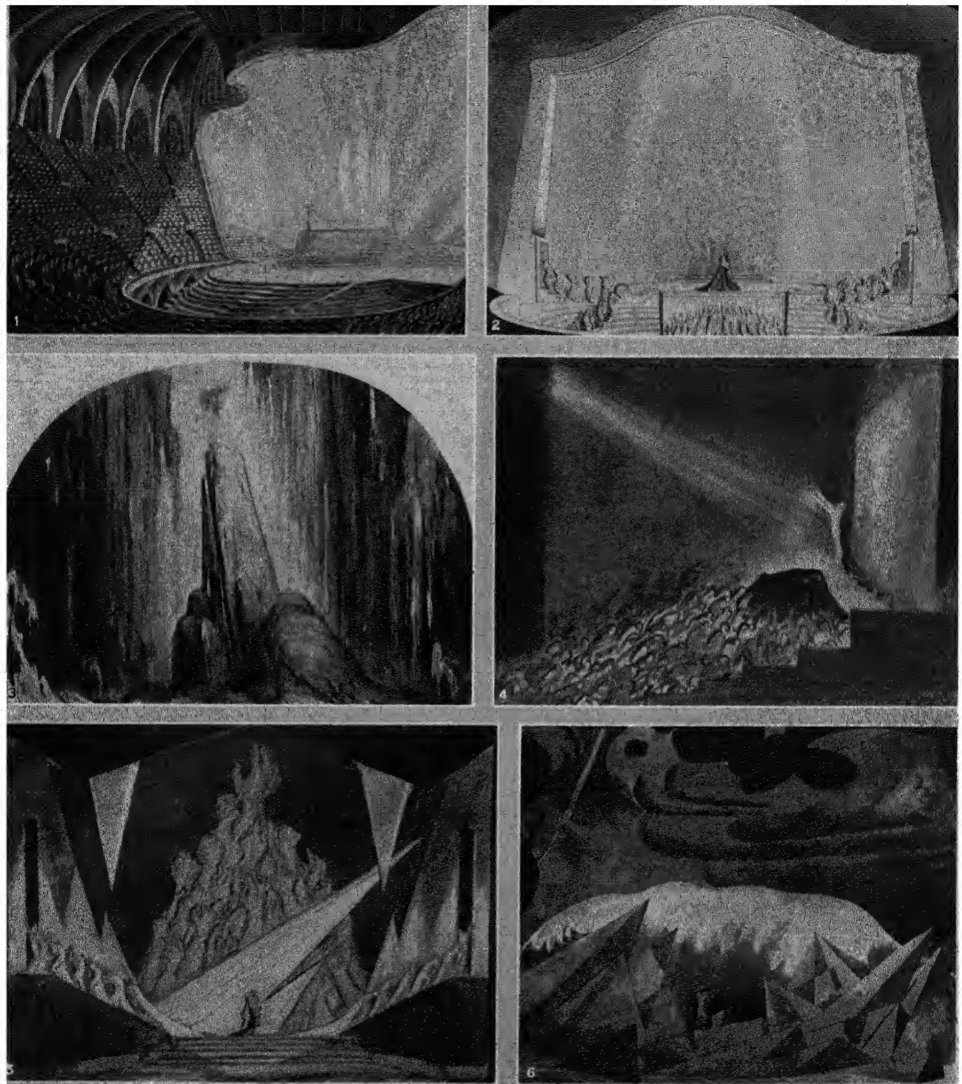
Renaissance Theatre.—The classic theatres were disused after toman civilization faded, but it was the classic theatre that deermined the form of the playhouse built by the learned academies 1 the cities of Renaissance Italy, and they were the links between he ancient theatre and that of to-day. At Vicenza, the Renaisance theatre of the Olympian academy, sometimes called the 'alladian theatre after its famous architect, still exists, with all :s distinctive architectural features and ornament intact. It is, 1 effect, a small Roman theatre roofed over and made more comact, with typical Renaissance modification of Roman motifs in he decoration. The stage wall is heavily encrusted with archiectural ornamentation and statuary, and the five classic doorays are in orthodox position. One addition, made by Scamozzi in 1585, links this classic stage with the theatres of later times. In that year were constructed the vistas or "perspectives" behind the five doorways of the stage wall, forming the earliest "makebelieve" scenes that have been preserved for posterity. (Already the mystery and miracle stages had in cases been characterized by a combination of half-formed architectural "stations" and realistic localized scenes like the famous "Hell-mouth"; and the court masques were being staged with picture scenes, including the "perspective" type.) The Roman-type building and the added vistas at Vicenza form a plan as shown in fig. 6.

The picture scenes were not yet designed as localized backgrounds for the action so much as an added spectacular attraction, in the Italian masques, and at first the "new style" settings had little effect on the form of the classic-revival playhouses; but the appeal of such pretty playthings could not be long denied, and the modern playhouse emerged where the two currents met. Thus

BY COURTESY OF (1, 2, 3, 5, 10) MORRIS GEST; PHOTOGRAPHS, (4, 6 9) BRUGUIERE

ACTORS OF THE MOSCOW ART THEATRE IN WELL-KNOWN RÔLES

1. A group of suppliant peasants in Count Alexei Tolstoy's "Tsar Fyodor Ivanovitch"
2. Scene in the Imperial Palace in the Kremlin, Moscow, in Count Alexei Tolstoy's "Tsar Fyodor Ivanovitch"
3. Vassily Katchaloff, one of the charter members and second leading actor of the Moscow Art Theatre as the dissolute card-sharper in Maxim Gorky's "The Lower Depths"
4. Lyoff Bulgakoff of the Moscow Art Theatre as Alyoshka in Gorky's "The Lower Depths"
5. Constantin Stanislavsky, co-founder, general director of and first artist of the Moscow Art Theatre, as Gaieff in Anton Tchekhoff's "The Cherry Orchard"
6. Maria Uspenskaya as Charlotta in Tchekhoff's "The Cherry Orchard"
7. Vassily Luzhsky as Fyodor Karamazoff in Dostoievsky's, "The Brothers Karamazoff"
8. Leonid M. Leonidoff as Dmitry in "The Brothers Karamazoff"
9. Nikolai Podgorny as the coroner in "The Brothers Karamazoff"
10. Ivan Moskvin as Captain Snegiryoff in "The Brothers Karamazoff"



BY COURTESY OF (5) ISAAC GRUNEWALD; PHOTOGRAPHS, (1, 4) NICKOLAS MURAY

EXPRESSIONISM AND CONSTRUCTIVISM IN MODERN STAGE SETTINGS

1. Design by Ernest DeWeerth for the auditorium and stage of Triarts Temple, intended for the production of performances combining music, lighting and movement. The figure of the man (centre) merely gives scale-background to an elaboration of Thomas Wilfred's colour organ which lights the high plastic dome
2. Design by Ernest DeWeerth for "Medea." The shadows cast on the background are done by a second cast and show what passes through the mind of Medea throughout the play. In this instance they illustrate the spirit of the children she is about to kill
3. First scene of "Rheingold" designed by Charles Ricketts, R.A., in 1908. The lightest colour shown in the photograph is pale emerald green. The upper part of the pillar has touches of crimson lake, flame colour and buff, gradually merging into emerald and grass green. There are small parts of brilliant emerald green and ultramarine throughout the sketch. The darkest tone, a very dark green with a mixture of brown, is produced by a sepia or vandyke ground colour which is allowed to show through the various coats of body colour
4. Design by Ernest DeWeerth for the speech of Mark Antony in "Julius Caesar." Light is concentrated on the principal figure, and the mob below is amplified by the shadows thrown on the backdrop
5. Design by Ernest DeWeerth for "The Trojan Women"
6. Design for "Oberon," as produced at the Royal Opera House, Stockholm

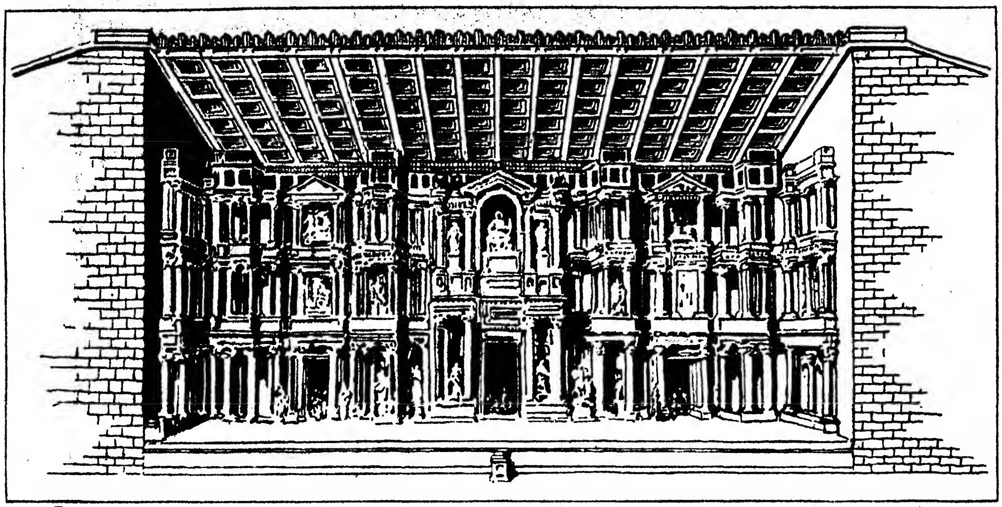


FIG. 7.—BACKGROUND OF THE ROMAN STAGE SHOWING THE NARROW CENTRAL "PALACE" DOORWAY WHICH WAS MODIFIED IN THE RENAISSANCE THEATRE, AS SHOWN IN FIG. 6, TO PROVIDE A MORE EXTENDED "VISTA"

the Palladian theatre at Vicenza takes on double importance as historic evidence: (1) as preserving the Roman playhouse form, including the rigid architectural stage; and (2) as providing for introduced "scenery" (not as yet changeable). The backgrounds of the Roman and Palladian Renaissance stages are shown in fig. 7. There are extant plans which indicate that certain artists of the time, trying to think through to a more practical combination of the classic stage with provision for pictorial backgrounds, saw a means in the widening of the central "palace" doorway to provide acting space within the "vista." Thus Inigo Jones made a plan and an elevation similar to those shown in fig. 8. And the theatre at Sabbioneta (of which the scene unfortunately no longer exists) showed the whole stage as one narrowing vista (1588); *see* fig. 10.

The next step is illustrated in the playhouse that is usually called "the first modern theatre," the Teatro Farnese at Parma (1618 or 1619), diagram of which is shown in fig. 9. Here the entire stage may be said to have been pushed through the central doorway of the old stage wall, the ornamentation of the Roman *skene* remaining only as decoration of what is now the proscenium

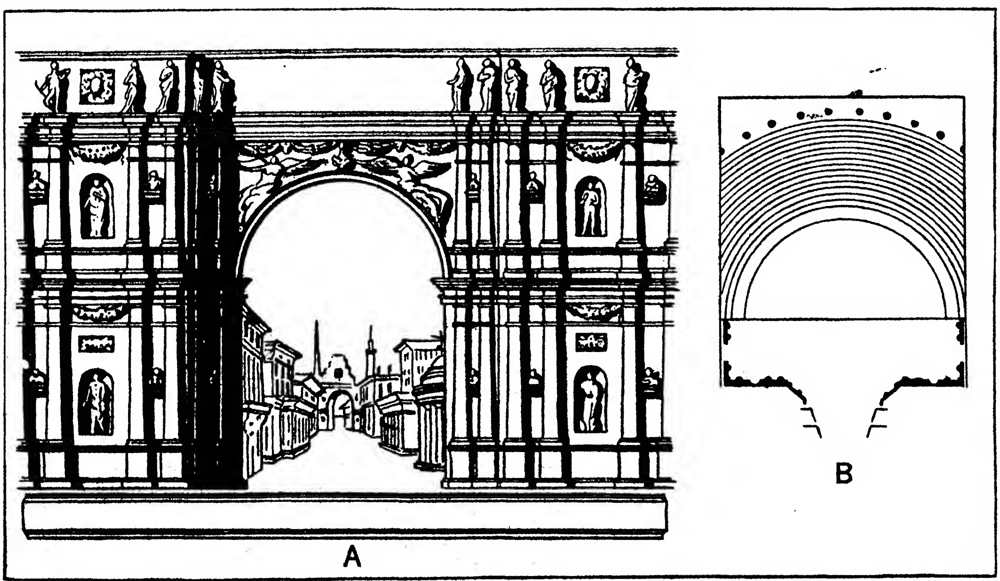


FIG. 8.—PLAN AND ELEVATION BY INIGO JONES OF A WIDENED CENTRAL "VISTA," DESIGNED NOT ONLY TO GIVE A PICTORIAL BACKGROUND BUT TO PROVIDE ACTING SPACE WITHIN THE "VISTA"

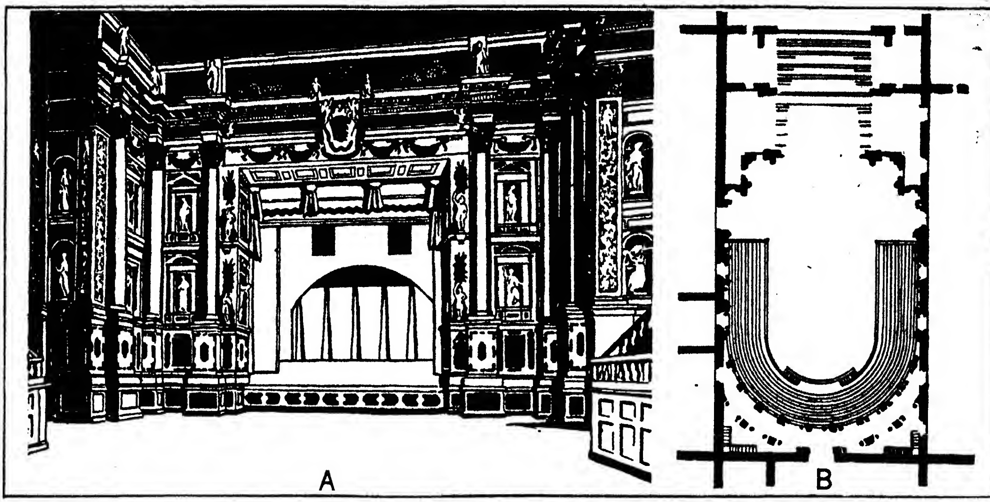


FIG. 9.—PLAN AND ELEVATION OF "THE FIRST MODERN THEATRE" (1618–19), THE TEATRO FARNESE AT PARMA, ITALY. (A) SHOWS THE STAGE CURTAINED OFF FROM THE AUDITORIUM, (B) THE U-SHAPED AUDITORIUM, A NEW INFLUENCE IN THEATRE DESIGNING

arch. The stage within is curtained off from the auditorium (fig. 9*A*) and is thus adapted to changing pictorial settings. From this time on the curtained stage and proscenium arch are unfailing features of the theatre. The plan of the Farnese theatre is particularly interesting, too, as showing the entry of another influence into the shaping of the auditorium: instead of a semicircular bank of seats, as illustrated in the diagrams so far, the auditorium is U-shaped (fig. 9*B*). This influence entered because the masques and court plays had been produced largely in ballrooms or banquet-halls, where one end of the hall had been reconstructed for an auxiliary stage, the main floor left free for dancing, or as an "arena" for pageantry, etc., with the spectators ranged around the three sides away from the stage, perhaps in chairs on temporary platforms, perhaps in balconies. Architects combining this U-shaped auditorium with the curtained proscenium-frame stage soon determined the theatre form that was the basic plan of the famous horseshoe auditorium (fig. 11).

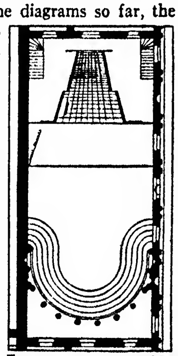


FIG. 10.— PLAN OF NARROWING VISTA. THEATRE (1588) AT SABBIONETA, ITALY, BUILT BY SCOMOZZI

It was this Italian plan that became the standard of theatre building throughout the Western world, conquering successively the French courts, the courts of Austria, Bavaria and other countries to which the Italian Renaissance influence extended, then England (where the Elizabethan theatre form was cast aside —having only the slightest influence after the Restoration), and indirectly America. "Scenery" was soon standardized so that the wings and backdrop restricted the playing space to a wedge-shaped section of the stage floor; and the auditorium lines roughly followed the lines formed by the edges of the wings (fig. 12). This picture scene persisted through two and a half centuries, with ever greater elaboration, demanding larger and larger stages; and the auditorium half of the building kept its many galleried horseshoe plan. With variations toward rounder or narrower auditorium, the general form persisted until late in the 19th century, from smaller court playhouses to immense opera houses.

At first the arena portion of the auditorium was merely a flat floor, and consequently the best seats were not there but at the front of the first balcony; and almost throughout the period of the horseshoe theatre, the main floor sloped but slightly thus allowing three, four or five superimposed balconies or galleries.

Modern Theatre.—The main changes in the construction of the 20th century theatre have been the exclusion of all but one balcony, and the steeper tilting of the main floor, thus throwing the best seats into the orchestra. Even to-day, however, in France and Italy, where the 17th–18th century theatre form stubbornly persists, the orchestra is contracted, and the more expensive seats are in the slightly raised ring of loges and the first balcony above.

During the 19th century there were efforts to reform the "picture" scene, and with it the horseshoe auditorium, which almost invariably had possessed the disadvantage of providing a considerable number of seats, at the gallery ends, which had a poor view of the stage. The first attempts of importance to design a more democratic type of theatre, and one in which "sight-lines" would more logically determine the form occurred in Germany. The Festival theatre at Bayreuth is the most noteworthy example, greatly antedating the present general movement toward the fan-shaped auditorium. Its main outlines are shown in fig. 13.

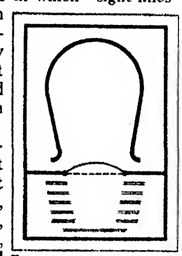
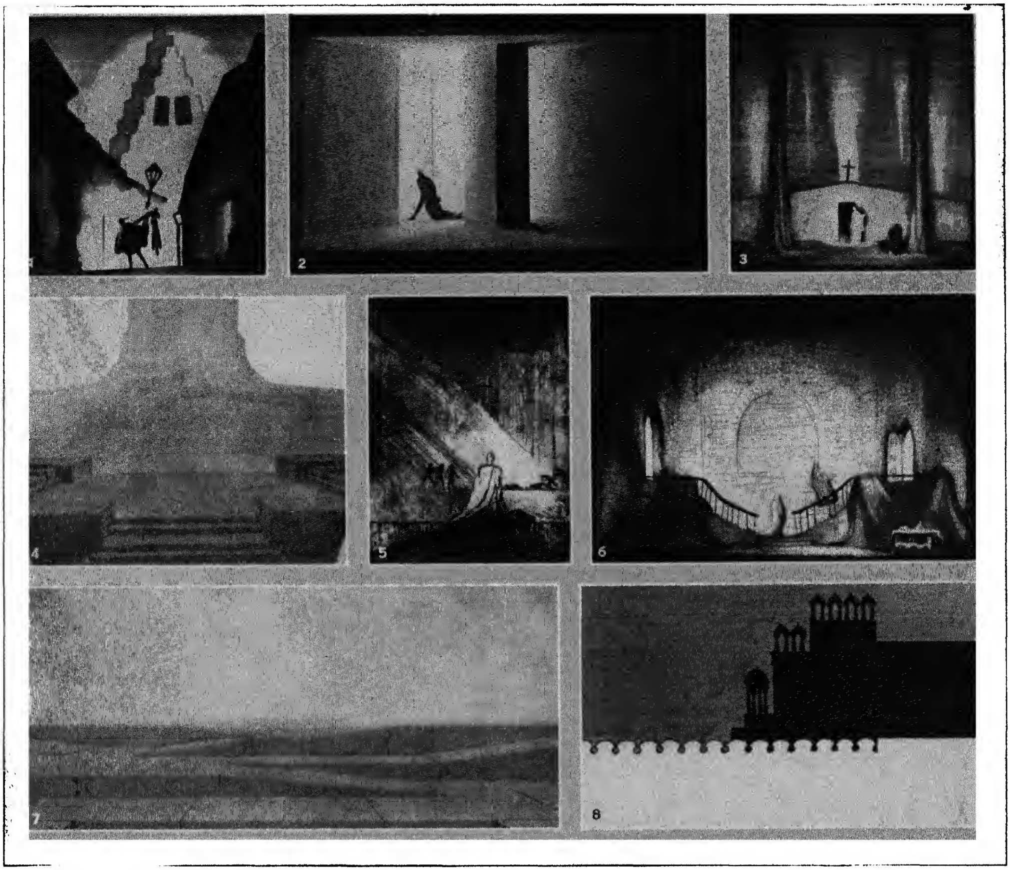


FIG. 11.—PLAN OF A HORSESHOE-SHAPED AUDITORIUM

The impulse was taken up by Max Littmann, the most notable theatre architect of the century-end; his Prince Regent theatre and Künstlertheatre in Munich, and his Schiller theatre in Charlottenburg, Berlin, all with simplified banks of seats, had great influence in both Europe and America. Littmann experimented also with the proscenium frame in an effort to adapt the theatre to the demands of modern stage lighting. More recently architectural practice, particularly in Germany and the United States, has come to the fairly standardized form that is shown in fig. 14. Here the architects restrict the horseshoe bowing-out, since the scene is no longer wedge-shaped but more usually box-like, and the auditorium is narrower in relation to the width of the proscenium opening. (In large cities where ground-value is such an important consideration, the commercial theatres are commonly built with wider proscenium openings and wider auditoriums, but

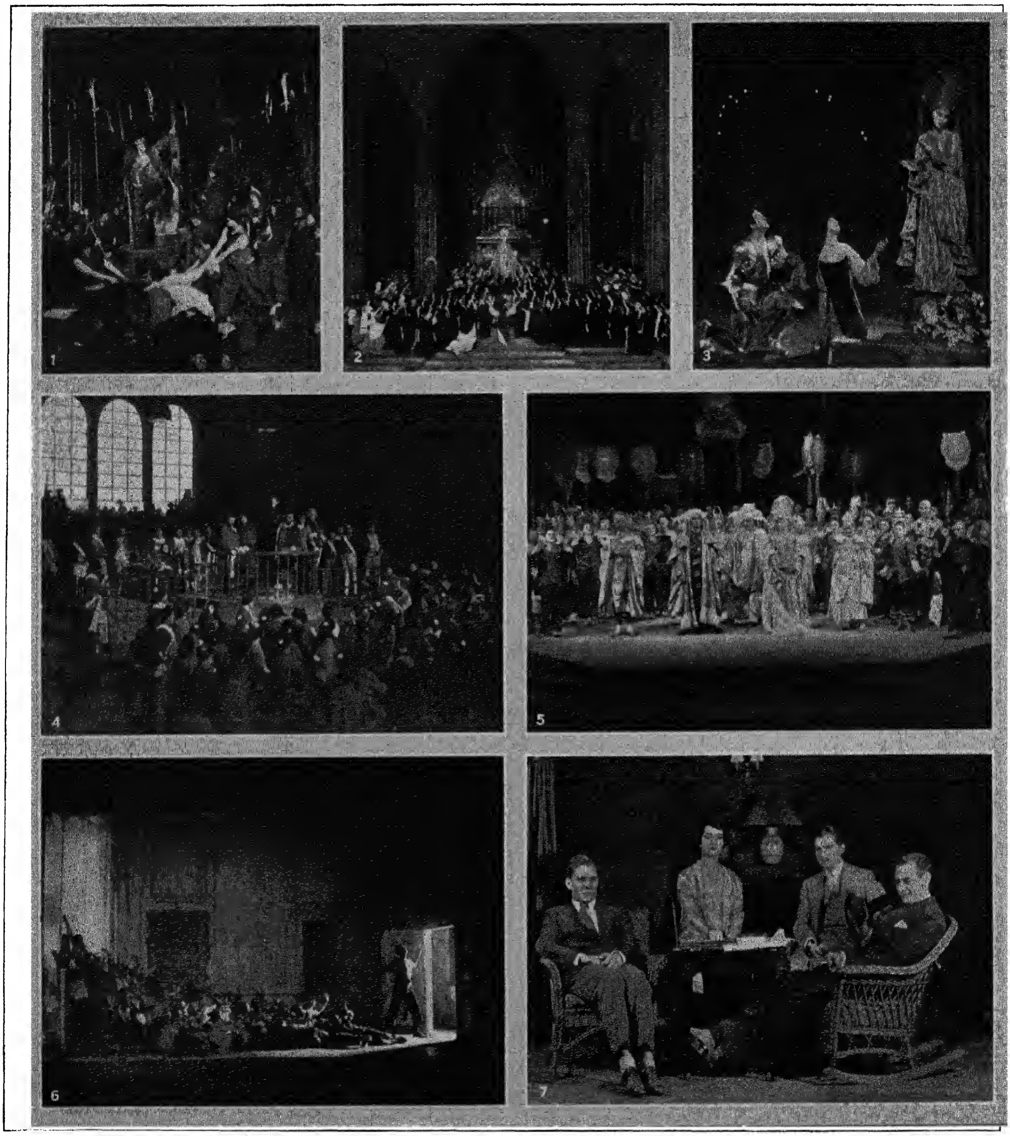


BY COU[illegible] DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (6) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM AND GORDON CRAIG; PHOTOGRAPHS, (2) COPR CONDE NA[illegible] FROM "VANITY FAIR," (4, 7) O. L. FOREL

EXPRESSIONISTIC, CONSTRUCTIVE AND ABSTRACT SETTINGS

1. Street scene by Robert Edmond Jones in "Faust," produced by the American Opera Company
2. Gordon Craig's design for "Hamlet" (article by N. Richardson in "Gordon Craig and his Roman studio," *Vanity Fair*, Feb. 1920)
3. A cemetery designed by Robert Edmond Jones for Pirandello's "At the Gateway"
4. Design by Adolphe Appia for Wagner's "Rheingold"
5. Plate X. In Gordon Craig's "Scene"
6. Setting by Robert Edmond Jones for Sidney Howard's "Swords"
7. Design by Adolphe Appia for Gluck's "Orpheus" ("The Elysian Fields")
8. A scene from Max Reinhardt's production of the wordless play "Sumarun," adapted from a design by Ernst Stern by Robert Edmond Jones

THEATRE



BY COURTESY OF (1-5) MORRIS GEST; PHOTOGRAPHS, (6, 7) VANDAMM

SCENES FROM MODERN THEATRICAL PRODUCTIONS

1, 2, 3. Scenes from "The Miracle," produced by Max Reinhardt. (1) The Piper, as the Tribune of the people, gives the signal for the execution of the Nun. (2) Jubilant worshippers surrounding the Lame One, who was healed at the shrine of the Wonder-Working Madonna. (3) The Knight and the Nun kneeling for the Virgin's blessing

4. Scene from "Danton's Tod," a Max Reinhardt production, showing the mob gathered before the tribunal during the denunciation of Danton, who is standing on the platform to the right with hands bound. There were also many members of the mob stationed in the balcony, where they shouted and jeered in response to the emotions stirred by the orators

5. Scene from "Turandot," produced by Max Reinhardt at Salzburg

6. Storm scene from the New York Theatre Guild's production of "Porgy." Crown, a negro, is defying God and the elements much to the horror of the other negroes who are shrinking away in terror

7. Act 6 of Eugene O'Neill's 9-act play "Strange Interlude," produced by the New York Theatre Guild. The four principal characters have come together for the first time in four years. Nina (centre) has just said, "Make yourselves at home! You are my three men! This is your home with me!" Facial expression and remarks, spoken aside, express the feelings which each seeks to conceal

on the fan principle Standard fire laws impose the necessity for a certain number of aisles and adjacent doorways, and have caused minor differences from the type as it developed in Germany) In general it may be said that the modern auditorium presents a single bank of seats, on a floor uniformly sloping or slightly saucer-shaped, more tilted than during the horseshoe period, and restricted at the sides along lines determined by the edges of the proscenium opening There is usually a single balcony, with a steeply sloped floor, at the rear There are seldom boxes (unless at the back of the orchestra); and modern engineering and steel construction make it possible to dispense with pillars and posts The outline plan is not unlike the plan of the arena or pit portion of the many-galleried opera houses, with the surrounding galleries sliced off. Along with this simplification of plan there has been a general simplification in decoration.

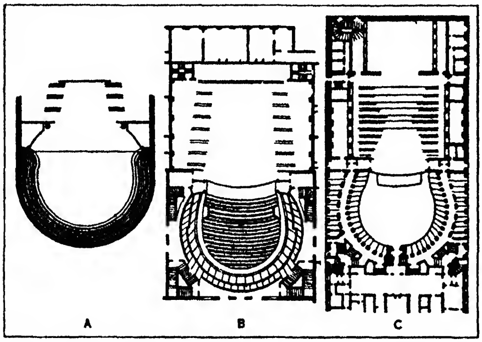


FIG 12 —PLANS SHOWING TYPES OF THEATRE DESIGN USED FROM MIDDLE 17TH TO LATE 19TH CENTURY (A) DRURY LANE, LONDON, (B) THEATRE-FRANÇAIS, PARIS (1790), (C) LA SCALA (1778), MILAN

Two examples of 20th century theatre building may be considered typical of progressive practice (fig. 15). The more radical experimenters have already called for the scrapping of the entire proscenium-frame house, and a return to the principles which determined the theatre form before "picture" scenes were introduced—with reference, however, to modern lighting advances. It may be assumed that some such change will come shortly, and that the return to an architectural stage will demand radical changes in auditorium construction But as yet the several theatres built with formal stages, without proscenium arch, are too different, and their advantages too tentative or too special, to warrant any generalization beyond the proscenium-frame house illustrated above

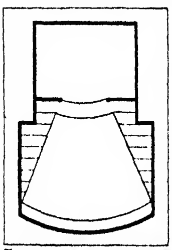


FIG 13.—MAIN OUTLINES OF FESTIVAL THEATRE AT BAYREUTH, AN ADVANCE IN "SIGHT-LINES"

(S CHE)

BIBLIOGRAPHY.—The only historical work in English dealing at all fully with this subject is *The Development of the Theatre*, by Allardyce Nicoll (London and New York, 1927). It is profusely illustrated, particularly as regards the Greek, Roman and English theatres. As a complementary volume, with many illustrations of the Continental court theatres of the 17th–18th century, the reader should consult *Der Moderne Theaterbau*, by Martin Hammitzsch (Berlin, 1906). Another useful reference work in German is Manfred Semper's *Theater*, in the *Handbuch der Archetektur* series (Stuttgart, 1904). In English a useful brief treatment from the 20th century viewpoint is to be found in *Modern Theatres*, by Irving Pichel (New York, 1925). The "standard" work on theatre architecture in English is *Modern Opera Houses and Theatres*, by Edwin O Sachs (London, 1896–98), a monumental work in three volumes, with extraordinarily fine plates; but it can be recommended only with the reservation that the conception of stage art has been so revolutionized in the last quarter-century that it is wholly out-of-date in its viewpoint. For an earlier period one may profitably consult G. M. Dumont's *Parallèle des plus belles salles de spectacle d'Italie et de France* (Paris, 1763). To trace the material about the theatres of individual countries or periods, the reader may best consult the descriptive bibliographies in Professor Nicoll's book

MODERN EXTERIORS AND INTERIORS

The theatre, with its special uses and special restrictions, naturally calls for special architectural treatment. The peculiarly public nature of dramatic art stamped one primary requirement on theatre architecture long before the advertising mania of the present age appeared to reinforce it: it must attract attention and its function must show in outer aspect

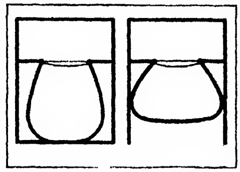


FIG. 14.—TO SHOW STANDARDIZED FORMS OF MODERN THEATRE

The essential architectural beauty of the exterior of a theatre must come not from decoration but rather from the massing of those portions of the walls which reveal the three essential inner parts of the playhouse—the stage, the auditorium and the foyers

Importance of Site.—The art of theatre building has reached its height in Europe where every period developed and perfected its own rich style of architectural expression, and where the conditions of life in the larger cities permitted the theatre to attract attention to itself and its structure through appearance of three or four façades. In Europe a theatre was usually built on a wide street or square—the Paris Opera House (Ch Garnier, arch), the Schauspielhaus in Berlin (Carl Friedrich Schindel, arch.); the Champs Élysées, Paris (A and G. Perret, archs), Staatsoper, Vienna (Vander, Nüll and von Siccardsburg, archs); Dresden Opernhaus (Gottfried and Manfred Semper, archs); or the Prinz Regenten theatre in Munich (Max Littmann, arch)—or even in a park, as in the case of the twin State theatres of Stuttgart (Littmann, arch), and many others Everywhere we find that it is growing more and more difficult to find such ample and predominant sites in the larger cities on account of the high value of land,

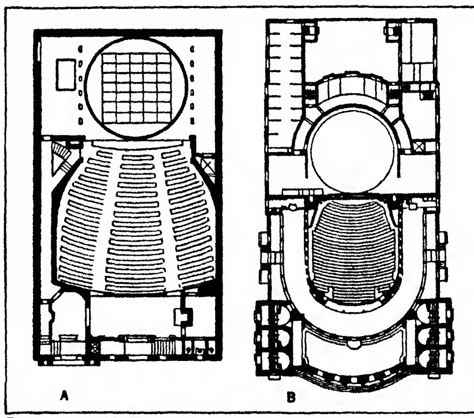


FIG. 15.—EXAMPLES OF FLOOR PLANS FOR MODERN THEATRE BUILDING (A) THE LITTLE THEATRE, NEW YORK. HARRY C. INGALLS AND F. B HOFFMAN. JR , ARCH'TS., (B) VOLKSBÜHNE (PEOPLE'S THEATRE), BERLIN, OSKAR KAUFMAN, ARCH'T

the lengths of blocks, and the type of buildings dominating the view. Difficult conditions reach their acme in New York. The Metropolitan Opera House (Cady, Berg and See, archs.) alone occupies an entire block, and only the Century theatre, opposite Central Park (Carrere and Hastings, archs), can show three sides. The largest theatre in the world, the Roxy, in New York (Walter W. Ahlschlager, arch) is away from the corner and down a side street. In London, among many examples showing one façade only there are the new Carlton theatre (F. Verity, arch), and the Fortune theatre. The theatre architect in all countries has

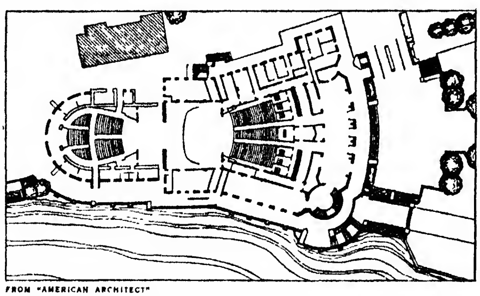
now usually only one façade available to tell the story which two, three or even four told in the past.

Modern Conditions and Restrictions.—The architect limited to one façade facing a narrow street, has found it hardest to show in the outer form of his building the anatomy that lives within. Yet even under these conditions the Guild theatre (C. Howard Crane and Kenneth Frazenheim, archs) manages to mark off handsomely the stage-house like an Italian brick tower above the stucco front of the lower auditorium.

Congestion and fire regulations play particular havoc with theatre architecture, yet several more or less successful attempts have been made to combine necessity with beauty. In the bold Martin Beck theatre (G. Albert Lansburgh, arch) and in the charming Music Box (Crane and Frazenheim, archs.) the inevitable fire-escapes required by law find a pleasant hiding place within porticoes. The Henry Miller theatre (Paul R. Allen and Harry Creighton Ingalls, archs) conceals unsightly alleyways—again required by law—within its Georgian walls The law does not require the builder of a theatre to protect his patrons from the rain while they wait for taxis and motor-cars, yet the marquee becomes inevitably one of the most important items of the façade, unless an arcade or portico has been designed to protect the waiting crowds.

Electric Signs.—The worst problems of the architect who builds theatres in a great city come from the primary requirements of such a building—that it must be seen and tell its story at the greatest possible distance The set-back laws, new treatments of L-shaped, U-shaped, or H-shaped courts in front of tall buildings, and the enormous height of the skyscrapers make period fronts on three or four-storied theatres an insufficient and even ridiculous attraction against the gigantic, varied and vital proportions of the neighbouring buildings To compete for visual notice under these conditions, the theatre owner turns to enormous electric signs, and blankets the façade behind flashing bulbs and painted tin London examples of good exterior lighting arrangements are the Plaza theatre (F. Verity, arch), and the Astoria cinema (E. A. Stone, arch)

The modern architect has to consider as the main requirements in the exterior design of theatres three things which the architect has never before had to deal with These are electric advertising signs, fire escapes and marquees Not until we have made these necessities a part of our architecture, not until these necessary evils have been fused into a thing of beauty and have formed their own architectonic style and expression, can we hope for a new, adequate and handsome theatre façade.

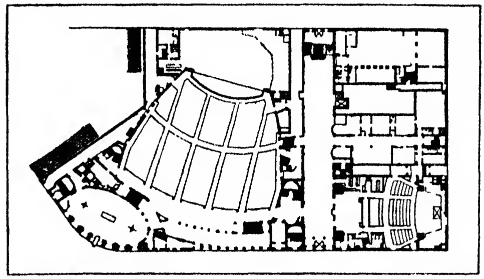


FROM "AMERICAN ARCHITECT"

PLAN OF THE SHAKESPEARE MEMORIAL THEATRE, PRIZE WINNING DESIGN IN THE PROCESS OF CONSTRUCTION IN STRATFORD-ON-AVON, ENGLAND

Type of Entertainment Determines Type of Auditorium.—Each type of dramatic entertainment—including the motion picture—demands its own type of auditorium In the ancient world the Greek theatre developed along lines suited to drama and comedy that employed large choruses, while in Rome something nearer the modern stage came into being as the chorus disappeared. Unfortunately the theatre architect of to-day is much too uncertain of the type of entertainment which will ultimately make use of his creation He may intend the building for popular melodrama, but financial misfortunes may turn it over to motion pictures or to musical revues. It is only in the smaller communities that a theatre should be built for general usage, and some compromise arrived at which will suit both stage and auditorium to almost any kind of entertainment.

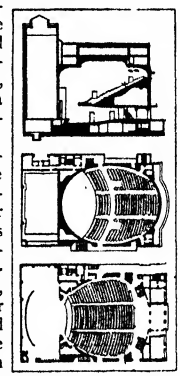
The Motion Picture House.—In a motion picture theatre, where the attention of the audience is concentrated on a silver screen and on figures of actors that are well over lifesize, the auditorium may be very deep without incommoding the spectator. On the other hand, it must not be too broad or too high, for that would distort the appearance of these two-dimensional figures on the flat screen The mass of the audience must be concentrated in the centre and placed on two main floors. The theatres that carry this out most notably are the Marmorhaus, Berlin (Hugo Pal, arch), the U-T Theater, Berlin (Fritz Wilms and Max Bischoff, archs.), the Capitol theatre, New York (Thos W. Lamb, arch), the Roxy theatre, New York, the Plaza theatre, London, the Empire theatre, London, the Piccadilly theatre, London.



FROM SEXTON AND BETTS, "AMERICAN THEATRES OF TO DAY" (ARCHITECTURAL BOOK PUBLISHING CO)

PLAN OF THE EASTMAN THEATRE, ROCHESTER, N Y , DESIGNED BY GORDON AND KAELBER, ARCHITECTS, AND MCKIM, MEAD AND WHITE, ASSOCIATE ARCHITECTS

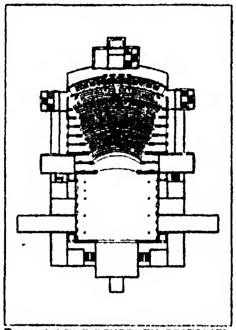
The Revue Theatre.—The theatre intended for the use of the big musical revue is rather closely related to the moving picture house, though it, too, has its peculiar requirements. Here the main interest lies in the stage picture, the beauty of costumes and scenery, and so a large auditorium is possible Care must be taken, however, to avoid too great a depth, for comedy scenes and solo singing demand more intimacy and a closer view of the performer than in the case of the motion picture. Here it is of great importance that the height of the seats in relation to the stage floor shall permit everyone in the house to see the feet of the dancers. For the revue house—as well as for any theatre, that is not used on the one hand, for the motion picture, or on the other for the strictly realistic, peep-show type of drama —the architect must take great care to avoid anything in the proportions of stage and auditorium that may indicate a separation between the actors and the spectators. He must strive to use every means for uniting both groups in close spiritual contact.



LONGITUDINAL SECTION OF THE ZIEGFELD THEATRE (TOP), PLAN OF BALCONY (CENTRE), AND OF THE ORCHESTRA (BOTTOM), DESIGNED BY JOSEPH URBAN AND THOMAS W LAMB, ASSOCIATE ARCHITECTS

The realistic play of the type which presupposes the presence of a fourth-wall between the actor and the audience has set special problems for the modern architect. Hitherto he has solved these as perfectly as possible—and, of course, by the very nature of the case he has not achieved anything exhilarating, notable or truly theatric. In the main he has had to restrict himself to a

small auditorium and if he sought larger capacity, a single balcony hung far out over the orchestra floor. He has done away with boxes as obtrusions between the audience and the picture frame. And this picture frame has become a definite and complete separation between the audience and the actors. In decoration he has been forced to subdue the colour of his auditorium so as to leave the audience in peep-show darkness while the play goes on. Two of Ingalls's playhouses in New York, the Little theatre and the Henry Miller, meet these stultifying conditions as well as they can be met.

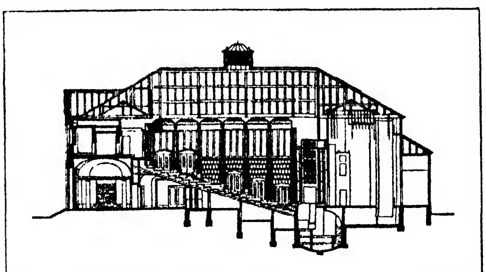


PLAN OF THE BEYREUTH FESTSPIELHAUS. MANFRED SEMPER, ARCH'T: THE FAN WITH STRAIGHT SIDES AND A WIDE SPLAY WAS USED

Problems of Site and Seating Capacity.—Within the limits of the particular piece of land on which he has to build, the architect must work out as large a seating capacity, and as roomy and convenient an arrangement of stage, dressing rooms, and foyers as possible Where the site is rectangular the problem is comparatively simple, but where the site is irregular it is often difficult to accommodate the auditorium and stage

The architect has generally to secure the largest seating capacity possible on a given site. Usually this has meant widening the stage and still further widening the fan-like auditorium until only revues can be properly presented. The architect plans one very large, overhanging balcony because the higher prices that can be charged in a balcony, compared with a second balcony or gallery, more than make up in financial capacity for the greater number of seats that a double-decker arrangement provides

Occasionally the architect tries some new method of getting a large but intimate auditorium on a piece of property of restricted size A popular method is to place the stage in one corner of the site instead of along the back, and then to throw the auditorium diagonally across the lot Though this arrangement is better suited to the almost stageless motion picture theatre, it has been used in a "legitimate" theatre, The Ambassador, New York (Herbert J. Krapp, arch) Among large motion picture houses with



FROM LITTMANN, "DAS MÜNCHENER KÜNSTLER THEATER"

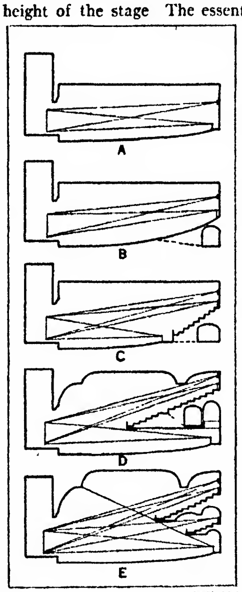
SECTION OF MUNICH ARTISTS' THEATRE, SHOWING THE STEEPLY SLANTING FLOOR

well-equipped stages which have also utilized this seating plan are the Paramount theatre, Palm Beach, Fla. (Joseph Urban, arch), the Bondi theatre, Sydney, N S W. (C Bohringer, arch.), "the Majestic," Leeds (Messrs. Skinlet and Maxwell, archs) and the Roxy, New York.

Auditorium Shapes.—The shape of the auditorium itself, which used to be invariably a horseshoe, is now most apt to take the form of a fan with convex sides curved in towards the front and rear. An elliptical form has been tried with good decorative effect in the theatre of the Carnegie Institute of Technology, Pittsburgh, Pa. (Alden and Harlow, archs.) and in the Ziegfeld theatre, New York (Urban and Lamb, archs.). The New Cinema, Portsmouth (A. E. Lutte, arch.) is also a good example of this type. The fan with straight sides and a wide splay was used in the Beyreuth Festspielhaus (Manfred Semper, Arch) where the boxes are located in a straight row across the back of the theatre and the "diamond horseshoe" of boxes eliminated.

Acoustics.—Any divergence in shape from auditoriums tried and tested by time involves the risk, of course, of producing bad acoustics But the danger is far from absent in any theatre for the problem of acoustics is the most difficult that an architect has to meet. In 1895 Prof Wallace C Sabine of Harvard, beginning by means of formulae and of photographs of sound waves in models of auditoriums, was able to determine in advance with a certain degree of accuracy the acoustic properties of a given design of theatre. Later research has devised methods of correcting bad acoustics by means of felts, wires, sounding boards, etc, but the fact remains that the best material for the interior of an auditorium, wood, generally cannot be used on account of the restrictions of the fire laws

Visibility.—A problem of theatre construction which has not had as complete a study and formulation as it deserves is the line of slant in auditorium floor and balconies in relation to the height of the stage The essential aimed at is the most perfect visibility from every seat in the house One of Germany's theatre reformers, Littmann, in a desire to give the last row as clear a view as the first, prescribed a very steeply slanting floor, but made the grave mistake of making it merely a straight inclined plane The result was that the front rows had more range of vision than they needed, while the last rows suffered from the feeling of looking down a narrow tunnel The better method, which is generally followed today, is to begin with little or no inclination at the front, and then to increase this radically towards the rear The slant of the auditorium and, of course, of the balconies, too, is controlled in most cities by the requirements of the building regulations The height of the stage above the auditorium floor is not so restricted, and can be worked out freely to give the whole auditorium a complete and comfortable view of the actors upon the stage It is often very badly handled



FROM SEXTON AND BETTS, "AMERICAN THEATRES OF TO DAY" (ARCHITECTURAL BOOK PUBLISHING CO.)

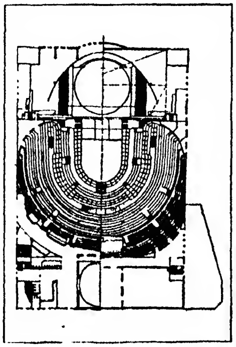
LONGITUDINAL SECTIONS OF VARIOUS TYPES OF THEATRES

A One floor type, B. Bleacher type, C. Stadium type, D. Single balcony type, E. Balcony-mezzanine type

The slant of the floor and the arrangement of the balconies bring out many interesting possibilities. Krapp combined the "bleacher," "stadium," and "single balcony" types in a so-called "arena" arrangement used experimentally in Chanin's Forty-Sixth Street theatre, New York, and better worked out in another Chanin playhouse, the Majestic, New York. The purpose is to get a very deep orchestra floor by running the entrance foyers under its steeply slanting rear. The Guild theatre, New York, (on a suggestion by Norman-Bel Geddes) managed to place its roomy lobbies under the auditorium without raising the latter so far above the street as to bring it into conflict with the fire regulations.

German Seating Arrangements.—In most countries fire laws have prevented the wider use of an arrangement of the

seats themselves which has found general popularity in Germany. This arrangement abolishes the aisles dividing the floor into sections, and the seating of the audience in one unbroken mass of solid, continuous rows from wall to wall. Adequate entrance and exit are obtained by spacing the rows a little wider apart than in the ordinary arrangement, and making the walls of both sides of the auditorium a succession of doors emptying into the lobbies. The effect of this arrangement is that the spectators are seated in one solid mass An equally important consideration — which should argue a change in fire regulations—is that a house seated on the German model can be cleared in half the time it takes an audience to press into and up the ordinary narrow aisles. This German seating arrangement has been used with success in the Kenneth Sawyer Goodman Memorial theatre, Chicago (Howard Shaw, arch), which happens to be located outside the jurisdiction of the Chicago fire commissioners



FROM ZUCKER 'THEATER & LICHTSPIELHAUSER (WASMUTH)

FLOOR PLAN OF SECOND AND THIRD BALCONY OF THE GROSSES SCHAUSPIELHAUS, BERLIN, DESIGNED BY HANS POELZIG, ARCHITECT

Stage Lighting from the Auditorium.—The stage arrangements, except as to adequate dressing rooms, property rooms, and scene stacking space, are matters for the theatre technician—scene designer, electrician, etc —not the theatre architect, although the architect should see that there is ample space allowed. Something should be said, however, on one point connected with lighting arrangements; this is the necessity of providing room in the auditorium for the placing of lights for the illumination of the stage and the actors In 1914 Granville Barker introduced at Wallack's theatre in New York a row of powerful incandescent lamps around the balcony rail to replace the footlights David Belasco took the next step forward by installing such lights in a recess in the balcony rail closed by doors automatically controlled from the stage switchboard Some such provision, or perhaps a light bridge concealed in the ceiling beams, as in the Yale university theatre, New Haven, Conn. (C H Blackall, arch), or the Guild theatre, New York, ought to be a part of every architect's plan of a new house

Decoration.—The decorative problem within the auditorium has found many solutions, depending on the kind of dramatic entertainment to be presented The modern decorative movement towards larger, smoother and less ornamented surfaces has its peculiar applicability to the playhouse, where the eye should not be distracted from the players by too ornate detail. Yet there is something undeniably exciting and truly theatrical in the rococo interior of the Residenz theatre in Munich (Cuvilliés, arch.), and Oskar H. Kaufmann, beginning with a rigid simplicity in the Volksbuehne and other houses in Berlin, has had delightfully amusing recourse to the Chinese baroque for the Theater am Kurfuerstendamm and the Komoedie also in Berlin. The limitations and the values of decoration depend, after all, on the interpretive genius of the architect

The new attempts to break away alike from the old horseshoe opera house and the realistic peep-show theatre all look back for their justification to the history of the development of playhouse architecture, and borrow heavily from the past.

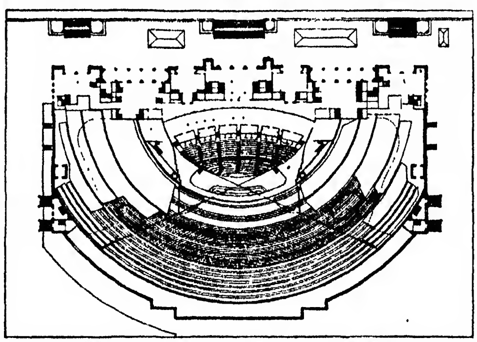
Development of the Opera House.—Following the Fall of Rome and the decline of classic culture the classic theatre disappeared save for a renewal of some of its form and spirit during a few brief decades of the Renaissance The theatre, and especially the early opera, supposed ironically enough to be founded on classical tragedy, became a mere excuse for brilliant court festivity. As a result of the desire on the part of the audience to be observed by one another good visibility for the stage suffered The style of the popular Italian opera predominated. The singers delivered their important arias as close to the prompter's box as possible while the chorus stood practically inanimate. Contact between the stage and auditorium disappeared and with it the spiritual union of performers and audience. Good acoustics and a brilliant social display were the demands made upon the Baroque theatre. The decorative type of auditorium with its heritage of the richness of the Renaissance and the charm of the rococo had originally been a thing of gorgeous, festive yet graceful beauty

In the course of years it added to the pernicious Italian shape new horrors of decoration and became that horrid overladen gold-and-plush spectre of its former self of which unfortunately we still see examples.

Toward the latter part of the nineteenth century, however, came evidence of change and reform Splendid acting was increasingly in demand and rich settings and appropriate historical costumes were considered essential to enhance the beauty of operatic music The problem of displaying these adjuncts began to make even the architects of the opera houses see that their art had reached a standstill and that some attempt had to be made to recapture the spirit and some of the form of the classic stage. Their efforts were partly compromises in the shape of the auditorium, partly a simplification of the baroque theatre following the more serious and less social tendencies of the legitimate theatre

The reform dates from the work of the Sempers in mid-Victorian days and is punctuated with March's Festbuhne for Worms in 1887. The attempts at a new type of auditorium seldom aim at a direct return to the classic but only to one of its descendants, the Shakespearian stage Already the results in projects and even a few completed playhouses have been notable

The Circus Theatre.—Steele MacKaye, actor, playwright, artist, director and inventor, was the first to produce a notable plan for a circus-theatre. In 1892 he had almost completed in Chicago as part of the World's Fair a remarkable structure called the Spectatorium Like so many efforts at the "theatre of the 10,000," it strove to gather together the huge audiences of Greek days and to bring them into close contact with all the possibilities of the stage. MacKaye devised a means of bringing his actors and choruses up from under the audience through steps in the orchestra pit He invented a proscenium opening that could be



PLAN OF STEELE MACKAYE'S SPECTATORIUM-THEATRE DESIGNED TO SEAT TEN THOUSAND PEOPLE AND TO INTRODUCE SLIDING STAGES, A LINOLEUM CYCLORAMA AND MANY OTHER MODERN STAGE REFORMS

made wide or narrow, thin or deep He provided a crescent-shaped stage with scenery sliding on tracks. This stage could be flooded with water. He closed in the back of his semi-circular stage with a linoleum cyclorama. He invented cloud machines for projecting moving clouds on the sky. There were few reforms of modern stage technique that this remarkable man did not foreshadow in this project, which the American financial panic of 1893 arrested when only half built.

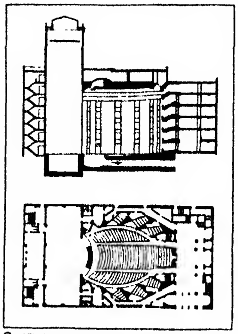
It was along the lines of this MacKaye theatre that Max Reinhardt built when he developed his performances of Greek tragedies

BY COURTESY OF ALAN PRIEST

CELEBRATED FIGURES OF THE CHINESE STAGE

1. Ch'êng Yen-Ch'iu, the greatest contemporary singer of popular female rôles, appearing as a female warrior
2. Yang Hsiao-Lou, left, and Wang Fêng-Ch'ing in "Lien Hua Hu," (Lotus Flower Lake). Yang Hsiao-Lou is reputed to be the greatest contemporary singer and actor of male K'un Ch'ü (classical) rôles
3. Han Shih Ch'ang, the greatest contemporary singer and actor of female classical rôles
4. Huo Shou-Chên as "Ts'ao Ts'ao," the traditional villain of the Three Kingdoms in "Ch'ang Fan P'o" (Long Hillside)
5. Chen Pi-Yen, right, and Chin Chung-Jên in "Hung I Kuan" (The Rainbow Pass)
6. Mei Lan-Fang in "Tai Chên Wai Chuan" (The Story of Yang Kuei-Fei)

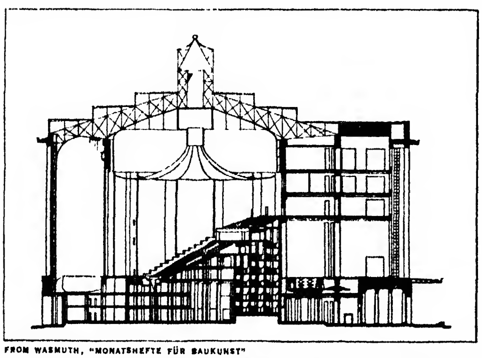
in circus buildings into the finally realized Grosses Schauspielhaus in Berlin (Hans Poelzig, arch.) Here he came close to the true conditions of the classic stage, with the actors appearing on a semi-circular orchestra floor almost in the midst of the spectators, and then retreating up steps to a completely equipped stage with sky-dome, revolving stage, and all the modern appurtenances The son of Steele MacKaye, Percy MacKaye, realized many of the values his father had planned in his open air performances of "masques" at St Louis, New York and Cambridge, Mass., between 1912 and 1927.



SECTION AND PLAN OF THE REINHARDT THEATRE, NEW YORK CITY, DESIGNED BY JOSEPH URBAN, ARCHITECT

Copeau's Theatre.—At the opposite extreme in size, Jacques Copeau created in the Théâtre du Vieux Colombier, Paris, a playhouse which united the actors on a naked architectural stage with an audience seated within auditorium walls that continued back unbroken by any proscenium to make the walls of the stage itself The Théâtre du Marais, Brussels (Louis Jouvet, arch), and other projects were offshoots from this pattern.

Non-realistic Theatres.—The stimulus of trying to give Shakespeare's plays as he wrote them and not garbled and condensed to fit the modern realistic theatre has resulted in a number of attempts to revive the conditions of the Shakespearean stage on the stage of an ordinary theatre This has brought back canvas make-believe, the portals of proscenium doors which all English theatres rejoiced in a century ago From merely represented as part of the scenery, these means of linking the actor and the auditorium have now been built into the actual prosceniums of many new houses, especially in the "little theatres" built here and there about the United States Some such theatricalizing of the stage is present in the Werkbund Theater, Cologne (Van de Velde, arch), with its tripartite division of the

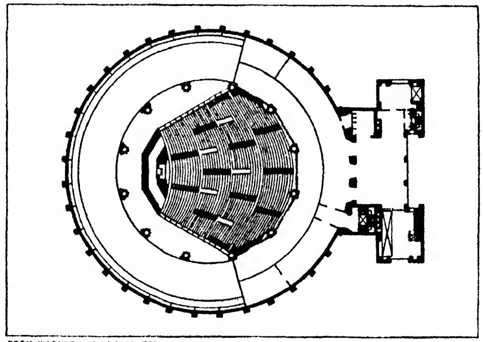


FROM WASMUTH, "MONATSHEFTE FÜR BAUKUNST"

SECTION OF A THEATRE DESIGNED BY OSKAR STRNAD, VIENNA

stage, and in A. and G. Perret's and A Granet's theatre in the Arts Décoratives exhibition in Paris. But certainly the handsomest playhouse of a formal and ultra-theatrical sort is the Theater in der Redoutensaal, Vienna (Sebastien Heinrich, arch.), a stage with permanent walls but no proscenium or fly gallery, set down in a ballroom of Maria Theresa. From productions in this house Reinhardt turned to the rejuvenation of a lovely old Viennese theatre, the Josephstaedter, and then created in Salzburg in the Reitschule a non-realistic playhouse which he hopes finally to replace by a magnificent, neo-classic festival theatre from the plans of Poelzig

Radical Projects.—Radical designs, which are as yet largely projects, include those of the distinguished American pioneer architect, Frank Lloyd Wright Norman-Bel Geddes has devised a remarkable theatre with the stage in one corner, the whole auditorium and playing floor surrounded by a single dome of light. He has also devised a long rectangular playhouse with the action



FROM WASMUTH, "MONATSHEFTE FUR BAUKUNST"

PROJECT OF A CIRCULATORY STAGE IN A THEATRE, DESIGNED BY OSKAR STRNAD, VIENNA

passing on a stage stretching down the middle from end to end, and with the audience on both sides, as well as a circular playhouse with the stage in the centre, a scheme suggested by Robert Edmond Jones's project for Shelley's *The Cenci* in a prize ring Variants on the usual relations of stage and audience are many, including a scheme by Friederich Kiesler for two opposing auditoriums sharing the same stage One of the most remarkable is Oskar Strnad's circular theatre with the audience seated in the centre and the big ring of the revolving stage coming into view a segment at a time

Out of all these attempts and projects, a really healthful new theatre is slowly but surely developing It will not reach its full maturity until actors can enter naturally and easily from the auditorium as well as from the stage and step down from their own level to the level of the spectators When every division between the world of the actors and the world of the spectators is eliminated, and when those who give and those who receive are —in the spirit of the classic theatre—once more surrounded by the walls of the same room, then and only then will it be possible to meet completely all the demands not alone for proper acoustics and proper visibility, but for purely spiritual pleasure achieved without hampering physical effort

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GENERAL PLANNING

Real development in modern theatre architecture started in the latter part of the 19th century and each year has brought added progress in planning and designing. Theatres 10 years old are out of date, while some 20 years old are practically obsolete From the point of view of construction, new methods due to the advent of modern steel framing, progress made in the science of lighting (*see* Stage Design) and the necessary adherence to present day building codes have been a few of the potent factors in this advancement Changing social and economic conditions continue to affect the theatre and its planning radically. The old style theatre with posts and horse-shoe balconies is gone. The theatres of only a few years ago containing a balcony and gallery

are now "old fashioned."

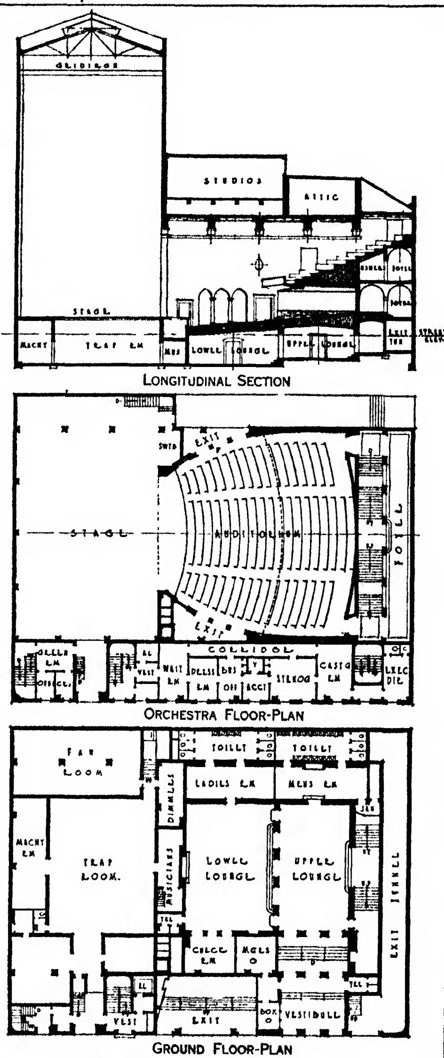
The modern theatre consists of a lower floor, or orchestra level, and one large sloping balcony. Sometimes a small mezzanine or loggia is placed between the lower floor and balcony. Every seat must be so situated as to have an unobstructed view of the stage. The auditorium floor and balconies must have the proper curve or incline, to ensure proper "sight lines." The acoustic problem must be worked out so that each patron will hear distinctly, to accomplish which methods that eliminate as much as possible all reverberations must be employed. The stairways, foyers, lobbies, box offices, lounges and retiring rooms should be so laid out as to avoid confusion. The architect should strive for perfect circulation of the patrons. The box office should be situated at the right hand side on entering a theatre. The entrance doors and the main stairs to the balcony should also be placed at the right hand side. The exit doors and a stairway from the balcony to be used when leaving the theatre should be on the left hand side of the main lobby. This arrangement allows the incoming and outgoing audiences to pass without mixing.

On account of the high land value, it has often been necessary for the architect to get a maximum building on comparatively small property, with the result that after space has been utilized for an adequate stage and maximum seating capacity, there remains in most cases comparatively small areas for public spaces such as foyers and general lounges. The traffic problem in most of the larger cities makes it impossible for the entire audience to be in their seats at the rise of the curtain. Late arrivals coming into the small vestibule and foyer spaces of the usual dramatic theatre spoil the opening of many performances. A constructive development to alleviate this condition is represented by the device used in the new Theatre Guild theatre in New York, where the audience enters the theatre by a lower level than the street. On this level are situated the lounges and retiring rooms. A large stairway leads to the promenade and the rear of the auditorium from which the patron enters without confusion. Although in this scheme the main floor is above the street level, the necessary slope of the floor brings the lower part of the main auditorium to street level elevation, where the main exits are situated.

The motion picture industry has had more to do with the building and development of theatres than any other agency. The so-called "movie" is usually a theatre with a fairly large seating capacity, spacious provisions for orchestra and organ, but no stage. A small platform usually suffices for the performance given in addition to the pictures. These auditoriums in most cases are treated architecturally and decoratively as one room. As this type of theatre is usually longer than it is wide, the auditorium treatment is as elaborate in the rear as at the front, giving the patron sitting in the rear seat the feeling of closeness to the stage.

Problems.—Architecturally, each type of theatre has distinct problems. Dramatic houses and opera houses have to care for audiences during intermissions, these audiences usually leave en masse; therefore, lounges, foyers and promenade spaces must be provided to allow the free movement of the people and to avoid congestion. Most moving picture theatres are run continuously and the patrons for the most part come and go at no specific time, in them perfect circulation is most necessary. The exterior treatment of all types should be somewhat festive and characteristic of their function. More restraint and dignity should be expressed on the exterior of dramatic than vaudeville or picture houses. Since the moving picture theatre depends a great deal on the passer-by for its patrons, its exterior should be designed to attract attention and should have a very inviting and unusual façade; electric illumination is utilized to a great extent to enliven and add glamour to it.

Every theatre should have a marquee at the entrance. This marquee or ornamental canopy is used for a double purpose: (1) to protect the public on entering or leaving the theatre during inclement weather; (2) to afford an excellent means of advertising. The marquee of a modern theatre is in reality a very ornamental electrical sign attached to the three sides. It should be carefully designed so as to add to the appearance of the façade.

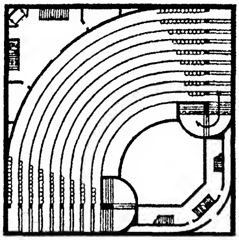


PLAN OF THE THEATRE GUILD THEATRE, NEW YORK CITY, DESIGNED BY C. HOWARD CRANE, FRANZHEIM AND BETTIS, ARCHITECTS

Rarely does one of these signs enhance the architecture of the building and in most cases hideous results are obtained because it is designed by inexperienced draughtsmen without regard for the architectural treatment of the exterior. However, much more extensive consideration is now being devoted to the problem of the marquee not only by architects but by sign makers also. In consequence of this changed attitude more harmonious and artistic results are being attained.

The old method of treating the interior of theatres was first to design an elaborate proscenium arch or frame, then to treat the proscenium boxes very ornamentally but less elaborately than the proscenium. From these boxes back to a point near the centre of the balcony, a very simple treatment was generally used, and

from this point to the extreme rear a very plain one. In this type the audience was really sitting in so many different rooms, varying with the distance from the stage. There was no continuity of design. The modern method is to unify the auditorium or to treat the theatre as one room, making no distinction in elaborateness of detail because of location. Psychologically, a higher 'audience *moral* is effected as this scheme of decoration, eliminating segregation by sections, establishes a feeling of equality between patrons



NORMAN BEL GEDDES THEATRE
This theatre provides for a stage and auditorium both under one domed roof. The triangular stage in the lower right corner sinks into the basement for changes of setting

Increase in Size.—The latest development in the design of the theatre is brought about by the building of the present-day "super cinema palace" Here the architect has been allowed to use to the fullest his imagination and ability. The acoustics and sight lines must be perfect Unusual lighting effects must be devised and provisions made for the latest modern development such as talking pictures, public address or amplifying systems, and mechanically operated stage and organ lifts. These theatres operate usually on a 12-hour schedule and are often attended by as many as 30,000 persons in one day Expert planning is necessary adequately to house and control these large audiences Some noteworthy examples have been completed recently; they are rich in ornament and gorgeous in colouring and lighting effects, and they are usually extremely elaborate in furnishings Due to their extreme widths and to the essential absence of posts, these large modern theatres present great structural problems. Fresh, cooled air in summer and pure, warmed air in winter must be constantly and evenly distributed to every part.

Equipment.—Theatres seating between 5,000–6,000 persons, with large comfortable chairs liberally spaced, are now being built in nearly all the large cities of almost every country Theatres of this size would ordinarily produce serious problems in acoustics. By means of public address systems or a series of cleverly concealed amplifiers, evenly distributed over the theatre, an operator, by simply turning dials similar to those on a radio set, can increase or diminish the stage performer's voice at will Proper precautions must be taken to overcome reverberations. This is usually done by careful and scientific use of absorbent materials, of either specially prepared plaster or felt. Disappearing organ and orchestra lifts, enabling large orchestras to enter and leave the pit without confusion to the audience, are necessary. They also permit the orchestra to be raised in full view for the overtures and special numbers, and to be concealed when playing incidental music accompanying the pictures These lifts or elevating platforms are controlled by push buttons fixed by the leader's desk. The operating rooms or projection booths are becoming the most important part of the entire ensemble. With the introduction of talking pictures, coloured photography and amplifying systems, projection booths have to be very carefully planned They are strictly fire-proof and contain all the modern fire prevention equipment possible. Automatic shutters cover all openings Metal furniture is used throughout, and a decorative note is often afforded by fine tiles. Dressing and rest rooms, including showers and toilets, are provided for the operators, and there is usually a separate room for rewinding film.

The stage equipment is also of the latest and finest description The switchboard, controlling the many coloured effects both on the stage and in the main auditorium, is a complicated work. With its many-coloured pilot lights, pre-set switch handles, and numerous other controls it almost resembles a complete organ manual and is almost as difficult to operate. The old-fashioned fly gallery and pin rail, with sand bags for counterweights, is gone. The modern method of handling scenery is by the latest improved counterweight systems The operation of a small lever will bring a drop into position quickly and without effort. The controls are usually placed on the stage level. Wire cables have replaced the old-style ropes, and gas pipes the wooden battens, to which the scenery was formerly attached. All stages are equipped with sprinkler systems, automatic ventilators and fire curtains Modern safety laws require fire-proof scenery, with the result that the fire hazard, in the present-day theatre, is reduced to a minimum One of the most important pieces of stage equipment to-day is the cyclorama. This is a large elliptical-shaped piece of scenery reaching from the stage floor nearly to the gridiron. It is absolutely plain and usually painted a neutral tone so that all kinds of lighting will be effective on it It is used as the sky or back piece of the settings. The cyclorama is unequalled as an agency in obtaining beautiful stage effects The usual cyclorama is constructed of plaster or heavy sheet boarding and in many instances also acts as a sounding board.

The following represents a list of some of the rooms required in the operation of a large modern theatre. assembly room or green room; dressing rooms; chorus and ballet rooms, for both men and women, all equipped in a modern manner with bath and toilet facilities; stage manager's and assistant stage manager's office; wardrobe rooms; commissary department; carpenter and electrical shops; large and small property rooms; private offices for the conductor, assistant conductor and organist, a music library and a fire-proof vault for sheet music storage; a lounge room with necessary toilets and locker rooms adjoining, for the musicians, an instrument storage room; soundproof motor rooms for the organ blowers and mechanical lifts; rehearsal room with picture screen and operating booth; locker and toilet rooms for the men and women ushers; building superintendent's office, lockers and wash rooms for the scrub women; numerous small rooms for electric lamp storage and other supplies One of the greatest developments is in the lounges and retiring rooms provided for patrons

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(C. H Cr)

MODERN THEORY OF DESIGN

To the Greeks, the theatre was their most vital creative expression, and they succeeded in achieving results that for "pure theatre" have never been surpassed They built them to look like theatres and to dignify what transpired within them The Greeks lived in an age of imagination. Their knowledge of the material world was much more restricted than ours It was as uncharted to them as the universe is to us, and life had a greater interest for them because of this mystery In this mood, they created their drama. Their tragedy penetrated the mysteries of nature beyond the humdrum of ordinary life Their comedy was carried to an extreme that, to our gradually neutralizing mind, appears exaggerated and vulgar Civilization has by degrees impoverished its audiences from an enthusiastic appreciation of extremes toward a glorification of the commonplace mean

We live in an industrial age. We should have theatres that belong to our time, drama that voices this time. Instead, our theatre is a secondary expression We exercise our emotions by reading daily papers, riding in automobiles, listening in on the radio, playing bridge and seeing mediocre motion pictures. The theatre is in a state of sham. The plays, the actors, the scenery, all try to make audiences forget they are in a theatre The buildings themselves are made to look like office buildings, taverns,

museums, Renaissance palaces, Spanish missions or casinos To plan a practical theatre, the designer, architect, or engineer should possess a knowledge of theatres, past and present, and of the latest experiments toward the future, with an experience in the theatre that would class him with such specialists as are called upon to build our sky-scrapers, suspension bridges and subway tubes In exterior design, the most conspicuous elements, such obviously dominating features as the electric signs, the *porte cochère,* the huge cubical mass of the flying space above the stage, offer problems of unusual contrast specifically in theatre design

Primarily, the theatre in this modern world, from every standpoint, lacks style. Inside and out, it should be distinguished It should look and be "theatre," in its architecture, plays, acting or staging Theatres naturally vary in size, requirements and class of entertainment. The point of view of the artists engaged in the theatre should likewise vary The working parts of a theatre must possess the utmost flexibility, must be alterable, in simple practical terms, from one person's use of it to another's, hampering experiment as little as possible Until the theatre, architecturally, becomes more flexible, the dramatist, producer, designer, will continue to have difficulties in exploring new forms For any radical or improved or experimental idea, in dramatization or staging, beyond what has been developed in the last 15 years, the present stage is inadequate It suffices for only a few types of plays, and is completely impractical for any style out of this groove It is probably the most restricting theatre man has ever conceived New basic ideas of architecture will materially stir the imagination of everyone connected with it Instigate a type of stage of a three dimensional order and see what happens in the actual creative work in the theatre

To any student of the subject, the development of the theatre since the Greeks shows gradual deterioration The single item that has most influenced these changes is the proscenium arch There was no arch in the Greek theatre, but by successive stages from that time to the present, the arch idea has developed Its two dimensional aspect imposes an effect which is deadening, as compared with the exhilaration of an audience surrounding the actors, such as we get in the circus There is no more reason or logic in asking an audience to look at a play through a proscenium arch than there would be in asking them to watch a prize fight through one At a prize fight, although each individual looks into the ring from one point of view, a more intensified atmosphere is gained by the sight of the audience seated on all sides of the ring In an art gallery, looking at a piece of sculpture, you instinctively walk slowly around the object to view it from different directions, rather than merely standing and looking at it as you would a painting. The exaggerated importance of the picture-frame stage of the past generation is undoubtedly due to lack of imagination of the minds working in the theatre After all, the proscenium in its present maximum form has only existed over one-fifteenth of the time that has lapsed since the theatre of Dionysus.

In thinking of the theatre, we naturally begin with the stage. The auditorium is built around the stage and a relationship must be maintained between these two major elements. In nearly all modern examples, the stages are too small in proportion to the auditoriums Half of the audience is in a poor position to see and hear The inadequacy of the stage is accepted as a matter of course, since the actors have sufficient space to move in during a performance Actually, the part of the stage that the actor utilizes during the playing of a scene is only about a tenth of the total cube required for stage purposes The off stage space (to both sides and rear of the acting area) should equal three times the floor space of the acting area in order to handle adequately the changes of settings In most modern theatres, it is not even equal to it The entrances and exits for actors, the facilities for handling scenery, properties and electrical apparatus are neglected correspondingly The flying space (above the stage) should be four times the height of the maximum scene, but seldom is. The present-day stage does nothing for the dramatist but cause him to worry as to how this or that idea will be visualized in two dimensional terms, and it has gradually reduced the actor to an immobile loud speaker. The last few years have brought out various mechanical features, such as the application of the hydraulic, revolving, sliding and turning-over principles for changing part or all of the stage with its scenery; and a permanent plaster cyclorama to replace the drop cloth painted to represent a sky, upon which light of any colour can be thrown. But although all of these are important, they fail to get at the root of the difficulty, which is the adjustment of the style and proportions of the theatre to its uses and needs while the building is being planned.

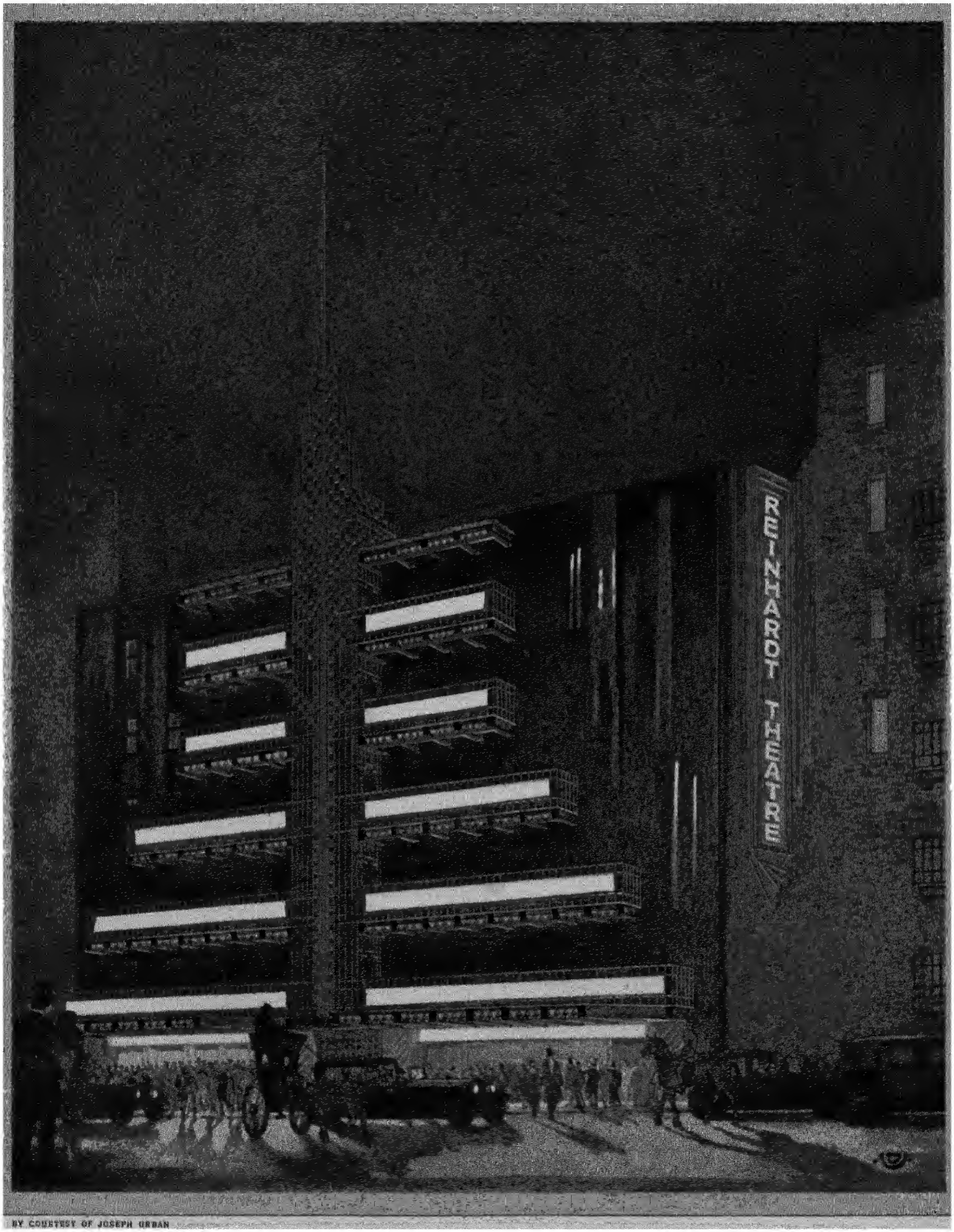
The auditorium should be designed so that everyone may enter easily, reach his seat without annoying other people, sit comfortably, see and hear everything on the stage. The best angle of vision between the stage and the seats, because we are most accustomed to it in everyday life, is shoulder height, yet in our theatres to-day, the best seats, judging from the scale of prices, place the spectator's eye on a level with the actors' feet Each successive row of seats should be at an angle in relation to the stage, so that the spectator does not have to peer between the heads of those in front of him

The audience is the governing factor of drama There can be no drama without it All the dramatist, director, designer and actor do is to project elements which will create a certain effect in the audience's imagination A dramatic production has no significance until it is performed in conjunction with its audience This is why each type of play sifts out its particular audience The theatre takes its place among the arts when the audience not merely witnesses a reproduction of life as it is outside the theatre, but takes part in an experience that does not exist anywhere outside the theatre

Suffering from the limitation that it is not a single-vision medium as that of painters, sculptors, poets, musicians and architects, the usage of the theatre is contradictory to what is accepted as the ordinary working procedure of an artist The dramatist works in a composite medium, which is stage, actor and audience The designer takes the play and develops it for production in all its visual phases, working out its rhythm, movement, manner of staging, setting, costuming, lighting Finally the director, whose position is synonymous to that of the orchestra conductor but who uses actors instead of musicians, rehearses all of these elements into an unified performance The dramatist reaches his audience indirectly through the director, designer and actors His work may be limited by these people, or his stimulation may inspire them to develop his ideas further than he could have done alone The result, good or bad, is the very element that gives the theatre its unique qualities, its advantages and disadvantages, over other forms of expression

The end we seem to be going toward has a more plastic three dimensional stage structure, formal, dignified and neutral, as a basis, its various acting platforms inviting a variety of movement, and provided with adequate space for lighting instead of the cramped condition of the present. Such a structure is designed for the playing of a sequence of scenes of diverse mood, locale and character, not imitative in geographical terms, but creative in dramatic terms, with emphasis on the intensity of dramatic action and its projection to an audience. It will give the impression of being solid and enduring, and will be composed of a variety of levels, ramps, platforms, aprons projecting into the audience, high stages towering to the rear, the whole achieving pictorial qualities by the composition of actors on various levels and their movements in conjunction with lighting. Portions of these settings may or may not be changed to vary as a play goes on Any adequate technique for staging plays should permit of a play being run off in any combination or series of rhythms and not destroyed by such crude makeshifts as darkening the stage or lowering of the curtain to make changes in the setting

Theatres for motion pictures are bound to alter and become distinct from theatres for plastic drama, and in the same way that screen drama is of necessity going to emphasize two dimensional vision, the stage drama, as it develops away from the picture medium in a mental sense, will likewise grow away from it in a physical sense and become decidedly more three dimensional. (N B. G.)



BY COURTESY OF JOSEPH URBAN

THE PROJECTED REINHARDT THEATRE IN NEW YORK CITY

The projected Reinhardt theatre, designed by Joseph Urban as the American home of the well-known German impresario, is an example of the adaptation of theatre architecture to modern needs. On a façade of black glass, balconies of gold metal-work conceal fire-escapes and serve, at the same time, as display boards for illuminated advertisements. The grilled tower contains an emergency staircase

PRODUCTION AND DIRECTION

MODERN TENDENCIES

At one time or another the theatre has used some part of every method of production that we so fervently hail—or condemn—as the last word in modernism to-day, for in 25 centuries it has been all things to all men. It has been religious and blasphemous. It has been as noble as its god-heroes and as petty as its bourgeoisie—whether of Rome or London It has been fantastic and formal in the temples of the living masks where men meet the gods throughout the East It has been minutely realistic Back in Greece, when someone painted wave-lines on the *periaktoi,* and thus let the audience know that it stood by the shore of the sea, the theatre was expressionistic A performance of *The Tempest* on Shakespeare's open stage, with the sailors swarming up the ropes into the canopy overhead, would have satisfied the constructivism of Meyerhold. And when Reinhardt puts *Oedipus Rex* into a circus or gives Calderon's *The Great World Theatre* in a cathedral he is merely imitating with conscious art the naive habit that the ancient theatre had of playing cuckoo and laying its eggs of art in amphitheatres, chancels, inn yards, bear-pits, tennis courts, market places, and court ballrooms

Enter the Régisseur or Director.—Yet, in a narrow sense, there are modern tendencies in the theatre—two major tendencies, both founded on a new attitude towards the complex business of getting actors to speak lines in an effective *ensemble* The new attitude is seen in the commanding presence of a director Some one has always insisted that the actors learn their lines, speak them with a certain skill, and walk where they will not trip over one another's heels or become entangled with the properties. But the commanding director—or *régisseur*—is the notable contribution of the theatre of the past half century From Duke George II. of the little German State of Meiningen—who fused supers into true mobs, put ceilings on box sets, and created the first modern *ensemble* acting in the middle '70s—through Otto Brahm, first master of naturalism at the beginning of the 20th century, Max Reinhardt, Brahm's disciple to begin with, then pioneer in every form of theatre from cabaret to cathedral and little theatre to circus, Meyerhold the Russian, who preached and performed the "theatre theatrical"—from these masters on to the director of the tiniest of community theatres in some Californian town, the *régisseur* has taken his place as the centre of the modern theatre. His business has been to dominate, synthesize, and unify each production, and thus to bring forth a single work of theatrical art in-instead of a histrionic accident

Realism Versus the Theatric.—Without the *régisseur* neither of the two great schools of modern production could have developed A single mind was needed to shape the performance, set its character, give it its pace, provide its atmosphere in scenery and lights. It did not matter whether the result was to be a realistic production or a production in which the true theatricalism of the stage was to be liberated—one creative spirit had to dominate.

In the terms of the past century, realism is a much older thing than the theatric, although the theatric goes far deeper into the historic past Realism is likely to dominate the stage as long as machine civilization dominates life It has already come to a fine perfection, and we are more familiar with it than with the theatric. We have seen realism at its height in Stanislavsky of the Moscow Art theatre, and occasionally in David Belasco or Basil Dean We have not seen much theatric acting outside Russia and Germany. In America and England the theatric and imaginative movement has expressed itself largely in things of the eye—in the scenery of the new stage-craft The battle of realism and the theatric—first with a common enemy, then with each other—can in many ways be seen best through the activities of the *régisseurs* of scenery, the stage designers who have given it outward physical form. Nothing but the theatre could harbour artistic tendencies so diverse. But, though one is photographic and one is imaginative, both began in fierce opposition to the theatre of Victorian days. The thing that both hated in this theatre was typified in its scenery, ugly, unillusive, accidental.

Thus two very different types of artists were leagued as allies. One was the realist, like Belasco, who wanted solid, plausible rooms on the stage. The other was the man of imagination, like Gordon Craig, who wanted beauty or something full of expressive artifice There was a little of each in the first great *régisseur* of the 20th century, Max Reinhardt. Together, the realist and the artist of the imagination banished the mechanism of the older stage. They banned false perspective and shallow pretence, muddy colour on flapping backdrops.

Realism triumphed first It had the great dramatists of the day behind it, and the mood of 20th century audiences. Maeterlinck and von Hofmannstahl and d'Annunzio put up an anaemic front to Ibsen, Hauptmann, Sudermann, Brieux, Pinero, Jones, and Shaw The *régisseur* developed actors who could convey emotion by the quiver of an eyelash, and he found ways to surround them with the solid world of reality

Mechanical Progress.—But how were the solid columns, weighty staircases, well-braced walls to be moved? How were scenes to be shifted quickly and economically? The problem was not alone a problem for the realistic producer, for when the *régisseur* put on Shakespeare the new settings were solid, plastic, three-dimensional, and he had dozens of these scenes and no long intermissions in which to change them The answer—the typical answer—was modern machinery America led—for just a moment or two in 1888—when Steele MacKaye, *régisseur,* actor, playwright, painter and mechanist, installed his double elevator stage in the Madison Square Theatre, New York, to shift scenery, actors and all. The great bulk of mechanical reform, however, has come from Germany, and dates from 1896 when Lautenschlaeger of Munich borrowed the revolving stage from Japan Other scene-shifting machines from Germany include the sliding stage, which carries whole settings on great wagons, and sinking stages, which bring up the scenery from the basement Arthur Hopkins, the first American *régisseur* of imagination to follow MacKaye, introduced, about 1914, stages that swung on pivots, and Lee Simonson, the American designer, has made most ingenious use of small revolving units in Theatre Guild productions such as *Peer Gynt.* (*See* STAGE DESIGN)

Progress in Lighting.—Even more energy and resourcefulness has gone into the improvement of lighting equipment since the days of gas, and this has served both the realist and the producer of imagination. The first notable attempt was made in Germany by the Venetian, Fortuny. His aim was to provide diffused and softened light, more like the reflected sunlight of a shaded spot. He threw all the light rays of an arc upon screens of coloured silk which reflected them upon the stage. His sky-dome or *Kuppelhorizont* further diffused the light while producing an illusive sky of almost infinite depth From the mechanism of Fortuny and the ideas of Gordon Craig's great rival, Adolphe Appia—who first called for the shadowed, sculpturesque lighting that comes from large sources of illumination, instead of the blank glare of the footlights—electrical invention has gone on to a surprising degree of perfection in Germany and America. Through Max Hasait and Adolph Linnebach, both working at Dresden in hot rivalry, devices were at last perfected for projecting scenery by means of light on to backdrops or cycloramas. Simonson made fine use of the Linnebach process in *Back to Methuselah* and *Peer Gynt.*

There is, after all, a considerable difference between a decoration thrown on a backdrop by electric light and interiors so solid and heavy that they must be shifted by machinery And yet both extremes fall easily within the limits of the revolt which realist and theatricalist began in the name of the new stagecraft. Even the old-fashioned backdrops of the opera house, painted in false perspective, have their place in the modern movement of the imagination if only they are painted with the boldness, the dramatic vigour, and the expressive colour of a Russian like Bakst or Roerich or Golovin If the artist can create an effect upon the stage just as characteristic of the play and its emotion as anything the actors may do, then he has done the work expected of him. The medium and the method do not matter

Pioneers of the New Stage-craft.—This was not quite so clear when Gordon Craig and Adolph Appia began their campaign of scenic enlightenment about the beginning of the 20th century.

All about them the stage was filled with flat and shallow artificiality There was neither beauty nor truth to life in the jaundiced meadows and mildewed mountains and splayed rooms which the hack scene painters spread over backdrops and wings in very, very false perspective. The realist and the imaginative artist had to hate them equally Craig and Appia might have accepted the stage conventions of the old theatre—the simple flats and backdrops, and awakened them to new life as the Russians did Instead they fought them, and fought them on the one legitimate issue on which they can be fought Paintings in two dimensions do not and cannot harmonize with three dimensional actors. So away with false perspective and its painted shadows. Make room for solid plastics, for rocks and walls against which the actor may lean

Gordon Craig did a great deal more than argue against backdrops and wings In his articles and books he showed that the theatre is a composite art made up of the contributions of playwright and actor and painter and musician. He demanded unity upon the stage and he declared that the ideal artist of the theatre must be the man who can write the play, direct the actors, design the scenery and lights, and provide any other element such as the music or the dance that may be needed Only in this fashion can the theatre have the creative unity which is at its heart. And in all his writing and through all his brilliant designs, Craig sought to interpret in as dramatic a fashion as possible the emotion of the play.

Appia, a Swiss doctor, who began theorizing and sketching in the early '90s, stood likewise against false perspective and in favour of the plastic stage. Like Craig, he was truly a *régisseur.* His great contribution was a sense for the value of light. In his book describing and picturing the production of Wagner's music-dramas, Appia provided many appropriate and striking sketches, dictating the movements of actors as well as lights He showed how spotlights, used instead of footlights, produce shadows; how light and shadow give a sculpturesque quality to everything on the stage, and how changes in the light can indicate the passage of time and the development of the drama. To demonstrate this, he drew a series of sketches of scenes from Wagner's music-dramas following the light changes throughout each act.

When the theories of Craig and Appia annihilated the old stage setting, they opened the way for something they were not the least interested in—realism. Fortunately they also provided the corrective for it. When realism is most complete it is at its worst It then furnishes an absolute photograph of life. A room becomes a junk shop. It is solid, real and wooden, and utterly confused. There are so many knick-knacks about that you can hardly find the actors The eye is tempted to wander off and count the bowls of flowers and admire the woodwork and discover curios all over the place. Belasco and all the realists have now learned better than this So far as America is concerned, Arthur Hopkins and the artists of the new stage-craft have taught them how to make a room seem real and plausible and yet never distracting, and how to make it express something of the drama that goes on within

Making Scenery Abstract.—The modern theatre has been quick to recognize that the mood created by a background is the important thing, and that, generally speaking, the less the material world is involved, the more the actor can summon up an ideal world of the theatrical imagination. Directors and designers tended, therefore, towards experiments with more and more abstract settings Craig began with curtains, using them for walls. In a scene for a modern play, Robert Edmond Jones painted his curtains brown and green and hung them in folds that, under proper lighting, suggested a forest Other artists—Norman Wilkinson, for example, working in England under its one modern *régisseur,* Granville Barker—go a step further and treat curtains frankly as curtains, painting them with a landscape or a formal arrangement of stars, and then—so there cannot be the least possible mistake about it—draping the curtains in folds, and banishing even the quasi-illusion of the old backdrop.

Screens can be used even more abstractly. About 1912, Craig worked out a scheme for equipping a theatre with a set of folding screens of all sizes which could be rearranged in an endless variety of ways When Stanislavsky tried to use this system of screens for *Hamlet* at the Moscow Art theatre, he found grave difficulties in the way of its practical employment. These difficulties were largely removed in a scheme devised by a pupil of Craig's, Sam Hume, which he used at the Detroit Arts and Crafts theatre.

In all this talk of scenery, you must note implication after implication of how the *régisseur* will direct the company towards an art far, far removed from the realism of the Moscow Art theatre. When the theatre goes still further into the abstract or the fantastic in stage setting, it must carry the actor along with it, or it is nothing Already designers have thrust upon the stage the expressionistic methods of modern painters like Picasso —himself a designer for the Russian ballet of Diaghileff In America, and in most of the Continent outside Russia, the *régisseurs* have done little to match these backgrounds with acting The outstanding exceptions—Meyerhold, Yevreynoff, Komisarshefsky, Tairoff and Zemach, all of Russia—have laboured to infuse into the actor and the *ensemble* a stylized vitality which distinguishes their performances from anything in the Western world.

Expressionism and Constructivism.—Expressionism, whether of acting or scenery, postulates that the expression of inner emotion—which ought to be the emotion of the playwright and his play—comes before any resemblance to the outer aspect of life. Expressionistic productions use distortion to arrest and excite the attention. Doorways assume strange forms, as in that notable attempt in *Macbeth* which Robert Edmond Jones and Arthur Hopkins made in New York some years ago without acting to back them up Walls topple The floor shoots up at weird angles. Lights flare in with no relation to reality, and shift in colour almost word by word The make-up of the actors is startlingly obvious in its distorted lines, and the clothes of even modern characters are painted with high lights and shadows.

One can almost go back to Appia for the beginnings of constructivism, for Appia was the first to stress the necessity of varied levels on the stage They have become increasingly important in the work of the more radical *régisseurs.* Leopold Jessner, Germany's outstanding director since Reinhardt, added these levels to the formal stage of the more conservative expressionists. By using steps and parapets, he was able to move his people in three dimensions, and make their physical relationships more vivid and significant In each of his Shakespeare productions he stuck to a single arrangement of steps, upon which he arranged a few of Emil Pirchan's simply sketched indications of *locale,* all within the neutral wall of the often unlighted cyclorama.

From Jessner one leaps to Russia to find Meyerhold, a great theatrical pioneer, developing in constructivism an art which seems to steal its settings from the American skyscraper. High platforms, skeletonized structures, inclined planes, all manner of bare, unsentimentalized construction provide the footing as well as the background for the actors, and three or four *locales* are shown at one time—a trick of the Renaissance. Tairoff mingles canvas expressionism with this when he mounts Eugene O'Neill's *The Hairy Ape* or *Desire under the Elms.* In the musical studio of the Moscow Art theatre Dantchenko has refined and humanized constructivism in performances of *Lysistrata* and *Carmen.*

New Theatres for Old.—Certain attempts at formalizing the existing stage carry us clear out of this phase and into new types of playhouses Robert Edmond Jones's *Hamlet,* for instance, turned a Romanesque hall into a permanent setting for the whole drama. Such a scheme makes no pretence at the illusion of turrets, woods or any place except the theatre, tinged with the colour and mood of the drama. This recognition of the playhouse as a place of frank make-believe has carried many modern directors into experiments in theatre architecture that recall the stages of Greece and Elizabethan England. Reinhardt, after producing Greek tragedy in the one-ring circus buildings of Germany, reconstructed one of these houses into the Grosses Schauspielhaus. Here the actors could appear on the orchestra floor in the midst of the audience or retreat to a fully equipped modern stage with

sky-dome and revolving floor

Half a dozen artists have designed theatres of even more revolutionary character. One of these, not yet built, however, is Norman-Bel Geddes's project for a stage in the corner of a sky-dome completely arching in the auditorium as well. The stage itself sinks into the basement for changes of scene to be made by means of rolling platforms already set. MacKaye's Spectatorium, conceived and partially built for the World's Fair in Chicago, was to seat 10,000 people. The stage itself was to introduce a number of reforms now adopted abroad—the sky-dome, the adaptable proscenium opening and fore stage, the cloud machine, and a sliding stage on wheels The whole stage could be submerged in water for the discovery of America by Columbus.

Europe created two theatres of outstanding novelty in the Vieux Colombier of Copeau and the Theater in dem Redoutensaal opened in Vienna by Adolf Vetter, then head of the State theatres. The Vieux Colombier was a tiny playhouse without a proscenium opening in which the audience and stage were contained in a single room. The stage itself was provided with a permanent architectural setting of steps and balcony which could be converted, for example, from a classic exterior into a scene for *Twelfth Night* by altering parts of the decoration.

The Theater in der Redoutensaal is again a theatre with no proscenium and, therefore, no fourth wall and no peep-show. At one end of this great and glorious ballroom of Maria Theresa, Vetter and Oberbaurat Sebastien Heinrich placed an acting platform without proscenium or "flies" Upon this platform is a curving wall perhaps 15 ft high, carrying out the decorative motifs of the hall and making a permanent background for the stage In the middle, double stairways curve up to a balcony above. Upon the balcony are great doors leading to other rooms. The shell of cream and gold wall is pierced by openings for doors and windows Screens or simple set-pieces serve to vary this setting, and to indicate mood and place. *The Marriage of Figaro* was there presented by the forces of the State opera, and Max Reinhardt has staged many classic comedies in the Redoutensaal.

The bulk of this effort to match the realistic theatre with a theatre of imagination has gone forward unsupported by proper plays. The classics have served best Some modern dramas have been badly distorted to fit them to the Procrustean bed of expressionism In Germany a certain number of playwrights, led by Georg Kaiser and Walter Hasenclever, have made valiant and none too successful efforts to provide free and vivid plays of to-day cast in a nervous, fast-moving, subjective form. The success of the Russians in matching plays to constructivist production had not been so notable as to pass the frontiers by 1928. The only distinctly promising efforts towards new dramatic form have come from America and largely from the pen of one writer, Eugene O'Neill Elmer Rice's *The Adding Machine* and George S. Kaufman and Marc Connelly's *Beggar on Horseback*, adapted from a German original, have succeeded in enkindling a public response, but the pioneer work of John Howard Lawson, Francis E Faragoh, John Dos Passos, and Em Jo Bassche has failed to meet the requirements of the audiences of to-day. O'Neill's expressionistic drama *The Hairy Ape*, his constructivist experiment *Desire Under the Elms*, his drama of masks *The Great God Brown*, his nine-act exposition of spoken thoughts *Strange Interlude*, and his printed play *Lazarus Laughed*, seem the only completely mastered attempts of a playwright to strike out along the paths that modern pioneers in direction, scenery and acting have marked out.

(*See* STAGE DESIGN: *Stage Lighting, Theory; Modern Practice;* COSTUME DESIGN; THEATRE ARCHITECTURE; THEATRE: *Direction and Acting;* ACTING.)

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DIRECTION AND ACTING

Theatrical art has always been collective, arising only where poetical-dramatic talent was actively combined with the actor's The basis of a play is always a dramatic conception; a general artistic sense is imparted to the theatrical action by the unifying, creative genius of the actor Thus the actor's dramatic activity begins at the foundation of the play In the first place, each actor, either independently or through the theatre manager, must probe for the fundamental motive in the finished play—the creative idea that is characteristic of the author and that reveals itself as the germ from which his work grows organically. The motive of the play always holds the character developing before the spectator; each personality in the work takes a part conforming to his own character; the work, then developing in the appointed direction, flows on to the final point conceived by the author The first stage in the work of the actor and theatre manager is to probe for the germ of the play, investigating the fundamental line of action that traverses all of its episodes and is therefore called by the writer its transparent effect or action. In contrast to some theatrical directors, who consider every play only as material for theatrical repetition, the writer believes that in the production of every important drama the director and actor must go straight for the most exact and profound conception of the mind and ideal of the dramatist, and must not change that ideal for their own. The interpretation of the play and the character of its artistic incarnation inevitably appear in a certain measure subjective, and bear the mark of the individual peculiarities of the manager and actors; but only by profound attention to the artistic individuality of the author and to his ideal and mentality, which have been disclosed as the creative germ of the play, can the theatre realize all its artistic depth and transmit, as in a poetical production, completeness and harmony of composition Every part of the future spectacle is then unified in it by its own artistic work; each part, in the measure of its own genius, will flow on to the artistic realization aimed at by the dramatist

The actor's task, then, begins with the search for the play's artistic seed. All artistic action—organic action, as in every constructive operation of nature—starts from this seed at the moment when it is conveyed to the mind On reaching the actor's mind, the seed must wander around, germinate, put out roots, drinking in the juices of the soil in which it is planted, grow and eventually bring forth a lively flowering plant Artistic process must in all cases flow very rapidly, but usually, in order that it may preserve the character of the true organic action and may lead to the creation of life, of a clear truly artistic theatrical image, and not of a trade substitute, it demands much more time than is allotted to it in the best European theatres That is why in the writer's theatre every dramatization passes through eight to ten revisions, as is also done in Germany by the famous theatre manager and theorist, K Hagemann Sometimes even more than ten revisions are needed, occasionally extending over several months But even under these conditions, the creative genius of the actor does not appear so freely as does, for instance, the creative genius of the dramatist Bound by the strict obligations of his *collectif*, the actor must not postpone his work to the moment when his physical and psychic condition appears propitious for creative genius Meanwhile, his exacting and capricious artistic nature is prompted by aspirations of his artistic intuition, and in the absence of creative genius is not reached by any effort of his will. He is not aided in that respect by outward technique—his skill in making use of his body, his vocal equipment and his powers of speech

The Artistic Condition.—But is it really impossible? Are there no means, no processes that sensibly would help us, and spontaneously lead to that artistic condition which is born of

genius without any effort on its part? If that capacity is unattainable all at once, by some process or other, it may, perhaps, be acquired in parts, and through progressive stages may perfect those elements out of which the artistic condition is composed, and which are subject to our will Of course the general run of acting does not come into being from this genius, but cannot such acting, in some measure, be brought by it near to what is evidence of genius? These are the problems which presented themselves to the writer about 20 years ago, when reflecting on the external obstacles that hamper actors' artistic genius, and partly compel substitution of the crude outward marks of the actor's profession for its results. They drove him to the rediscovery of processes of external technique, *i.e.*, methods proceeding from consciousness to sub-consciousness, in which domain flow nine-tenths of all real artistic processes. Observations both upon himself and other actors with whom he happened to rehearse, but chiefly upon growing theatrical skill in Russia and abroad, allowed him to do some generalizing, which thereupon he verified in practice

The first is that, in an artistic condition, full freedom of body plays a principal rôle, *i e*, the freedom from that muscular strain which, without our knowing it, fetters us not only on the stage but also in ordinary life, hindering us from being obedient conductors of our psychic action. This muscular strain, reaching its maximum at those times when the actor is called upon to perform something especially difficult in his theatrical work, swallows up the bulk of this external energy, diverting him from activity of the higher centres This teaches us the possibility of availing ourselves of the muscular energy of our limbs only as necessity demands, and in exact conformity with our creative efforts

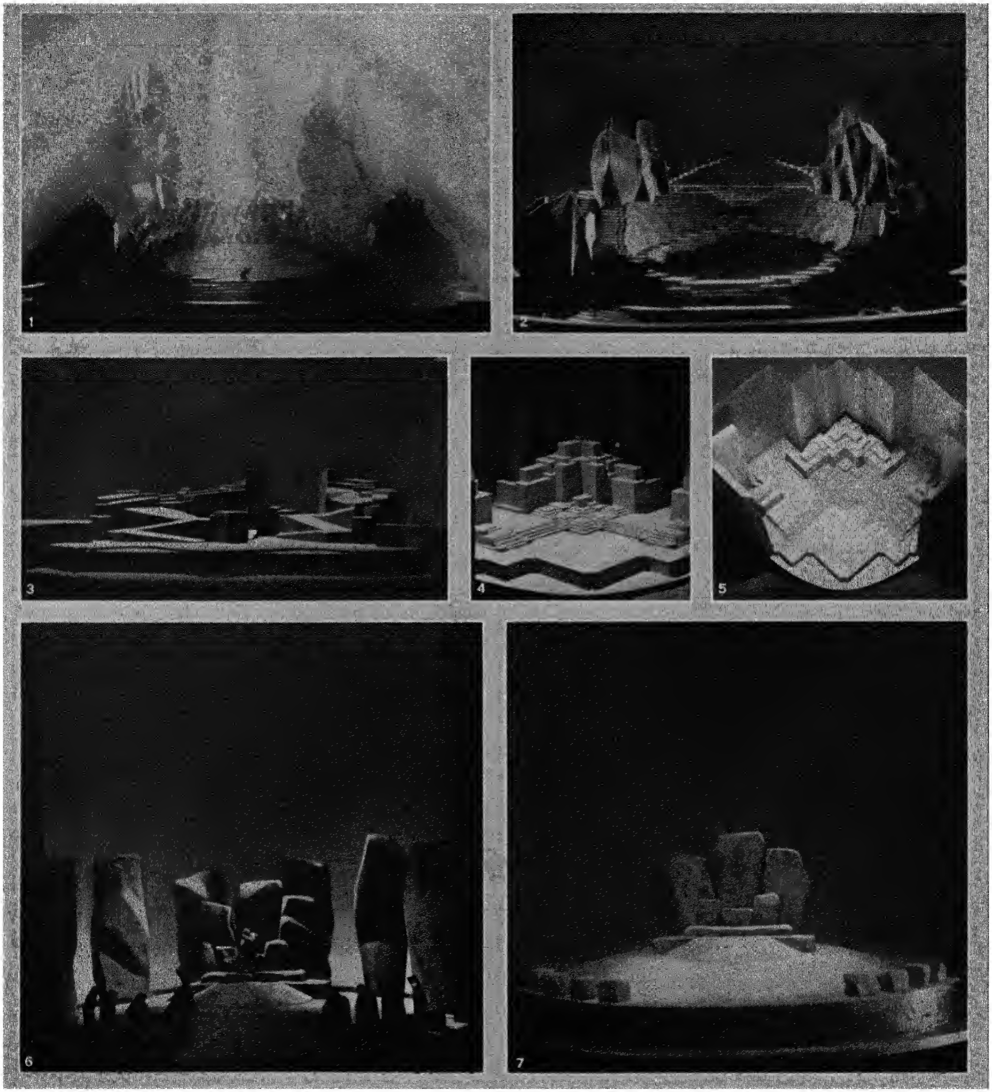
The second observation is that the flow of the actor's artistic force is considerably retarded by the visual auditorium and the public, whose presence may hamper his outward freedom of movement, and powerfully hinder his concentration on his own artistic taste. It is almost unnecessary to remark that the artistic achievement of great actors is always bound by the concentration of attention to the action of their own performance, and that when in that condition, *i e*, just when the actor's attention is taken away from the spectator, he gains a particular power over the audience, grips it, and compels it to take an active share in his artistic existence This does not mean, of course, that the actor must altogether cease to feel the public; but the public is concerned only in so far as it neither exerts pressure on him nor diverts him unnecessarily from the artistic demands of the moment, which last might happen to him even while knowing how to regulate his attention The actor suitably disciplined must automatically restrict the sphere of his attention, concentrating on what comes within this sphere, and only half consciously seizing on what comes within its aura. If need be, he must restrict that sphere to such an extent that it reaches a condition that may be called *public solitude*. But as a rule this sphere of attention is elastic, it expands or contracts for the actor, with regard to the course of his theatrical actions Within the boundary of this sphere, as one of the actual aspects of the play, there is also the actor's immediate central *object of attention*, the object on which, somehow or other, his will is concentrated at the moment with which, in the course of the play, he is in inward communication This theatrical sympathy with the object can only be complete when the actor has trained himself by long practice to surrender himself in his own impressions, and also in his reactions to those impressions, with maximum intensity· only so does theatrical action attain the necessary force, only so is created between the actual aspects of the play, *i e*, between the actors, that link, that living bond. which is essential for the carrying through of the play to its goal, with the general maintenance of the rhythm and time of each performance.

Concentration.—But whatever may be the sphere of the actor's attention, whether it confines him at some moments to public solitude, or whether it grips the faces of all those before the stage, dramatic artistic genius, as in the preparation of the part so in its repeated performance, requires a full concentration of all the mental and physical talents of the actor, and the participation of the whole of his physical and psychic capacity. It takes hold of his sight and hearing, all his external senses, it draws out not only the periphery but also the essential depth of his existence, and it evokes to activity his memory, imagination, emotions, intelligence and will. The whole mental and physical being of the actor must be directed to that which is derived from his facial expression. At the moment of inspiration, of the involuntary use of all the actor's qualities, at that moment he actually exists. On the other hand, in the absence of this employment of his qualities, the actor is gradually led astray along the road leading to time-honoured theatrical traditions; he begins to "produce" wherever he sees them, or, glancing at his own image, imitates the inward manifestations of his emotions, or tries to draw from himself the emotions of the perfected part, to "inspire" them within himself But when forcing such an image by his own psychic equipment, with its unchanging organic laws. he by no means attains that desired result of artistic genius, he must present only the rough counterfeit of emotion, because emotions do not come to order By no effort of conscious will can one awake them in oneself at a moment, nor can they ever be of use for creative genius striving to bring this about by searching the depths of its mind A fundamental axiom, therefore, for the actor who wishes to be a real artist on the stage, may be stated thus he must not play to produce emotions, and he must not involuntarily evoke them in himself

Activity of Imagination.—Considerations on the nature of artistically gifted people, however, inevitably open up the road to the possession of the emotion of the part This road traverses activity of imagination, which in most of its stages is subject to the action of consciousness. One must not suddenly begin to operate on emotion, one must put oneself in motion in the direction of artistic imagination, but imagination—as is also shown by observations of scientific psychology—disturbs our aberrant memory, and, luring from the hidden recesses beyond the boundaries of its sense of harmony whatever elements there may be of proved emotions, organizes them afresh in sympathy with those that have arisen in our imagery So surrounded within our figures of imagination, without effort on our part, the answer to our aberrant memory is found and the sounds of sympathetic emotion are called out from us This is why the creative imagination presents itself afresh, the indispensable gift of the actor Without a well developed, mobile imagination, creative faculty is by no means possible, not by instinct nor intuition nor the aid of external technique In the acquiring of it, that which has lain dormant in the mind of the artist is, when immersed in his sphere of unconscious imagery and emotion, completely harmonized within him.

This practical method for the artistic education of the actor, directed by means of his imagination to the storing up of effective memory, is sufficiently enlarged upon, his individual emotional experience, by its limits, actually leads to the restriction of the sphere of his creative genius, and does not allow him to play parts dissimilar to those of his psychic harmony. This opinion is fundamental for the clearing away of misunderstandings of those elements of reality from which are produced fictitious creations of imagination, these are also derived from organic experience, but a wealth and variety of these creations are only obtained by combinations drawn from a trial of elements The musical scale has only its basic notes, the solar spectrum its radical colours, but the combination of sounds in music and of colours in painting are infinite One can in the same way speak of radical emotions preserved in imaginative memory, just as the reception in imagination of outward harmony remains in the intellectual memory; the sum of these radical emotions in the inner experience of each person is limited, but the shades and combinations are as infinite as the combinations that create activity of imagination out of the elements of inward experience.

Certainly, but the actor's outward experience—*i.e.*, his sphere of vital sensations and reflections—must always be elastic, for only in that condition can the actor enlarge the sphere of his creative faculty. On the other hand, he must judiciously develop his imagination, harnessing it again and again to new propositions.

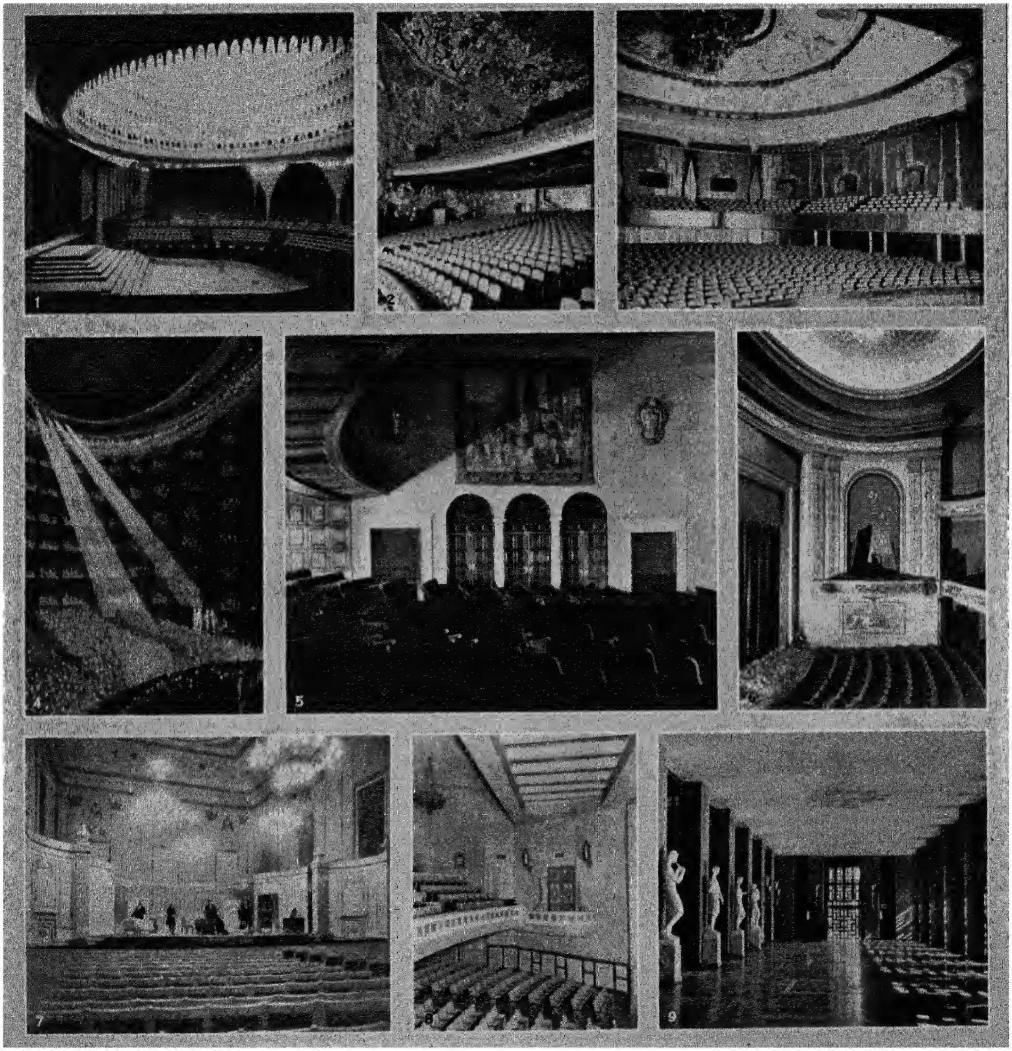


SETTINGS DESIGNED BY NORMAN BEL GEDDES; PHOTOGRAPHS, FRANCIS BRUGUIÈRE

STAGE STRUCTURES OF THE MODERN THEATRE

1, 2. Scene in "The Divine Comedy" by Dante, as dramatized and projected for production by Norman Bel Geddes. The stage rises around a pit in its centre; changes of scene are made by lighting and the massing of actors. The drawings represent the moment when the earth opens to receive Dante. The actors, who prior to this point have covered the pit of light completely, withdraw in groups, then crumple up and disappear leaving the void for Dante and Virgil to descend into. **3.** Model for "Lazarus Laughed," a play by Eugene O'Neill planned for production in 1927. The nine scenes are made by the rearrangement of two monumental units which can be turned to different positions in a few seconds by a controlling motor. They are set off with properties and decorations carried by the supers, against the cyclorama, with immense variety of effect. In this photograph of the model the proscenium arch has been removed. **4, 5.** Model for the stage structure of "Jeanne D'Arc," a play by Mercedes de Acosta, produced at the Porte Saint Martin Théâtre, Paris, 1925, under the direction of Norman Bel Geddes. On this single setting ten scenes are played, each of a different nature. Changes are made in full view of the audience by properties carried by actors and by subtle lighting of architectural embryos in the rear of the stage which are concealed in shadow when not intended to be seen. **6, 7.** Model for Shakespeare's "King Lear." A circular ramped platform, a geometrical mound and huge variformed monoliths, that are easily movable into various positions, are set against a vast space of darkness. The scenes, appearing in pagan colours, fade into one another without pause. The mood achieved by the setting is emphasized by the costumes which are so heavy they seem to hold the body inside fast to the earth, suggesting figures scarcely human

THEATRE ARCHITECTURE



BY COURTESY OF (1, 7) MORRIS GEST, (3) THE GERMAN RAILROADS INFORMATION BUREAU; PHOTOGRAPHS, (2) DRIX DURYEA

MODERN INTERIORS OF THEATRES FOR MUSICAL COMEDY, OPERA AND DRAMA

1. The Grosses Schauspielhaus, Berlin, a circus building converted into a theatre for Max Reinhardt. The acting space is in the midst of the spectators; steps lead to a main stage fully equipped with a plaster sky-dome and a revolving stage. Architect, Hans Poelzig
2. The Ziegfield Theatre, New York city, a musical comedy house with an elliptical shaped auditorium fancifully decorated. Architects, Joseph Urban and Thomas W. Lamb
3. The Kroll Opera House, Berlin, an intimate opera house expressing severe German modernism. The second balcony is over the boxes. Architect, Oskar Kaufmann
4. Rendering of a projected theatre designed for Max Reinhardt by Joseph Urban. A large part of the audience is niched in boxes invisible to one another but with a clear view of the stage. Runways lead from the sides of the stage to the back
5. The Guild Theatre, New York city, a period interior. Architect, C. Howard Crane
6. The Piccadilly Theatre, London, an interior in the more subdued convention of modern English design. Architect, Edward A. Stone
7. The Theater in dem Redoutensaal, Vienna, a ballroom in the Hofburg Palace converted into a theatre without a proscenium for formalized production. Here under the glow of crystal chandeliers, and with wall hangings of Gobelin tapestries, Max Reinhardt produced classic and modern comedy. Architect, Sebastian Heinrich
8. The John Golden Theatre, New York, an excellently arranged auditorium along the prevailing American lines, with a rather emphatic period treatment. Architect, Harrison G. Wiseman
9. Concert House Vestibule, Stockholm. Architect, Ivan Jengborn.

But, in order that that imaginary union which is the actor's very foundation, produced by the creative genius of the dramatist, should take hold of him emotionally and lead him on to theatrical action, it is necessary that the actor should "swing toward" that union, as toward something as real as the union of reality surrounding him.

The Emotion of Truth.—This does not mean that the actor must surrender himself on the stage to some such hallucination as that when playing he should lose the sense of reality around him, to take scenery for real trees, etc On the contrary, some part of his senses must remain free from the grip of the play to control everything that he attempts and achieves as the performer' of his part. He does not forget that surrounding him on the stage are decorations, scenery, etc , but they have no meaning for him. He says to himself, as it were: "I know that all around me on the stage is a rough counterfeit of reality It is false. But if all should be real, see how I might be carried away to some such scene; then I would act " And at that instant, when there arises in his mind that artistic "suppose," encircling his real life, he loses interest in it, and is transported to another plane, created for him, of imaginary life. Restored to real life again, the actor must perforce modify the truth, as in the actual construction of his invention, so also in the survivals connected to it. His invention can be shown to be illogical, wide of the truth—and then he ceases to believe it Emotion rises in him with invention; *i e.*, his outward regard for imagined circumstances may be shown as "determined" without relation to the individual nature of a given emotion Finally, in the expression of the outward life of his part, the actor, as a living complex emotion, never making use of sufficient perfection of all his bodily equipment, may give an untrue intonation, may not keep the artistic mean in gesticulation and may through the temptation of cheap effect drift into mannerism or awkwardness

Only by a strongly developed sense of the truth may he achieve that, in order that every one of his poses, and every gesture may be outwardly realistic, *i e*, he may express the condition representing the character, and may not serve, like the conventional theatrical gestures and poses of every race, a single inward beauty.

Internal Technique.—The combination of all the abovenamed procedure and habits also composes the actor's external technique. Parallel with its development must go also the development of internal technique—the perfecting of that bodily equipment which serves for the incarnation of the theatrical image created by the actor, and the exact, clear expression of his external consciousness With this aim in view the actor must work out within himself not only the ordinary flexibility and mobility of action, but also the particular consciousness that directs all his groups of muscles, and the ability to feel the energy transfused within him, which, arising from his highest creative centres, forms in a definite manner his mimicry and gestures, and, radiating from him, brings into the circle of its influence his partners on the stage and in the auditorium. The same growth of consciousness and fineness of internal feelings must be worked out by the actor in relation to his vocal equipment Ordinary speech—as in life, so on the stage—is prosaic and monotonous; in it words sound disjointed, without any harmonious stringing together in a vocal melody as continuous as that of a violin, which by the hand of a master violinist can become fuller, deeper, finer and more transparent, and can without difficulty run from the higher to the lower notes and vice versa, and can alternate from pianissimo to forte To counteract the wearisome monotony of reading, actors often elaborate, especially when declaiming poetry, with those artificial vocal *fioritures,* cadences and sudden raising and lowering of the voice, which are so characteristic of the conventional, pompous declamation, and which are not influenced by the corresponding emotion of the part, and therefore impress the more sensitive auditors with a feeling of unreality.

But there exists another natural musical sonorousness of speech, which we may see in great actors at the moment of their own true artistic elation, and which is closely knit to the internal sonorousness of their rôle. The actor must develop within himself this natural musical speech by practising his voice with due regard to his sense of reality, almost as much as a singer. At the same time he must perfect his elocution. It is possible to have a strong, flexible, impressive voice, and still distort speech, on the one hand by incorrect pronunciation, on the other by neglect of those almost imperceptible pauses and emphases through which are attained the exact transmission of the sense of the sentence, and also its particular emotional colouring In the perfect production of the dramatist, every word, every letter, every punctuation mark has its part in transmitting his inward reality; the actor in his interpretation of the play, according to his intelligence, introduces into each sentence his individual nuances, which must be transmitted not only by the motions of his body, but also by artistically developed speech He must bear this in mind, that every sound which goes to make a word appears as a separate note, which has its part in the harmonious sound of the word, and which is the expression of one or other particle of the soul drawn out through the word. The perfecting, therefore, of the phonetics of speech cannot be limited to mechanical exercise of the vocal equipment, but must also be directed in such a way that the actor learns to feel each separate sound in a word as an instrument of artistic expression But in regard to the musical tone of the voice, freedom, elasticity, rhythm of movement and generally all external technique of dramatic art, to say nothing of internal technique, the present day actor is still on a low rung of the ladder of artistic culture, still far behind in this respect, from many causes, the masters of music, poetry and painting, with an almost infinite road of development to travel

Production.—It is evident that under these conditions, the staging of a play, which will satisfy highly artistic demands, cannot be achieved at the speed that economic factors unfortunately make necessary in most theatres. This creative process, which every actor must go through, from his conception of the part to its artistic incarnation, is essentially very complicated, and is hampered by lack of perfection of outward and inward technique It is also much hindered by the necessity of fitting in the actors one with another—the adjustment of their artistic individualities into an artistic whole

Responsibility for bringing about this accord, and the artistic integrity and expression of the performance rests with the theatre manager During the period when the manager exercised a despotic rule in the theatre, a period starting with the Meiningen players and still in force even in many of the foremost theatres, the manager worked out in advance all the plans for staging a play, and, while certainly having regard to the existing cast, indicated to the actors the general outlines of the scenic effects, and the *mise-en-scène*. The writer also adhered to this system, but now he has come to the conclusion that the creative work of the manager must be done in collaboration with the actor's work, neither ignoring nor confirming it To encourage the actor's creative genius, to control and adjust it, ensuring that this creative genius grows out of the unique artistic germ of the drama, as much as the external building up of the performance—that in the opinion of the writer is the problem of the theatre director to-day

The joint work of the director and actor begins with the analysis of the drama and the discovery of its artistic germ, and with the investigation of its *transparent effect* The next step is the discovery of the transparent effect of individual parts—of that fundamental will direction of each individual actor, which, organically derived from his character, determines his place in the general action of the play. If the actor cannot at once secure this transparent effect, then it must be traced bit by bit with the manager's aid—by dividing the part into sections corresponding to the separate stages of the life of the particular actor—from the separate problems developing before him in his struggle for the attainment of his goal. Each such section of a part or each problem, can, if necessary, be subjected to further psychological analysis, and sub-divided into problems even more detailed, corresponding to those separate mind actions of the performer out of which stage life is summed up. The actor must catch the *mind axes* of the emotions and temperaments, but not the emotions and temperaments that give colour to these sections of the part. In other words, when studying each portion of his part, he must

ask himself what he wants, what he requires as a performer of the play and which definite partial problem he is putting before himself at a given moment. The answer to this question should not be in the form of a noun, but rather of a verb: "I wish to obtain possession of the heart of this lady"—"I wish to enter her house"—"I wish to push aside the servants who are protecting her," etc Formulated in this manner, the mind problem, of which the object and setting, thanks to the working of his creative imagination, are forming a brighter and clearer picture for the actor, begins to grip him and to excite him, extracting from the recesses of his working memory the combinations of emotions necessary to the part, of emotions that have an active character and mould themselves into dramatic action. In this way the different sections of the actor's part grow more lively and richer by degrees, owing to the involuntary play of the complicated organic survivals By joining together and grafting these sections, the *score of the part* is formed, the scores of the separate parts, after the continual joint work of the actors during rehearsals and by the necessary adjustment of them one with another, are summed up in a single *score of the performance*.

The Score Condensed.—Nevertheless, the work of the actors and manager is still unfinished. The actor is studying and living in the part and the play deeper and deeper still, finding their deeper artistic motives; so he lives in the score of his part still more profoundly. But the score of the part itself and of the play are actually subject by degrees during the work to further alterations As in a perfect poetical production there are no superfluous words but only those necessary to the poet's artistic scheme, so in a score of the part there must not be a single superfluous emotion but only emotions necessary for the *transparent effect*. The score of each part must be condensed, as also the form of its transmitting, and bright, simple and compelling forms of its incarnation must be found Only then, when in each actor every part not only organically ripens and comes to life but also all emotions are stripped of the superfluous, when they all crystallize and sum up into a live contact, when they harmonize amongst themselves in the general tune, rhythm and time of the performance, then the play may be presented to the public

During repeated presentations the theatrical score of the play and each part remains in general unaltered. But that does not mean that from the moment the performance is shown to the public the actor's creative process is to be considered ended, and that there remains for him only the mechanical repetition of his achievement at the first presentation. On the contrary, every performance imposes on him creative conditions; all his psychical forces must take part in it, because only in these conditions can they creatively adapt the score of the part to those capricious changes which may develop in them from hour to hour, as in all living nervous creatures influencing one another by their emotions, and only then can they transmit to the spectator that invisible something, inexpressible in words, which forms the spiritual content of the plays And that is the whole origin of the substance of dramatic art

As regards the outward arrangements of the play—scenery, theatrical properties, etc —all are of value in so far as they correspond to the expression of dramatic action, *i.e*, to the actors' talents; in no case may they claim to have an independent artistic importance in the theatre, although up to now they have been so considered by many great scene painters The art of scene painting, as well as the music included in the play, is on the stage only an auxiliary art, and the manager's duty is to get from each what is necessary for the illumination of the play performed before an audience, while subordinating each to the problems of the actors. (*See* ACTING; MOTION PICTURES: *Acting* and *Direction*) (C. St)

THE ACTOR

It is to the actor and to no one else that the theatre belongs. This does not mean, of course, the professional actor alone, but the actor as poet, as director, stage-manager, musician, scene-designer, painter, and, certainly not least of all, the actor as spectator, for the contribution of the spectators is almost as important as that of the cast The audience must take its part in the play if we are ever to see arise a true art of the theatre—the oldest, most powerful, and most immediate of the arts, combining the many in one

We all bear within us the potentiality for every kind of passion, every fate, every way of life Nothing human is alien to us. If this were not so, we could not understand other people, either in life or in art. But inheritance and upbringing foster individual experiences and develop only a few of our thousands of possibilities The others gradually sicken and die.

Bourgeois life to-day is narrowly circumscribed, and poor in feeling. Out of its poverty it has made merely virtues through which it pushes its way, severe and upright. The normal man generally feels once in his life the whole blessedness of love, and once the joy of freedom. Once in his life he hates bitterly Once with deep grief he buries a loved one, and once, finally, he dies himself That gives all too little scope for our innate capacity to love, hate, enjoy, and suffer We exercise daily to strengthen our muscles and sinews that they may not grow feeble, but our spiritual organs, which were made to act for an entire lifetime, remain unused, undeveloped, and so, with the passing years, they lose their vitality. Yet our spiritual like our bodily health depends upon the regular functioning of these organs. Unconsciously we feel how a hearty laugh liberates us, how a good cry or an outbreak of anger relieves us We have an absolute need of emotion and its expression

Against this our upbringing constantly works. Its first commandment is: "Hide what goes on within you Never let it be seen that you are stirred up, that you are hungry or thirsty; every grief, every joy, every rage, all that is fundamental and craves utterance, must be repressed." Hence the well-known sublimations, the hysterical tendencies of the time, and finally that empty play-acting of which modern life is full Passion, bursts of feeling and fancy, are ruled outside the bounds In their place we have set up in a row common stereotyped forms of expression that are part of our social armour. This armour is so rigid and constricted that there is hardly any room for natural action. We cultivate a few useful expressions of interest, of pleasure, of dignity, and a set grimace of politeness We ask people how they feel without waiting for an answer or, in any case, without paying attention to it With a fixed intonation, which could be written down and reproduced wholesale, we say that we are happy to see them, though the encounter may be a matter of complete indifference to us when it is not actually fatal At weddings, christenings, burials, festivities we make out of hand-shaking and bowing, out of frowns and grins, a ghostly play, in which the absence of feeling is shocking.

The modern social code has crippled the actor, whose business it is to body forth feeling When generations have been brought up to repress the emotions, nothing in the end remains either to inhibit or to show. How can the actor, rooted deep in the bourgeois existence of every-day, suddenly in the evening leap into the life of the mad king, whose unrestrained passion sweeps like a storm across the moors? How shall he make it credible that he is killing himself through love, or that he has killed another through jealousy? It is significant that our modern theatre can hardly boast a true lover When the actor on the stage says "I love you," it is the custom in many theatres to resort to musical accompaniment of the wood instruments, in order to evoke a poetical atmosphere The soul is set vibrating by a *vibrato* of the violins—otherwise one could scarcely distinguish an "I-love-you" from a "How-do-you-do." Generally, the women are more impulsive because they still live closer to nature than men.

In former times, when actors were excluded from bourgeois society and wandered about like gypsies, they undoubtedly developed stronger, rarer personalities. They were more unbridled in their passions; their outbursts were more powerful, the spirits that possessed them, more masterful. They had no outside interests They were actors, body and soul To-day the body is willing, but the spirit is weak, and their interests are divided.

Of course, all these observations and all rules fail before the wonder of genius But there is little genius, and there are many theatres. Now, to every person nature gives a face of his own.

There is as small chance of finding two men who exactly resemble each other as of finding two leaves on a tree which are precisely alike. Yet in the narrow course of bourgeois life, driven hither and thither by the current of every-day, they are in time worn down until they become like round pebbles One individual looks like another. This grinding process also has its effect upon their psychological make-up. But the highest boon of mankind is personality. In the arts, personality is the decisive factor; it is the living kernel which we seek in every artistic work.

Bourgeois standards should not be applied to artists, for what is it that distinguishes the artist? It is that he reacts to whatever he encounters deeply and powerfully; that things hardly visible, hardly audible, stir and move him, that he is driven by an irresistible impulsion to give all that he experiences back again, realized in some form of expression It would be a gross injustice to wish to profit by these gifts in the arts, and yet in life outside to condemn them.

The art of acting originated in the earliest childhood of the race Man, allotted a brief existence, in a close-pressing crowd of various kinds of individuals, who were so near him and yet so elusively far, had an irresistible desire to throw himself into a fantastic play of changing one form into another, one fate into another, one effect into another These were the first attempts to fly above his narrow material existence The possibilities inherent in him but not brought to full growth by his life thus unfolded their shadowy wings and carried him far over his knowledge and away into the heart of a strange experience. He discovered all the delights of transformation, all the ecstasy of passion, all the illusive life of dreams

Made as we are in God's image, we have in us something of the godlike creative will Therefore we create the whole world over again in the arts, with all the elements, and on the first day of creation, as the crown of our work, we make men in *our* image

Shakespeare is the greatest, the one truly incomparable boon that the theatre has had He was poet, actor, and producer in one. He painted landscapes and fashioned architectural scenes with his words. In his plays everything is bathed in music and flows into the dance. He stands nearest to the Creator It is a wonderful full-rounded world that he made—the earth with all its flowers, the sea with all its storms, the light of the sun, the moon, the stars; fire with all its terrors and the air with all its spirits—and in between, human beings with all their passions, their humour and tragedy, beings of elemental grandeur and, at the same time, utter truth His omnipotence is infinite. He was Hamlet, King Claudius, Ophelia, and Polonius in one person Othello and Iago, Brutus and Cassius, Romeo and Juliet, Falstaff and Prince Henry, Shylock and Antonio, Bottom and Titania, and the whole line of merry and sorrowful fools lived within him He engendered them and brought them to birth; they were part of his inscrutable being Over them he hovers like a godhead, invisible and intangible Nothing of him is there but this great world. Yet in it he is ever present and mighty. He lives eternally

Only that art is living, in whose inmost chamber the human heart beats

For the moment the theatre is, we realize, threatened; it is in a decline to-day because in the noise and rush of the great cities, though material means of existence are given it, its peculiar festal beauty, the enchanted sense of play, has been taken from it. It has not yet been organically co-ordinated with the sudden growth of the modern metropolis

The arts, especially the theatre, forsaken by the good spirits, can be the sorriest business, the poorest prostitution—there is its pale first cousin, the film, which was born in the city and has undoubtedly flourished better there. But the passion to act in the theatre, to go to the theatre, is an elemental desire in mankind. It will always draw actors and spectators together to the play, and out of that dionysian union in which they rise above the earth, it will produce the highest art that alone brings felicity.

The theatre is deathless. It is the happiest loophole of escape for those who have secretly put their childhood in their pockets and have gone off with it to play to the end of their days. The art of the stage affords also liberation from the conventional drama of life, for it is not dissimulation that is the business of the play but revelation. Only the actor who cannot lie, who is himself undisguised, and who profoundly unlocks his heart deserves the laurel The supreme goal of the theatre is truth, not the outward, naturalistic truth of every-day, but the ultimate truth of the soul.

We can telegraph and telephone and wire pictures across the ocean; we can fly over it. But the way to the human being next us is still as far as to the stars The actor takes us on this way. With the light of the poet he climbs the unexplored peaks of the human soul, his own soul, in order to transform it secretly there and to return with his hands, eyes, and voice full of wonders.

He is at once sculptor and sculpture, he is man at the farthest borderline between reality and dream, and he stands with both feet in both realms The actor's power of self-suggestion is so great that he can bring about in his body not only inner and psychological but even outer and physical changes. And when one ponders on the miracle of Konnersreuth, whereby a simple peasant girl experiences every Friday the Passion of Christ, with so strong an imaginative power that her hands and feet show wounds and she actually weeps tears of blood, one may judge to what wonders and to what a mysterious world the art of acting may lead; for it is assuredly by the same process that the player, in Shakespeare's words, changes utterly his accustomed visage, his aspect and carriage, his whole being, and can weep for Hecuba and make others weep Every night the actor bears the stigmata, which his imagination inflicts upon him, and bleeds from a thousand wounds. (M RE)

THEORY OF MODERN PRODUCTION

The theatre at any period in history has always provided an immediate reflection of the life of that period, and accordingly, we find in the theatre of to-day splendour, speed, luxury and an eager reaching out in every direction for new ways in which to seize and to communicate every phase of modern life. A brief glance at the illustrations, shown herewith, which are chosen from the designs of artists whose work is characteristic of the theatre of our time, will confirm this statement. Life is moving and changing and the theatre is moving and changing very swiftly with it. We are living in a period of high nervous vitality, of discontent, of restless experimentation, of feverish search for new ideals and new standards.

In the midst of this incessant activity it is difficult to indicate any one precise direction in which the theatre is moving at the present time or to prophesy the forms it may assume even in the near future A decade hence the theatre of 1929 may come to be regarded as incredibly crude, naive and amorphous. But it is suggested that at this moment we have at our disposal a new and hitherto undeveloped medium of dramatic expression which during the next few years may profoundly change modern theatrical production. This medium is the talking picture.

Modern psychology has made us all familiar with the idea of the subconscious. We have learned that just beneath the surface of our everyday normal conscious existence there lies a vast region of dreams, a hinterland of energy which has a form of its own and laws of its own, laws that motivate our inmost thoughts and actions This conception has profoundly influenced the intellectual life of our day It has already become a commonplace of our thinking, and it is beginning to find expression in our art. Writers like James Joyce, painters like Matisse and Picasso, musicians like Debussy and Stravinsky, have ventured into the realm of the subjective and have recorded the results of their explorations in all sorts of new and arresting forms. Our playwrights, too, have begun to explore this land of dreams In two dramas recently produced in New York, Eugene O'Neill's *Strange Interlude* and Sophie Treadwell's *Machinal*, an attempt has been made to express directly to the audience the unspoken thoughts of the characters, to show us not only their conscious behaviour but the actual pattern of their subconscious lives. These adventures into the subjective indicate a trend in dramatic writing which is bound to become more general as the laws of the subconscious become more and more clearly understood It seems strange, strik-

ing, that just at this moment in the world's history there has come into existence the talking picture, a perfect instrument for expressing the subconscious in theatrical productions. *In the simultaneous use of the living actor and the talking picture in the theatre there lies a wholly new theatrical art, an art whose possibilities are as infinite as those of speech itself*

The dramatists of to-day are casting about for ways in which to express the workings of the subconscious, to express thought before it becomes articulate. They have not seen that the moving and talking picture is itself a direct expression of thought before thought becomes articulate They are trying to give us in the theatre not only the outward actuality of our lives, but the inward reality of our thoughts They are seeking to go beyond the everyday life we normally know into the never-ending stream of images which has its source in the depths of the self, in the unknown springs of our being But in their search for ways in which to express their new awareness of life, they have not observed that the moving picture is thought made visible.

This statement is in itself a revolutionary one, but it is true The moving picture runs in a stream of images, just as our thoughts do, and the speed of the moving picture, with its "flash-backs" and abrupt transitions from subject to subject, is very close to the speed of our thoughts Here lies the potential dramatic importance of this new invention The dramatist has it in his power to enhance and elaborate the characters of his drama to an infinite extent by means of these moving and speaking images Some new playwright will presently set a motion picture screen on the stage above and behind his living actors and will reveal the two worlds that together make up the world we live in—the outer world and the inner world, the world of actuality and the world of dream *Strange Interlude, Machinal* and the "talkies" have shown us the way toward this new drama Within the next decade a new dimension may be added to our theatre.

(R E J.)

CHINESE THEATRE

The Chinese drama, as it had existed from ancient times up to the time of the Revolution in 1911, was a continuous development from simple primitive forms to a very complex and elaborate one. (*See* DRAMA, CHINESE) Such evidence as can be found in the Chinese classics makes it certain that the origins were in ancestor worship and religious dancing, and in the acrobats and clowns who entertained the courts, presenting an obvious analogy to the drama of the middle ages Added to this, we have the evidence of the engraved reliefs of the Wu tombs and of such stelae as that in the Boston museum (dated A D 529) Also the numerous grave figurines which present a variety of actors and dancers, giving visual proof of the type of dancing engaged in in the Six Dynasties and the T'ang dynasty Traditionally, the acting of stories is attributed to the Han dynasty References are made to stories accompanied by song and dance in the North Ch'i dynasty. The use of animal and demon masks was probably primitive and early, but legend ascribes the origin of the terrifying warrior masks to the prince of Lan Ling who had a face so beautiful that he had to invent a "false face" of carved wood in order to frighten the enemy. Whatever the truth of the matter, the Chinese have developed painted faces which are the equivalent of the Japanese Nō masks (*See* MASKS)

In the T'ang dynasty the Emperor Ming Huang was famous as a patron of the arts of drama and dancing He established the "Pear Garden," a court institute of music, dancing and acting, and established a similar institute for the training of females, a reference which seems to indicate that the 19th century tradition of the segregation of sexes in dramatic companies was an old and persistent one.

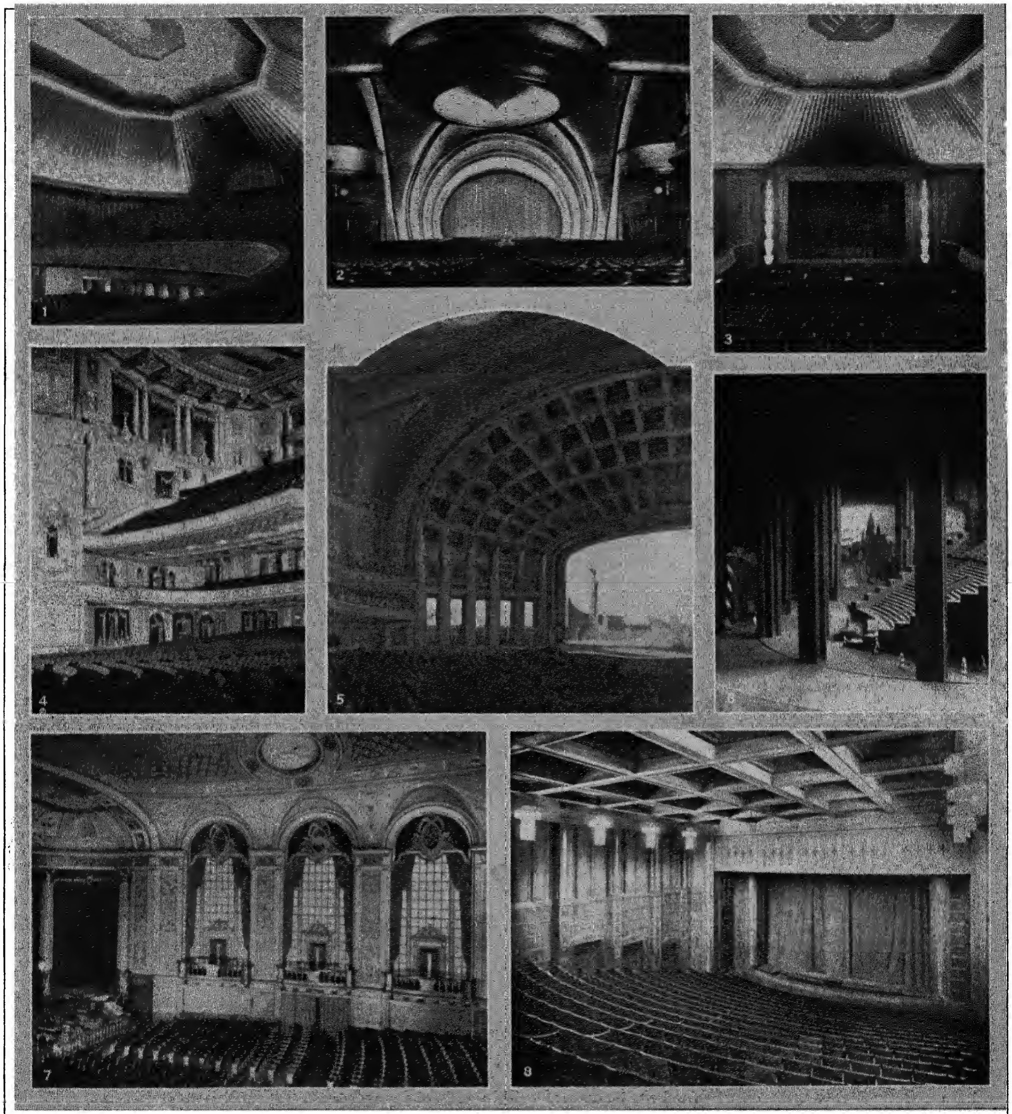
Development.—The Chinese speak of three epochs in the development of the drama. (1) from the reign of Ming Huang (A D 720) to the fall of the T'ang dynasty; (2) from the beginning of the Sung dynasty up to the close of the reign of Hui Tsung, a great patron of all the arts; (3) from and including the reign of the Golden Tatars of North China and the whole Yüan (Mongol) dynasty. This classification seems to be purely arbitrary and the real puzzle to the historian of Chinese drama lies in the question of the Mongol drama. All the proper pre-Yüan dramatic literature is lost; the theory is that Chinese littérateurs under a barbarian rule turned their genius to an art which they considered inferior. This they did partly as a matter of politics, partly for diversion and partly out of contempt.

From this period the names of plays and dramatists are preserved. (Among the dramatists were Wang Shih-fu, 王實甫 Shih Chün-mei, 施君美, Kuan Han-shêng, 關漢聲, Ma Chih-yüan, 馬致遠, and Ch'iao Lifu, 喬立符.) Sure as it seems that the drama as serious literature was at its height during this period, the question of how much of the theatre of that period was an innovation and how much was the elaboration of straight tradition is a completely open one The opinion of the author is that the tradition, however tricked out, was not changed. Dancers of the 20th century move from posture to posture which are identical with those of the T'ang dynasty grave figurines and there are many analogies to the Nō drama of Japan which have never been properly looked into, notably similar conventions, and, in the male characters, a similar use of intoned chanting (*See* NŌ DRAMA.)

The drama continued to flourish under the Ming dynasty and apparently did not give way to a new form until the middle of the Ch'ing period when an easier and more popular style became the mode. The classical drama, or *k'un ch'u*, 崑曲 has persisted to the present day but is largely kept up by scholarly amateur societies. There are a few great professional singers of the classical drama, and the great popular actors usually include a few classical rôles in their repertoires, but for the most part dramatic performances are in the popular (*êrh huang*) 二黃 mode developed under the Manchus In the third decade of the 20th century the modernists were attacking the stage tradition with everything else that has been great in China and have fallen into weak imitation of the western dramatic forms, so far with very little effect on the old theatre except that the fashionable actors are deserting the traditional type of stage and are taking to western stages, painted scenery and spotlights.

Forms of Entertainment.—The Chinese employ a form of entertainment for which we have no single word. It is a combination of spoken dialogue, operatic singing and ballet dancing Both the theatre and the performance present immediate analogies to the Elizabethan drama The theatre, except for refinement of decoration, is almost identical in arrangement, but the Chinese theatre always has a roof except in the case of temple theatres which consist only of the actual stage itself Like the Elizabethan theatre, the Chinese use only the scantiest stage properties an embroidered curtain at the rear with entrances left and right, furniture carried in and out during the performance, landscapes indicated by symbolic plaques. The imperial theatres went further and had contraptions which resemble those described in writings of the Italian Renaissance, including balconies, pits in the floors and holes in the ceilings through which actors could be lowered Further analogies with the Elizabethan theatre appear in the long monologues which the actor addresses to an audience in a fully lighted house, and monologues so presented become logical and exciting confidences and not at all the dull and abstract versions which westerners present in Elizabethan revivals Furthermore, the actors are all of one sex, usually males, and the perfection of female representation teaches the westerner what such representation must have been in England. Another analogy is in the comic interludes of exaggerated clowning, as yet happily unexpurgated

But the Chinese have developed a whole set of conventions which are apparently incomprehensible to Western nations Not only are the gestures and movements of the different sexes and ages represented bound by conventions, but the very voices themselves must conform to similar conventions The typical classification of parts is as follows. The *tan* (旦, Mongol colloquialism for "woman"), or young female, moves in a set, rhythmical sway and speaks and sings in a high falsetto. The clothes for these parts are designed and built in long flowing lines to increase the impression of flower-like grace; the make-up is elaborated red and white. The *lao tan* (老旦, *lao,* old; *tan,* see above), or old lady, walks in four-four time with a slight palsied shake; she bends a little but does not sway, wears no make-up and usually wears a



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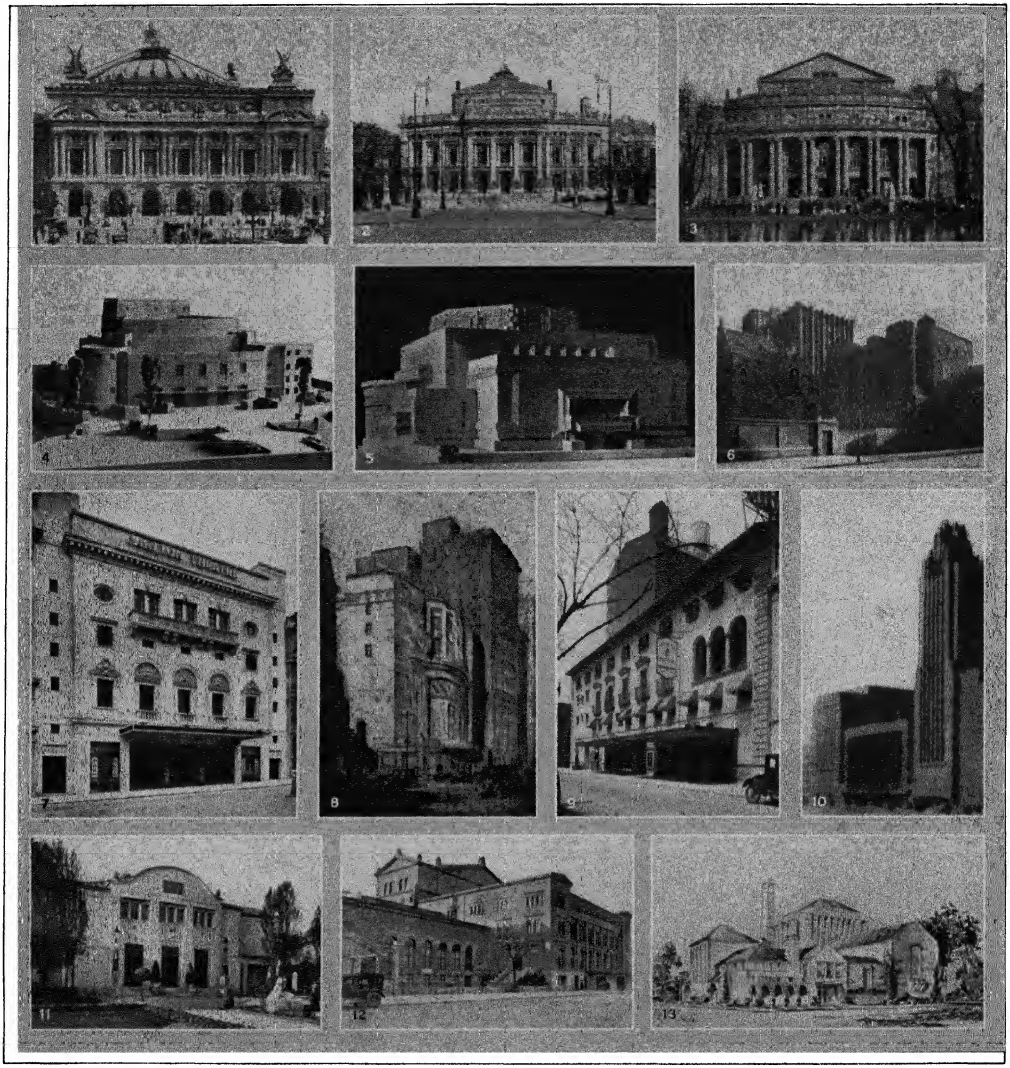
INTERIOR OF MODERN THEATRES

1, 3. The Capitol Theatre, Berlin, a German motion picture house, illustrative of the simple expression prevalent in contemporary German design. Changing light and colour on broad surfaces contribute most of the decorative effect. Architect, Hans Poelzig. 2. Titania Palace, Berlin, a motion picture house in which the successive elliptic arches of the proscenium and the modern lighting form the chief decorative feature. The seating arrangement, with a centre aisle, is contrary to the usual German manner. Architect, Stegnitz. 4. Roxy Theatre, New York city, a motion picture theatre with a seating capacity of 6,100, at the time of its construction the largest in the world. The Plateresque decoration follows the over-ornate fashion popular in American film houses. Architect, Walter Alschlager. 5. Proscenium of a projected opera house for New York city. The introduction of the side stages behind open colonnades provides for the spectacular pageantry of traditional opera and affords direct control of the choruses and stage music by a single conductor. The psychological effect of close contact between audience and performers of the classic theatre is also achieved by this means. Architect, Joseph Urban. 6. Model of Oskar Strnad's projected theatre, showing the auditorium as seen from one segment of the stage which is a doughnut-shaped, movable ring surrounding the auditorium. 7. The Allen Theatre, Cleveland, O., a motion picture theatre without a stage. Architect, C. Howard Crane. 8. The Künstler Theatre, Munich. The floor slants steeply and the seating arrangement is that commonly used in Germany, each row forming an aisle leading to side walls with many doors. Architect, Max Littmann.

THEATRE ARCHITECTURE



BY COURTESY OF (2) THE AUSTRIAN TOURIST OFFICE, (3, 12) THE GERMAN RAILROADS INFORMATION OFFICE, (7) "THE BUILDER," (11) MAX LITTMANN; PHOTOGRAPHS, (1) EWING GALLOWAY, (4) E. N. A., (6) GENERAL PHOTOGRAPHIC AGENCY

EXTERIORS OF 19TH AND 20TH CENTURY THEATRE BUILDINGS

1. The Opera House, Paris, erected 1861–75, in the court style of the period of Louis Napoleon. Architect, Charles Garnier. 2. The Burgtheater, Vienna, an elaborate structure of classic 19th century type, housing the outstanding repertory company of central Europe. Architects, Semper and Hasenauer. 3. View of the State Theatre, Stuttgart, showing the façade of the larger of the two auditoriums contained in the single unit building which fronts the lake in the park. Architect, Max Littmann. 4. Model of the prize-winning design for the Shakespeare Memorial Theatre, Stratford-on-Avon, England. Architect, Elizabeth Scott. 5. A project for a theatre by Frank Lloyd Wright, pioneer among modern American architects. He conventionalizes very frankly the exterior expression of the inner divisions of the house. 6. Back view of the Schauspielhaus, Düsseldorf, Germany, erected 1904–05. Architect, B. Sehring. 7. The Carlton Theatre, London, an exterior designed in a prevailing British mode, and crowded between neighbouring houses, like most American and British commercial theatres. 8. The Ziegfield Theatre, New York city, a musical comedy house, frankly theatrical in treatment, with the proscenium symbolized in the massive curve of the lower part of the façade. Architect, Joseph Urban. 9. The Guild Theatre, New York city, housing the offices and club rooms of the Theatre Guild, as well as its stage and auditorium. The stage house continues the period of the façade. Architect, C. Howard Crane. 10. Projected opera house and studio building for New York city, designed to harmonize a large theatre with the prevailing skyscraper architecture of New York. Architect, Joseph Urban. 11. Künstler Theater, Munich, a simple and thoroughly modern façade designed before the war for a theatre in an exposition park. Architect, Max Littmann. 12. The Kroll Opera House, Berlin, a severe design in keeping with the conventional architecture of Berlin, yet not too much at variance with its modernist interior. Architect, Oskar Kaufmann. 13. The Play House, Cleveland, O., one of the "little theatres" of America, containing two auditoriums, one seating 500, the other 200, along with workshops, offices, etc. Architects, Philip Small and Charles Bacon Rowley

bright orange bandeau to increase the effect of pallor. She speaks and sings in a falsetto The *hsiao shêng* (小生, young man) moves in a measured and animated stride. His make-up is slight, confined to pink-and-white cheeks and exaggerated eyebrows. He speaks and sings in falsetto and may, in speaking, change his range from falsetto to a natural tenor The cut of his costume is simple and sculpturesque, a long loose robe in which he moves easily. The *lao shêng* (老生, old man) uses movements and gestures the same as the young man's but with less buoyancy. He usually speaks and sings in falsetto but may talk in a sustained tenor His clothes are of the same cut as the young man's but differ in details of head-dress and are less gay in colour The *hua lien* (花臉, painted face) represents the warrior. With the exception of very young warriors, who wear neither painted faces nor beards, all actors representing warriors are made up with elaborately painted faces in bright colours and striking designs appropriate to the contours of the human face These painted faces are the equivalents of masks. The warrior moves in an exaggerated strut and speaks in a deep throaty roar He sings variously, according to part and actor, ordinarily in a forced bass but occasionally in a piercing tenor. His clothes are built to give the impression of force and strength and include elaborate underpads for the torso and shoulders, heavily embroidered epaulettes and stomachers and long scalloped panniers which flare as he moves. He wears enormous head-dresses, often with 6 ft pheasant feathers and sometimes four pennants attached to his back. The *ch'ou* (丑 *ch'ou*, is the second of the 12 zodiac signs but has come to be applied to the comedian or clown, probably because it is homonymous with *ch'ou*, 醜, meaning homely), or comedian, is allowed more liberty of voice and action, the result being close to our exaggerated clown parts He is almost always distinguished by white circles around the eyes

These are the main distinctions. The conventions are carried much further into the special representation of definite characters in which not only the exact make-up for that particular character is prescribed but even the colours used carry symbolic meanings The costumes themselves are far more subtle and complicated than those of the Nō drama of Japan, the obvious beauty of which is apparent to the dullest eye The Chinese costumes, like the Japanese Nō costumes, are in a style which might well be described as architectonic The actor is considered a kind of puppet on which the designer builds up a character of whatever sex and of whatever physique he chooses The outlines of the figures are always clearly defined but the surface of a given mask is often covered with intricate patterns, which makes an ensemble of Chinese actors a more complicated picture than an ensemble of the Nō actors The subject matter of the plays is almost always traditional It includes stories from famous novels, anecdotes and legends about historic personages, stories of the "Three Kingdoms," in content suggestive of the Morte d'Arthur legend, and satiric burlesques of the church and of historic villains.

Kinds of Drama in China.—The classical drama or *k'un ch'ü* (崑曲) takes its name from the K'un Shan district in the present province of Kiangsu It is a highly refined and perfected form in which every gesture is in prescribed concordance with words and music, but the gestures and, to a certain degree, the emphasis of the singing is not written down but is handed down from teacher to teacher The music itself includes an infinite number of tunes, each composed for a particular drama. The instruments include wind instruments (a kind of flute and oboe, and the *shêng*, 笙, a mouth organ made of 17 small bamboo pipes), trumpets, drums, bells and plucked string instruments Stringed instruments played with a bow are never used in the *k'un ch'ü*.

The popular drama which has several different names, most of which bear a geographical significance, is best referred to as *erh huang* (二黃) and *p'i huang* (皮黃), because it originated at Huang Kang and Huang P'i, two districts in the province of Hupei. It is sometimes known as *han tiao* (漢調) from the river Han which flows through the region. It is also called *ching tiao* (京調), a southern name given to it after it had become the popular form in Peking, the capital. It is a much more flexible and careless form than the classical form. Tunes are less varied and are often used for a number of different plays, and the tunes have far less quality than those of the classical drama. The accompaniment includes largely stringed instruments played with a bow, wind instruments (exclusive of the *shêng* which is not used), drums, gongs and cymbals The action is far less highly developed A third kind of theatrical entertainment is known as the *shansi pang tzŭ* (山西梆子) or *pang tzŭ ch'iang* (梆子腔), a rustic form of drama introduced from the province of Shansi, the outstanding characteristic of which is the persistent use of the trumpet and a kind of rattle known as *pang tzŭ* (梆子).

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(A. R Pr)

THÉÂTRE DE LA MONNAIE: *see* OPERA HOUSES, FAMOUS.

THEATRES, LAW RELATING TO. Playhouses grew up in England after the Renaissance, when the religious drama began to give place to the secular drama Apparently, licences for temporary theatres were first granted in the reign of Henry VIII.; but as the number of regular playhouses increased, letters patent to perform stage plays were granted to Burbage, Shakespeare and others by Elizabeth and James I. By an Order in Council passed in 1600, the number of playhouses in London was limited to two; one in Middlesex and one in Surrey, but this restriction was not strictly enforced. The theatres continued to function independently of legal control until 1647, when an Ordinance of the Roundhead Government closed all playhouses and even inflicted penalties on any spectator at stage plays With the Restoration, the theatres were re-established, and royal patents granted to Killigrew and Davenant, in 1662, for their theatres in Drury lane and Covent garden, the one enjoying the official patronage of Charles II, the other the patronage of the duke of York

The Theatres Act of 1737 (10 Geo. II *c.* 28) instituted statutory control over playhouses, the plays and players which continued for more than a century The act provided (*inter alia*) that no person should be authorized either by letters patent or by licence to perform stage plays anywhere in Great Britain except within the City of Westminster or the liberties thereof, or in places of royal residence during the period of such residence This limitation was subsequently modified by an act passed in 1788 (28 Geo III. *c* 30) The acting of plays at the universities (which had been privileged places originally) was forbidden by 10 Geo. II. *c.* 19.

Walpole's act of 1737 consolidated the position of the patent theatres, and in spite of a long and bitter struggle between the patent theatres and the non-patent theatres, the former maintained a virtual monopoly down to 1843, when the recommendations of the parliamentary committee of 1832 were put into effect by the passing of the Theatres Act, 1843 (6 and 7 Vict *c.* 68), which freed the London stage, and established legal control over playhouses as it exists to-day.

All theatres, music-halls and other places of public entertainment in Great Britain, must be licensed for the purpose for which they are intended to be used No theatre licence is required if the performances are not public (see *Harms* v *Martans Club*, 1926, 1 ch 870); or if the plays presented are not stage plays within the meaning of the act (for meaning of stage plays, *see* below); or if the premises are not of a permanent character (*e.g.*, a portable booth); or if the theatre is licensed by letters patent; or if the performance is given in any booth or show at a fair or other customary feast.

Theatre licences are granted by the lord chamberlain for all theatres within the parliamentary boundaries of the cities of London and Westminster, and of the boroughs of Finsbury and Marylebone, etc. For theatres situate elsewhere, the county councils are the proper licensing authority; but they may delegate

their powers to committees or to justices of the peace. Licences can only be granted to the responsible manager for the time being of the theatre in question, who must enter into a bond for a sum not exceeding £100 The fee for a licence is 10s. per calendar month in the case of the lord chamberlain's licence, and 5s. per calendar month for a licence granted by any other authority. All licensing authorities are empowered by the Theatres Act to make rules and regulations for maintaining order and decency in theatres licensed by them; and for ordering the closing of any theatre and suspending its licence where any riot or misbehaviour takes place (ss 8 and 9).

Music and Dancing Licences.—Music-halls and similar places of entertainment were first brought under legal control by the Disorderly Houses Act, 1751, which is still in force. A licence is required for any house, room, garden or other place kept for public dancing, music, or other such public entertainment.

The conditions under which music and dancing licences are granted vary according to the area in which the premises to be licensed are situate The London County Council deals with all licensing within the administrative county of London. Premises situate within the administrative county of Middlesex are governed by the Music and Dancing Licences (Middlesex) Act, 1894; and certain portions of the home counties (Buckinghamshire, Essex, Hertford, Kent, etc), are now governed by the Home Counties (Music and Dancing) Licensing Act, 1926 Outside these areas, either part IV of the Public Health Act, 1890, applies, or the licensing of music and dancing is provided for by local acts. In London, Middlesex and the home counties, licences are granted by the county councils, and elsewhere by the licensing justices, to such persons as they think fit, for any specified period up to one year Except in the case of licences granted by the London County Council, it is made a condition of every licence that an inscription must be affixed to licensed premises stating that they are licensed pursuant to the act of parliament, and that such premises may only be kept open during specified hours A licence which is granted only for music does not authorize public dancing and vice versa (*Brown* v *Nugent*, 1872, L R. 7, Q B. 588).

Neither a theatre licence nor a music and dancing licence is required in the case of an army or navy recreation room which is managed or conducted under the authority of a secretary of State or the Admiralty A theatre licence does not dispense with the necessity of holding a licence for music or dancing, and vice versa Licensing authorities have a discretion to refuse a theatre or music and dancing licence or to grant it only subject to such conditions as they think fit to impose; but they must act reasonably (*Reg.* v. *West Riding County Council*, 1896, 2 Q B 386)

Censorship and Legal Control of Stage Plays.—An Ordinance was published by James I. forbidding the representation of any living Christian king upon the stage. This was occasioned by the appearance of players in the character of the king of Spain and Gondomar; and it foreshadows part of the present policy of the censorship The control of stage plays was originally vested in and exercised by the master of the revels, whose office had been traced back to the year 1545 The supervision of stage plays was also carried out by the Privy Council, the Star Chamber and the lord chamberlain; but records show that about the year 1624 the lord chamberlain became the principal authority over these matters The lord chamberlain continued to control stage plays, deriving his authority from the royal prerogative until Walpole's act in 1737 gave statutory recognition to his censorship by enacting (ss 3 and 4) that all new plays must be submitted to the lord chamberlain for approval. He, in turn, named an examiner of plays to assist him. The stage censorship thus constituted was continued by the Theatres Act, 1843

Stage plays produced anywhere in Great Britain are now under the absolute control of the lord chamberlain of His Majesty's household. Under the Theatres Act, 1843, the lord chamberlain is empowered:—(*a*) to license every new stage play or any new addition to an old stage play or to an old prologue or epilogue which is intended to be produced and acted for hire in any theatre in Great Britain (s 12); (*b*) to control all stage plays, whether new or old, by forbidding them to be acted or presented if he is of opinion that it is fitting for the preservation of good manners, decorum, or of the public peace to do so (s. 14).

The lord chamberlain's "Regulations for the Submission of Stage Plays" set out the procedure to be observed in applying for a licence to perform a stage play, and the fees to be paid for the licences required (*See* also Theatres Act, s. 13.) A licence is only required if the performance is to be given "for hire" in a theatre; and a performance is only deemed to be given "for hire" if any money or other consideration is taken, directly or indirectly, for admission to the performance, or if it takes place in any house, room, etc , in which distilled or fermented excisable liquor is sold (s. 16). The lord chamberlain's regulations lay down some of the grounds on which the lord chamberlain may intervene to prohibit the performance or refuse a licence. As to penalties, *see* Theatres Act, s. 15, as amended by the Criminal Justice Act, 1925 (s. 43)

Days and Times of Performances.—The Sunday Observance Act, 1781, prohibits the opening on Sundays of any premises for public entertainment or amusement, to which the public are admitted by the payment of money or by tickets sold for money. The act does not apply to religious meetings, or to any entertainment to which persons are admitted without payment. Licences frequently contain a condition that performances shall not take place on certain specified days, and sec. 8 of the Theatres Act, 1843, empowers the lord chamberlain to order any patent theatre or theatres licensed by him to be closed on such public occasions.

Theatres under the jurisdiction of the lord chamberlain are not under any restrictions as to the hours for performances, but other licensing authorities may make rules regulating the times during which the theatre within their jurisdiction may be opened (s. 9 of Theatres Act, 1843). Premises licensed for music and dancing, etc , may only be opened for those purposes between noon and midnight, but the Licensing Statutes provide for these hours being extended on special occasions if permission is first obtained from the licensing authority

There are a number of statutory provisions relating to the construction and safety of theatres and other buildings used for public entertainments, the chief of which are to be found in the Metropolis Management Act, 1878, and the Public Health Act, 1875, sec. 158.

The Common Law Affecting Theatres, etc.—At common law the admission of the public to theatrical, etc., performances is in the discretion of the management, but once the right of admission is granted, it cannot be withdrawn except under certain circumstances. The legal position of the ordinary ticket-holder is that he has the irrevocable right to be admitted to see an entertainment until its close, provided that he behaves properly (*Hurst* v. *Picture Theatres Ltd* , 1915, 1 K B. 1), and that he has not obtained admission by fraud or by the concealment of identity (*Said* v. *Butt*, 1920, 3 K B 497). The purchase of a ticket for a performance carries an implied warranty by the management that the premises shall be reasonably safe; but this warranty does not extend to any unseen and unknown defects which could not be discovered by ordinary inspection (*Francis* v. *Cockrell*, 1870, L.R 5, Q B. 184, 501; *see* also NEGLIGENCE)

The management is also responsible for the safety of the performance itself; and they will be liable for injury caused to the audience by the negligence of any actor or other performer who is their servant or agent If, however, the actor is not the servant of the management but of another person (*e g* , a touring manager) who is presenting the play or entertainment under a contract with the management of the theatre, the latter will only be liable if the performance is intrinsically dangerous, or if they fail to take reasonable steps to ensure that any dangerous incidents are performed without risk to the playgoer (*Cox* v *Coulson*, 1916, 2 K.B. 177; *see* also NUISANCE).

Theatrical Performers and the Law.—The legal position of theatrical performers is now governed by (*a*) the common law of contract; (*b*) theatrical custom; and (*c*) special legislation.

(*a*) At common law an actor or other theatrical performer is regarded as being in a different position from that of the ordinary servant or employee Thus he is entitled to be given the oppor-

tunity of performing and of gaining the publicity which is an essential part of the consideration of the contract of performance (*Marbe* v. *George Edwardes* [*Daly's Theatre*], *Ltd.*, 1928, 1 K.B. 269). He may refuse a part which is unsuitable for him (*Clayton-Greene* v. *De Courville*, 1920, 36 T.L.R. 790); and may decline to play a part at unreasonably short notice (*Graddon* v. *Price*, 1827, 2 C. and P. 610). The tendency of recent years has been to standardize theatrical contracts. The standard form of contract for engagements of variety artists is the "Award" contract, evolved as the result of the arbitrations held in 1913 and 1919 to settle disputes between members of the variety profession and their employers. The "Valentine" form of contract is largely (but not universally) used for London (West End) engagements of actors and actresses. A contract to perform on premises which are not licensed, or in a play which has not been approved by the lord chamberlain will be void for illegality (*Galline* v. *Laborie*, 1793, 5 T.R. 242; *Gray* v. *The Oxford* [*Ltd.*], 1906, 22 T.L.R. 684, etc.). Similarly the presence of a "barring" clause (a form of restrictive covenant which prevents a performer from performing elsewhere within a certain area and within a specified time of the particular engagement) may vitiate the contract as being in restraint of trade, if its terms are too wide or unreasonable (*Tivoli* [*Manchester*] *Ltd.* v *Colley*, 1904, 20 T.L.R 436). A term in a contract restricting an actor from using his stage name has been held to be void (*Hepworth Manufacturing Co.* v. *Ryott*, 1920, 1 Ch 1).

Outside the law of contract, a theatrical employee is in practically the same position as the ordinary employee. The management is liable for negligent or tortious acts committed by him in the course of his employment (*e g*, an infringement of copyright; see *Performing Right Society, Ltd.* v *Mitchell, etc.*, 1924, 1 K B. 762). The management is also liable for the personal safety of the performers, unless the injury is occasioned by the negligent or wrongful act of a fellow performer or fellow employee, *e g.*, a scene shifter (see *Burr* v. *Theatre Royal, Drury Lane, Ltd.*, 1907, 1 K B 544).

The Employer's Liability Act, 1880, does not appear to apply to an actor or similar performer; but might apply to other classes of theatrical employees The Workmen's Compensation Acts have been held to apply to various classes of theatrical employees.

(*b*). The customs of the theatrical profession will govern contractual and other legal relations between performers and management, providing they fulfil the usual legal requirements as to custom The following theatrical customs have been upheld by the courts: That an engagement to perform in a play in the West End of London is for the run of the piece (*George Edwardes* [*Daly's Theatre*] *Ltd.* v *Comber*, 1926, 42 T L R. 247); that an engagement to perform elsewhere for an indefinite period may be terminated by either side giving two weeks' notice; that, in an engagement for one or more years, no payment of salary is payable during vacation when the theatre is closed (*Grant* v. *Maddox*, 1846, 15 M. and W. 737); that a manager who engages a theatrical company to perform for one week must not allow another company to perform at that theatre during the same week, either by means of a "flying matinee" or otherwise (*Cotton* v. *Sounes*, 1902, 18 T.L.R. 456); that a variety or music-hall artist shall be advertised in a manner suitable to his professional reputation.

(*c*). During recent years a great deal of legislation has been passed, with the object of protecting theatrical performers The Theatrical Employers Registration Act, 1925 (which was intended to protect theatrical performers against unreliable and unscrupulous managers), requires every person who employs at one time three or more theatrical performers, to be registered in accordance with the procedure laid down by the Act The Act also makes it an offence for theatrical employers to abandon the performers during the course of an engagement, and imposes penalties on persons who carry on business as theatrical employers without being registered, or who procure registration by supplying misleading information, etc. Furthermore, a theatrical employer may be struck off the register if he is shown to have attempted to evade payment of his employees. Theatrical agents who carry on (within the administrative county of London) the business of teaching or of finding employment for those desirous of obtaining employment as singers, dancers, etc., at theatres or in connection with film production, must be licensed for the purpose by the London County Council or by the City Corporation (*see* the London County Council (General Powers) Act, 1921, ss. 11, 14). The Performing Animals (Regulation) Act, 1925, provides for the registration of performing animals and for inspection of them by duly authorized officers, so as to ensure that their training and exhibition is not accompanied by cruelty A whole group of recent enactments protect children who are employed in theatrical, etc , performances The Children's Dangerous Performances Act, 1879 (as amended by the Dangerous Performances Act, 1897), makes it an offence to cause any male person under the age of 16 years, or any female person under the age of 18 years, to take part in any public performance or exhibition which is dangerous to life or limb The parent or guardian who aids or abets such an offence is liable to a penalty; and if any actual injury is sustained, the employer may be indicted for assault and ordered to pay compensation not exceeding £20

The Children (Employment Abroad) Act, 1913, makes it necessary for a licence to be obtained from a police magistrate to enable any young person under the age of 16 to go out of the United Kingdom for the purpose of singing, playing, performing or being exhibited for profit This licence will only be granted upon the conditions prescribed by the act, which include supervision by consular officers The Education Act, 1921 (s. 100), limits the hours during which children may be employed in public, theatrical, etc , performances, and also imposes certain restrictions on the training of young persons as acrobats or contortionists. These restrictions may, in certain cases, be relaxed by local education authorities or by courts of petty session But apparently, no child under the age of 12 years may be employed at *any* time on any public premises to which the public are admitted on payment

The Dramatic and Musical Performers Protection Act, 1925, prohibits the reproduction of the performances of actors, singers, etc , by mechanical means for the purposes of trade without their written consent. (S C. I)

United States.—In the United States questions of licensing theatres involve statutes in 48 States Where the licensing power has been delegated to the municipalities, ordinances in the various cities are likewise involved "Little Theatres," springing up in great numbers throughout the United States, ordinarily avoid requirements of a licence (as well as building regulations) by organizing as a club whose members subscribe for tickets

Although a theatre is a private enterprise (*Tyson and Brother* v *Banton* [1927], 273 U S 418), yet it is subject to State control through the licensing power, the taxing power and the police power. The right of governmental authority to require a licence for the privilege of conducting business is not peculiar to the theatre, but exists likewise in many other private enterprises. The taxing power affects theatres in the same manner as it affects other private concerns The police power goes further in that the State has a right of increased control, since the health or morals of people may be affected Censorship, in the sense of prior restraint, has been held constitutional as applied to motion pictures (*Mutual Film Corporation* v. *Industrial Commission of Ohio* [1915], 236 U S. 230). There is no such censorship of the theatre but productions are subject to penal statutes prohibiting obscenity Where the statutes are drastic, as in New York State under the Wales law (Penal Law, Sect 1140-A), those engaged in a play may be prosecuted if a line, scene or incident is indecent, and in case of conviction of those charged, the licence to operate the theatre may be revoked for a year. In a sense this is more drastic than any censorship since, because of the rigorous penalty, a mere threat by a prosecuting official may result in stopping a play.

A theatre ticket may be in the form of a revocable licence or of a contract If the former it may be revoked at the will of the proprietor; if the latter it may be non-transferable or otherwise conditioned (*Tyson and Brother* v *Banton* [1927], 273 U.S 418, 440). The producer is entitled to bar any person from the premises (*Woollcott* v. *Shubert* [1916], 217 N.Y. 212). If this is done the purchaser of a ticket may merely claim breach of contract and demand the return of his money and the repayment of any ex-

pense incurred (*Luxenberg* v *Keith and Proctor Amusement Co.* [1909], N.Y. 64 Misc 69; *People ex rel. Burnham* v *Flynn* [1907], 189 N Y. 180) The auditor, however, may acquire greater rights if once he has taken a seat (see *Cremore* v. *Huber* [1897], 18 N Y A D 231). A theatre has the right to refuse to accept tickets purchased from a speculator (*Collister* v *Hayman* [1905], 183 N.Y. 250).

The only limitation upon the right of a theatre to discriminate is found in "civil rights" laws which exist in a large number of States (*see* New York Civil Rights Law, Section 40, for type of statute), which laws provide that no discrimination shall be made in any place of public accommodation, resort or amusement because of race, creed or colour Violation is ordinarily a misdemeanour and subjects the wrongdoer to penalty payable to the party aggrieved (*Joyner* v. *Moore-Wiggins Co Ltd.* [1912], 152 N Y. App Div. 266, affirmed 211 N Y 522) Under these laws a dance hall is not regarded as a place of public accommodation (*Johnson* v *Auburn and Syracuse Electric R R Co* [1915], 169 A.D 1864).

A law providing for the limitation of the amount that speculators or agencies may charge has been held unconstitutional (*Tyson and Brother* v. *Banton* [1927], 273 U S. 418). On the other hand, tax laws assessing agencies to an almost prohibitive amount have been held constitutional by the circuit court of appeals in New York (*Alexander Theatre Ticket Office, Inc.*, v *United States*, 23 Fed, 2d series [1927], p. 44). The proprietor is not an insurer of persons or property in the theatre As respects either, he is liable only in case of negligence (property: *Pattison* v. *Hammerstein* [1896], N Y. 17 Misc. Rep 375 Person *Dunning* v *Jacobs* [1895], N Y 15 Misc 85; *Flanagan* v *Goldberg* [1910], 137 N.Y App Div 92), although it has been held that he warrants the premises to be reasonably safe (*Weiner* v. *Scherer* [1909], N.Y., 64 Misc 82)

Laws providing for Sunday closing have been held constitutional (*Lindenmuller* v. *The People* [1861], 33 Barb [N Y] 548).

Questions concerning relations between managers and authors, actors and others connected with the profession depend upon contract Within recent years in the United States various groups have been organized The Actors' Equity Association, which includes practically all actors of note and which is affiliated with the American Federation of Labor, demands a certain type of contract for actors The Dramatists' Guild of the Authors' League of America, which in its membership includes practically all playwrights, insists upon a minimum basic agreement limiting the rights of managers in dealing with its members The Authors' and Composers' League includes in its membership all musical writers of note, and controls the "small rights" connected with presentation.

See *Encyclopaedia of Law* and cases above cited. (A G. H.)

Other Countries.—In Scotland the Theatres Act, 1843, and the Burgh Police Act, 1892, regulate the licensing of theatres and other places of public entertainment. There is no stage censorship in Ireland In the United States of America public entertainments are governed by State legislation, the only act of Congress affecting theatres, etc, being a revenue act, passed in 1829, imposing taxes on admissions to public entertainments on somewhat similar lines to the English entertainment tax. There is usually no censorship of plays, but performances are subject to police supervision and prosecution if they offend.

In Continental Europe Sunday performances are lawful In most European countries (but Denmark is an exception) there is no State censorship, the regulation and supervision of stage plays and other public entertainments being placed in the hands of the police or the local municipal authorities.

See also CINEMATOGRAPH; LIQUOR LAWS, ENTERTAINMENTS DUTY

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THEATRICAL MAKE-UP AND COSMETICS: *see* MAKE-UP AND COSMETICS; MOTION PICTURE MAKE-UP.

THEBAINE, an opium alkaloid, $C_{19}H_{21}NO_3$, of the phenanthrene group (*see* ALKALOIDS and MORPHINE).

THEBES, an ancient Greek city in Boeotia (anciently Θῆβαι *Thebae*), is situated on low hilly ground a little north of the Asopus valley, overlooking the Ismenian plain, about 44 m. from Athens, whence it is reached by two carriage-roads and by railway It has about 4,800 inhabitants, and is the seat of a bishop. The present town occupies the site of the ancient citadel, the Cadmea; two fragments of ancient wall are visible on the N. and another, belonging either to the citadel or the outer wall, on the S There are remains of a Minoan "palace," and chamber-tombs The church of St. Luke, south-east of the Cadmea, is believed to contain his tomb. Two streams, rising a little south of the town, flow on the two sides, the ancient Ismenus on the east and Dirce Δ(ηl)κρ on the west The "waters" of Thebes are celebrated by Pindar and the Athenian poets, and the site is still, as described by Dicaearchus (3rd century B C), "all springs," κάθυδρος πᾶσα. From the abundance of water the neighbouring plain is extremely fertile. But the population is scanty, and the town unimportant

History.—The record of the earliest days of Thebes was preserved in a mass of legends. Five main cycles of story may be distinguished: (1) the foundation of the citadel Cadmeia by Cadmus; (2) the building of a "seven-gated" wall by Amphion, and the cognate stories, (3) the tale of the "house of Laius," culminating in the adventures of Oedipus and the wars of the "Seven" and the Epigoni; (4) the advent of Dionysus; and (5) the exploits of Heracles It is difficult to extract any historical fact out of this maze of myths; at most it seems safe to infer that it was one of the first Greek fortified cities

In the period of great invasions from the north Thebes received settlers of that stock which spread over Boeotia The military security of the city tended to raise it to a commanding position and its inhabitants endeavoured to establish a complete supremacy over the outlying towns. In the late 6th century the Thebans were brought into hostile contact with the Athenians, who helped the small fortress of Plataea to maintain its independence against them. The aversion to Athens explains the attitude of Thebes during the great Persian invasion, though it should be remembered that Herodotus, our chief authority for the period, wrote this part of his history in all probability at a period when feeling between Athens and Thebes was bitter in the extreme Though a contingent of 700 was sent to Thermopylae (480 B C) and remained there with Leonidas to the end, the governing aristocracy soon after joined the enemy and fought zealously on his behalf at the battle of Plataea (479 B C.). The victorious Greeks punished Thebes by depriving it of the presidency of the Boeotian League In 457 B C Sparta, needing a counterpoise against Athens in central Greece, reinstated Thebes as the dominant power in Boeotia The great fortress served this purpose well by holding out when the Athenians overran and occupied the rest of the country (457–447 B C). In the Peloponnesian War (*q v*) the Thebans, embittered by the support which Athens gave to the smaller Boeotian towns, and especially to Plataea, were firm allies of Sparta, which helped them to besiege Plataea and allowed them to destroy the town after capture (427 B C.). In 424 B C. at the head of the Boeotian levy, they inflicted a severe defeat upon an invading force of Athenians at Delium After the downfall of Athens at the end of the Peloponnesian war the Thebans, finding that Sparta intended to protect the states which they desired to annex, broke off the alliance. In 404 B C. they had urged the complete destruction of Athens, in 403 B C they secretly supported the restoration of its democracy in order to find in it a counterpoise against Sparta. A few years later, they forced on the so-called Corinthian War and formed the nucleus of the league against Sparta. The result of the war was disastrous to Thebes as the settlement of 387 B C. stipulated the autonomy of all Greek towns and so withdrew the other Boeotians from its political control Its power was further curtailed in 382 B.C., when a Spartan force occupied the citadel by a treacherous *coup-de-main*. Three years later the Spartan garrison was expelled;

in the consequent wars with Sparta the Theban army, trained and led by Epameinondas and Pelopidas (*qq v.*), proved itself the best in Greece. Some years of desultory fighting culminated in 371 B C. in a victory over the Spartans at Leuctra (*q.v.*). The winners carried their arms into Peloponnesus and at the head of a large coalition permanently crippled the power of Sparta. But the predominance of Thebes was short-lived The states which she protected were indisposed to commit themselves permanently to her tutelage, and the renewed rivalry of Athens prevented the formation of a Theban empire. With the death of Epameinondas in 362 B C the city sank again to the position of a secondary power. In a war with Phocis (356–346 B.C) it could not even maintain its predominance in central Greece, and by inviting Philip II. of Macedon to crush the Phocians it extended that monarch's power within dangerous proximity to its frontiers In 338 B.C. the orator Demosthenes persuaded Thebes to join Athens in a final attempt to bar Philip's advance upon Attica. The Theban contingent fought bravely in the decisive battle of Chaeroneia (*q v*) Philip was content to deprive Thebes of her dominion over Boeotia, but a revolt against Alexander was punished by the complete destruction of the city Thebes never again played a prominent part in history It suffered from the establishment of Chalcis as the chief fortress of central Greece, and was severely handled by the Roman conquerors Mummius and Sulla In Pausanias's time (A D. 170) its citadel alone was inhabited During the Byzantine period it served as a place of refuge against foreign invaders, and from the 10th century became a centre of the new silk trade In 1311 it was destroyed by the Catalans and passed out of history

The most famous monument of ancient Thebes was the outer wall with its seven gates, which even as late as the 6th century B C was probably the largest of artificial Greek fortresses. Two of the springs have been identified with some probability—that of St Theodore with the Oedipodeia, in which Oedipus is said to have purged himself from the pollution of homicide, and the Paraporti with the dragon-guarded fountain of Ares (*see* CADMUS). From the interest of the site in history and still more in literature, as the scene of so many dramas, the temptation to fix details has been specially strong There are two main difficulties to contend with. The description of Pausanias was written at a time when the lower city was deserted, and only the temples and the gates left; and the references to Thebes in the Attic dramatists are, like those to Mycenae and Argos, of no topographical value.

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Ancient authorities are Herodotus, v.–ix ; Thucydides and Xenophon (*Hellenica*), *passim;* Diodorus, xvii., xix.; Pausanias, ix, 5–17.

THEBES (Θῆβαι), the Greek name of the ancient capital of Upper Egypt. It occurs in Homer (*Il.* ix. 381–4) where it has the epithet ἑκατόμπυλος, "hundred-gated," probably derived in the first place from the gateways of its endless temples, for Thebes was never a walled city with gates, though its vast temple enclosures in different quarters would form as many fortresses in case of siege or tumult Its Egyptian name was Wesi (or Wis?), later Ne, "the city" (sometimes Ne-Amun, hence No-Amon in Nahum iii. 8). Ammon, Amen-Ra, or Amenrasonther ("Ammon-Ra king of the gods") was its deity, with his consort Mūt and their child Khons Mont also was a local deity and Hathor presided over the western cliffs of Thebes. In very ancient times the city lay on the east bank, the necropolis on the west. The chief nucleus of the ancient Wēsi was a town about the temple of Karnak: it probably reaches back to the prehistoric period At Drah abu'l nagga, opposite to it, are tombs of its princes under the VIth Dynasty The temple of Karnak is no doubt of immemorial antiquity. In it Senusret I. dedicated statues to his predecessors of the Vth Dynasty who had probably showed their devotion to Ammon in a substantial manner, and Cheops of the IVth Dynasty is named in it. After the end of the Old Kingdom Thebes grew from an obscure provincial town to be the seat of a strong line of princes who contended for supremacy with Heracleopolis and eventually triumphed in the XIth Dynasty The most important monument of the Middle Kingdom now extant at Thebes is the funerary temple of Mentuhotep III. at Deir el Bahri The name Amenemhet, so common in the XIIth Dynasty, shows the importance of the Theban god at this time It was, however, the early rulers of the XVIIIth Dynasty down to Tethmosis III. who developed Karnak, and on the west bank built the great funerary temple of Deir el Bahri and smaller temples as far south as Medinet Habu, and began the long series of royal tombs in the lonely Valley of the Kings far back in the desert Amenophis III continuing, transformed western Thebes monumentally. built three great temples in addition, that of Mont on the north of Karnak the temple of Mut on the south and the temple of Ammon at Luxor, and connected the last two with the state temple of Karnak by avenues of sphinxes The city and its monuments now covered an area about three miles square After this Thebes experienced a serious set-back with the heresy of Ikhnaton, the son of Amenophis III. He moved his capital northward to Akhetaton (El Amarna) and strove to suppress the worship of Ammon, doing infinite damage to the monuments of Thebes by defacing his name and figure After about twenty years, however, the reaction came, Thebes was again the capital and a little later under Seti (Sethos) I and Rameses II. of the XXth Dynasty it was raised to greater architectural magnificence than ever These two kings built the great columnar hall of Karnak, added a large court with pylons to Luxor, and on the west bank built the funerary temple of Seti at Kurna, and the Ramesseum with its gigantic colossus, besides other edifices of which only traces remain. Under the XVIIIth and XIXth Dynasties Thebes was at the height of its greatness. Conquering Pharaohs brought home trains of prisoners and spoil, embassies came thither of strange people in every variety of costume and of every hue of skin, from Ethiopia, Puoni (Punt), Mesopotamia, Asia Minor, Libya, and the islands of the Mediterranean, bringing precious stones, rare animals, beautiful slaves, costly garments and vessels of gold and silver The tombs of the XVIIIth Dynasty on the west bank and the sculptures in the temples reflect the brilliancy of these days. but with Rameses II came the turning-point of its glories, and the efforts of all his successors combined could add little to the wonders of Thebes The temple and tower of Rameses III (XXth Dynasty) at Medinet Habu, his tomb in the Biban el Moluk, the temple of Khons (Rameses III and later) and the court of Sheshonk I. (XXIInd Dynasty) at Karnak are the only great achievements

The tide of prosperity was now flowing northward and such monumental energy as remained was expended more widely. For several centuries after the fall of the New Empire Thebes was but one of several alternating or contemporaneous capitals Memphis, Tanis, Bubastis, Sais, Heracleopolis had at one time or another at least equal claims The Ethiopian conquerors of Egypt made Thebes their Egyptian capital, but in 668 Assur-bani-pal sacked the city Psammetichus did not neglect it, but Ptolemy I gave a new capital to the upper country in the Greek foundation of Ptolemais, and thus struck a fresh blow at the prosperity of Thebes For a short period in the reign of Epiphanes, when Upper Egypt was in rebellion against the Ptolemaic rule, Thebes was the capital of independent native dynasts. In a later rebellion, Thebes was captured after a three years' siege and severely punished by Lathyrus (Ptolemy X, Soter II). In the reign of Augustus, having joined in the insurrection against the tax-gatherers, it was destroyed by Cornelius Gallus and became a collection of villages Though its vast buildings have since served as quarries for mill-stones and for the lime-burner, Thebes still offers the greatest assemblage of monumental ruins in the world

We will now briefly enumerate the principal groups of monuments. On the east bank at Karnak stand the great state temple of Amen-Ra with its obelisks of Hatshepsut and Tethmosis I and the vast columnar hall of Rameses II ; the temple of Mūt and the well-preserved temple of Khons; the temple of Luxor and avenues of rams and sphinxes connecting all these. On the west bank, in front of the necropolis, on the edge of the desert or projecting into the cultivation, was a low row of temples· the north-

ernmost, placed far in front of the others, is the well-preserved temple of Seti I at Kurna; then follow the Ramesseum and Medinet Habu; and the foundations of many others can be traced The temple of Amenophis III, to which the colossi of "Memnon" were attached, was again far forward of the line. The Ramesseum contains the remains of a stupendous seated colossus, in black granite, of its builder Rameses II., thrown on its face. When perfect it was probably 57 ft. high and weighed about 1,000 tons, surpassing the "Memnon" statues of Amenophis III in size and weight The temple of Rameses III at Medinet Habu, sculptured with very interesting scenes from his Syrian, Libyan and other wars and from religious festivals, is remarkable also for the unique entrance-tower which probably formed part of the royal palace Northward and far back in the foot-hills is the Ptolemaic temple of Deir el Medina, and beyond under the cliffs of Deir el Bahri the terrace temple of Queen Hatshepsut, the walls of which are adorned with scenes from her expedition to Puoni (Somaliland) in search of incense trees, and many other subjects Far behind Medinet Habu are the Tombs of the Queens, where royal relatives of the XXth Dynasty are buried, and immediately behind the lofty cliffs of Deir el Bahri, but accessible only by a very circuitous route from Kurna, are the Tombs of the Kings (from Tethmosis I onward to the end of the XXth Dynasty) in the Biban el Moluk and the Western Valley Those of Seti I and Rameses III are the most remarkable These royal sepulchres are long galleries excavated in the rock with chambers at intervals. in one of the innermost chambers was laid the body in its sarcophagus. In the XXIst Dynasty, when tomb robberies were rife and most of their valuables had been stolen, the royal mummies were removed from place to place and at last deposited for safety in the tomb of Amenophis II. and in the burial-place of the priest-kings at Deir el Bahri The finding of the two *cachettes* nearly intact has been among the greatest marvels of archaeological discovery. The systematic exploration of the Valley of the Tombs of the Kings has been annually rewarded with results of the highest interest The greatest as well as the most recent of these is the discovery in Oct 1922 of the tomb of Tutankhamun (reigned 1360–1350 B C) with its magnificent equipment almost intact

See Baedeker's *Egypt*; E Naville, (Temple of) *Deir el Bahari*, introduction and parts i–v (London, 1894–1906); Sir W M F Petrie, *Six Temples at Thebes* (ruined temples on west bank) (London, 1897), G. Daressy, *Notice explicative des ruines de Medinet Habu* (Cairo, 1897), G Maspero, "Les Momies royales de Deir el Bahari" in *Mémoires de la mission archéologique française au Caire*, tome I, and many other works (F Ll G; X)

THECLA, ST., one of the most celebrated saints in the Greek Church (where she is commemorated on Sept. 24) and in the Latin Church (where her festival is Sept. 23) She is honoured with the title of "protomartyr" The centre of her cult was Seleucia, in Isauria Her basilica, south of Seleucia, on the mountain, long a popular place of pilgrimage, is mentioned in the two books of St Basil of Seleucia According to her *Acta*, Thecla came under the personal teaching of the apostle Paul at Iconium. In spite of their highly fabulous character (Thecla escaped from burning, from wild beasts, bulls and serpents), which caused them to be more than once condemned by the Church, the *Acta* of Paul and Thecla, which date back to the 2nd century, are interesting monuments of ancient Christian literature

See *Acta Sanctorum*, September, vi 546–568, J. A. Lipsius, *Acta apostolorum apocrypha* (Leipzig, 1891), i 235–269, C Schmidt, *Acta Pauli* (Leipzig, 1905), where an attempt is made to prove that the *Acta* of Paul and Thecla formed an integral part of the *Acta Pauli*; *see* also Apocryphal Literature, C Holzey, *Die Thekla-Akten, ihre Verbreitung und Beurtheilung in der Kirche* (Munich, 1905)

THEGN or **THANE,** an Anglo-Saxon word meaning an attendant, servant, retainer or official From the first, however, it had a military significance, and its usual Latin translation was *miles*, although *minister* was often used The word is used only once in the laws before the time of Aethelstan (*c* 895–940), but more frequently in the charters

The thegn became a member of a territorial nobility, and the dignity of thegnhood was attainable by those who fulfilled certain conditions In like manner a successful thegn might hope to become an earl There were others who were thegns on account of their birth, and thus thegnhood was partly inherited and partly acquired The thegn was inferior to the aethel, the member of a kingly family, but he was superior to the ceorl. The status of the thegn is shown by his wergild Over a large part of England the amount of this was fixed at 1,200 shillings, or six times that of the ceorl. He was the twelfhynde man of the laws

The increase in the number of thegns produced in time a subdivision of the order There arose a class of king's thegns, corresponding to the earlier thegns, and a larger class of inferior thegns, some of them the thegns of bishops or of other thegns. A king's thegn was a person of great importance, the contemporary idea being shown by the Latin translation of the word as *comes* He had certain special privileges No one save the king had the right of jurisdiction over him, while by a law of Canute we learn that he paid a larger heriot than an ordinary thegn

The 12 senior thegns of the hundred play a part, the nature of which is rather doubtful, in the development of the English system of justice By a law of Aethelred they "seem to have acted as the judicial committee of the court for the purposes of accusation" (Holdsworth, *Hist Eng Law*, vol i, 1921), and thus they have some connection with the grand jury of modern times

The word thane was used in Scotland until the 15th century to describe an hereditary non-military tenant of the Crown

THEINNI (now **HSENWI**) *see* Shan States

THEISM, in the broadest sense, means belief in God The word, however, is used generally with the implication that the belief is held in a conscious and rational manner, and hence Theism is usually applied only to a system of beliefs which has some claim to be regarded as a philosophy. According to the Oxford Dictionary the first occurrence of the word is in Cudworth's *Intellectual System of the Universe* (1678) The etymology of the word (*θεός*) would suggest that it might cover any conception of the universe which admitted the existence of Deity, but in practice Theism has come to mean a belief in one God, and the word is not easily distinguished from Monotheism, save that Theism has a more theoretical implication

Theism as a philosophical and theological position may be distinguished from other theories It is, of course, the direct antithesis to Atheism (*q v*), which, strictly speaking, is the denial that God exists It is to be distinguished, again, from Agnosticism (*q v*), the view that there is no sufficient ground for either an affirmative or negative answer to the question: Does God exist? and that the only rational attitude is absolute suspense of judgment It should be observed, however, that there is a sense of the word Agnosticism which is not wholly incompatible with Theistic belief The theory of Herbert Spencer, that we can know that an Ultimate Reality exists but can also know that that Reality is unknowable, is sometimes described as agnosticism Herbert Spencer's theory, as it stands, is plainly absurd, because in order to know that the Ultimate Reality is unknowable we must know enough of the nature of the Unknowable to be justified in making this assertion about it All reflective Theists would acknowledge, however, that there is an element of truth in the Agnostic position—the human mind is incapable of grasping completely the nature of the Divine, and though there is a genuine knowledge of God. for finite mind that knowledge must always be incomplete. It is customary to distinguish Theism from Deism (*q.v.*)

The Deists were writers on natural religion in the 18th century who shared the desire to set religion on a purely rational basis and tended, in a greater or less degree, to exclude the ideas of revelation and mystery, reducing Christianity to those truths which, it was alleged, could be attained by the unaided reason. Though some of these authors had pantheistic tendencies, the name Deism has been given to that type of theology which considers God and the world to be absolutely distinct from one another, thus conceiving the Deity as an external Creator and Governor. In the language of modern philosophy Deism is the view which emphasises the transcendence of God but denies His immanence. In contrast to Deism, Theism affirms the presence of God in the world, holding both immanence and transcendence. Pantheism (*q.v*) presents a contrast to Theism of the opposite kind to that which we have found in Deism Pantheistic systems,

though widely different from one another in spirit and presentation, agree in making an identification between God and the Universe. It is sometimes said that Pantheism maintains divine immanence while eliminating from its creed every vestige of divine transcendence. This manner of expression, though open to criticism, has the merit of making clear the main difference between Pantheism and both Deism and Theism. Certain philosophical systems may be classified for this purpose under the head of Pantheism. Spinoza's philosophy of God as the Infinite Substance and some forms of Absolute Idealism, as for example, that represented in England by the late F. H. Bradley cannot be described as theistic in the narrow sense of that word and are, theologically considered, pantheistic in tendency. Dualism is to be regarded as another theory which, in some of its forms, has affinities with Theism but is in essence different. Properly, Dualism means a view of the world which attributes its existence to two different or possibly antagonistic principles both equally ultimate, whether those principles be conceived as two deities, as in some forms of Zoroastrianism, or God and matter as in Manichaeism. A modified Dualism enters into most Theistic theories, but no theory could be called fully Theistic which was satisfied with a final Dualism.

We may now proceed to state in a positive manner the general tenets of Theism. It must be remembered that pure Theism has never been a widely influential religious belief. In the historical religions Theism is mixed with other elements, or rather perhaps is the basis of them. Thus Christianity is a Theistic religion, but its distinctive characteristic is the doctrine of the Incarnation. In the same way, Mohammedanism is Theism modified by special beliefs about the revelation of Allah through Mohammed. The fundamental conception of Theism in all its developed forms is that of a Being who is at once the supreme Value and the Source of all finite existence. Theism has usually thought of the Supreme Being as in some sense personal, or at least as One with whom personal relations were possible. This Supreme Being, in Anselm's phrase, *id quo majus cogitari non potest,* is, in the Theistic view, neither identical with the Universe nor wholly aloof and separate from it. The relation of God as Cause with the world has been conceived in various ways, the most common being creation, which itself may be capable of more than one interpretation. The idea of emanation, however, has also been employed, as in the Neo-Platonic philosophy (chief exponent Plotinus, A.D. 204–270) which exercised a considerable influence upon Christian theology. The peculiarly Theistic doctrine of the relation of God with the world is often expressed by the phrase, "God is both transcendent and immanent."

ARGUMENTS FOR THEISM

Theism, being a reflective theory and not simply a religious faith, has sought to defend its position by rational arguments. Historically, three arguments have been supremely important and are sometimes known as the "traditional proofs." They are the Cosmological, the Teleological, and the Ontological arguments.

The first philosopher, at least in the West, to state an argument which he held to be demonstrative of the existence of God is Plato. The proof which he gives (in the *Laws* X.) is the starting point of the rational theology or "natural" theology which claims to establish the being of God on the ground of reason. The *Laws* is universally admitted to be the work of Plato's old age. In his earlier writings Plato had made use of the idea of God and indeed the conception was central in his thought. He had constantly protested against unworthy ideas of the divine and asserts both in the *Republic* and *Theaetetus* that God is perfectly good and cannot be the cause of evil. The proof in the *Laws* may be regarded as the fruit of long reflection on the problem and contains the germ of much subsequent development. The proof turns upon the existence of motion and change. Motions and changes may be divided into several classes, but there is one fundamental distinction, that between spontaneous and communicated motion. It can be shown that spontaneous motion must be prior to communicated motion, since if there is motion at all it cannot all be communicated. Now the soul is the source of spontaneous motion, as distinguished from matter which can only receive communicated motion. Hence the soul is prior to the body. The motions in the Universe which have no human origin must likewise be referred to a soul. We are thus led to the conception of a Soul of the world. But the motions of the Universe, and in particular of the heavenly bodies, are orderly and thus indicate that the World Soul is rational and good, the "mind which ordered the universe." In Plato's argument two of the "rational" proofs are joined—the Cosmological (from the existence of a universe in which motion exists to a Source of motion), and the Teleological (from the existence of order to the Divine Mind as its ground). It will be convenient to consider these arguments in their subsequent formulations separately.

The Cosmological Argument.—The philosophy of Aristotle is not, like that of Plato, profoundly religious in spirit, and the concept of God in Aristotle's thought has little religious significance, being mainly a metaphysical conclusion; but the formulation of the cosmological argument by Aristotle has been of primary importance for Christian philosophy. Like his master Plato, Aristotle rises to the thought of God from the fact of change and motion (κίνησις) which means for him much more than change of place. Motion is conceived by Aristotle as the passage from potentiality to actuality (δύναμις and ἐνέργεια). Every change which actually occurs is the realization of a potentiality which was hitherto latent. Associated with this conception is Aristotle's doctrine of "form" and "matter." Every concrete and finite existence is composed of matter and form and it is the latter which gives to it a specific nature. In "sublunary" existences the expression of form is always imperfect, the matter never being absorbed in the form completely. The motion and change of the world are therefore explained as the striving of the potential to become actual, of the forms to become fully realised. The universe which is in constant motion is not, however, self-explanatory; the change must have some source beyond itself. This source is God, who must be conceived as at once the First Mover and the Unmoved. There can be nothing higher than God, otherwise He himself would be moved towards that higher being. God must exist or there would be no movement. God is therefore pure form and pure actuality, in Him there is no "matter" and no potentiality. He is the realization of all form and of all potentiality. Thus God moves the world ὡς ἐρώμενον, as an object of desire; but it is an essential part of Aristotle's view that God does not desire or need the world. The world is not even known to Him as it exists in actuality. He contemplates the pure forms which are the content of His own intellect. The outcome of Aristotle's reflection is then a Deity who is completely transcendent and pure thought. All personal relations with the world, every trace of emotion and even moral goodness is excluded from his nature which is described as a thinking of thought (νόησις νοήσεως) (Aristotle, *Physics,* Bk. VIII., *Metaphysics,* Bk. XII.)

It is one of the curiosities of history that a theology so "intellectualist" should have profoundly influenced the thought of Christianity which is in spirit widely different from that of Aristotle. Yet the Aristotelian logic and metaphysics formed the basis of the great constructive systems of the middle ages, the scholastic theology, of which the greatest representative is St. Thomas Aquinas (1227–1274). The cosmological argument forms the basis of St. Thomas's rational theology. It was a fundamental conviction with him that the *preambula fidei,* the foundation truths of religion, were demonstrable by the human reason without the aid of Revelation. In his greatest, though unfinished work, the *Summa Theologica* (Pt. I., Quaest. ii., art. 3), he gives five proofs of the existence of God, of which four are versions of the cosmological argument. (1) The argument from ***motion:*** "Any thing which is moved is moved by some other thing . . . one thing moves another in so far as the former is in actuality, for to move is nothing else than to draw anything from potentiality to actuality. But nothing can be brought from potentiality into actuality except by means of something which is already in actuality. . . . It is impossible that in the same respect and the same manner anything should be both moving and unmoved, or be self-moved." We cannot go on to infinity in the series of

"movers" which are themselves moved, for in that case there would be no first source of movement and consequently no movement at all We must then conclude that there is a first source of movement which is moved by nothing else—*i.e*, God. (2) The argument from *Efficient Causes:* Experience shows that there is an order of efficient causes Nothing can be the cause of itself, for that would imply that it was prior to itself We cannot rest content with an indefinite series of causes and effects, because if there is no First Cause there can be no last effect Hence we conclude that there is a First and Uncaused Cause—*i e*, God (3) Argument from *possible and necessary existence:* Some existences are possible and not necessary, *i e*, they may exist or not exist, being generated and corrupted But all existence cannot be of this nature, for unless there were necessary existence there would be no ground for possible existence If there are necessary existences there must be an existence which is necessary in itself and does not derive the necessity of its existence from some other necessary existence. An indefinite regress is as impossible here as in the case of efficient causes There must therefore be Something which is necessary *per se*—*i e*, God. (4) Argument from *degree of quality or value:* We find things more or less "good," "true" and "excellent" "More" or "less" is predicated according to degree of approach to a "greatest." There is therefore something which is most true, good and excellent—*i e.*, God

It should be observed that the first two forms of Aquinas' cosmological argument lead to the conception of a purely Transcendent Deity while the latter two suggest immanence

The cosmological argument, very much in the form which was given to it by Aristotle and Aquinas, appears as a fundamental element in many philosophies Mention must be made of Leibniz who supplemented it by laying down a new law of thought—the law of "sufficient reason"—according to which "for everything there must be a sufficient reason why it is so and not otherwise," thus making it clear that, for him, the basis of the cosmological argument was not empirical observation but a rational and self-evident principle—that of universal causation

The objections to the traditional cosmological argument have been formulated by Hume and Kant The former struck a blow at the simplest and most obvious version of the argument—that to a First Cause—by his sceptical analysis of the ideas of cause and necessary connection, though it should be noticed that he himself appears to have retained the conviction that the conception of a First Cause could not wholly be abandoned In Hume's view, however, there is no universal principle of causation The idea of necessary connection between phenomena is derived from habit breeding expectation, and the so-called "principle of causation" is due to nothing more than "the mind's propensity to feign," *i.e*, it is a convenient fiction Obviously this view, which was but the logical conclusion of the empirical movement in English philosophy, undermines the whole of our knowledge of the natural order and physical science, but it has also a direct bearing on the cosmological argument, for if causation is a principle on which we cannot rely when dealing with phenomena, we cannot use it to take us beyond phenomena to God. Kant attempted to save our knowledge of Nature from Hume's sceptical objections. He did so in a somewhat equivocal fashion He held that the "categories" which the mind employs in synthesizing perception (cause, substance, etc) are *a priori* in the sense that the mind does not derive them from experience but necessarily uses them in ordering experience—in short that Nature apart from Mind has no existence, but in some sense "Mind makes Nature" Kant is emphatic, however, in his limitation of this principle The categories of the understanding are confined to dealing with phenomena. The use of such a category as causation to carry us beyond phenomena to a super-phenomenal Reality is an illegitimate—a "transcendent"—use This is the real ground of Kant's objection; it is based upon his rigid limitation of the understanding to phenomena. Some special criticisms are also of permanent interest Kant points out that the argument, in the only form which he discusses (that of efficient causation), does not, even if sound, lead to the conclusion that God exists, but only that a First Cause of some kind exists, and in order to attain the conception of God we need another argument—the Ontological With reference to the alleged impossibility of conceiving an infinite series of causes, Kant remarks that the inconceivability attaches also to the idea of an uncaused cause, and there is therefore no reason why the mind should embrace one alternative rather than the other

In spite of the objections to which the traditional form is open, the cosmological argument in a wider application has kept its power. In modern philosophy all those systems which employ the idea of an Absolute Reality arrive at the Absolute by some kind of cosmological argument. An important example of this is found in the Theistic philosophy of Hermann Lotze The impossibility of rendering intelligible the fact of "transeunt" causation (*i.e*, that change in one thing is the occasion of change in another thing), so long as we conceive the ultimate reality to consist of a collection of independent "reals" leads to the conception of an all embracing Absolute of which the particular things and their changes are modifications Arguments of this type lead rather to an immanent Deity than to the transcendent God of Aristotle and Aquinas

The cosmological argument has permanent value, though it has not the demonstrative force which was formerly attributed to it. It serves to substantiate the conclusion that "nature," whatever we may mean by that term, is not a self-explanatory system, and therefore to support the Theistic view as preferable on rational grounds to rival hypotheses The form of the cosmological argument which begins with the apprehension of values, such as goodness and truth, has received little attention in the history of thought, but is one which has most positive weight for modern philosophy. Modern Theism would lay great stress on the contention that the existence of goodness, beauty and truth in finite experience compels us to postulate an absolute Goodness, Beauty and Truth

The Teleological Argument.—This argument, sometimes called "the argument from design," is rightly described by Kant as the most impressive, the most easily comprehended of the traditional "proofs." Like the cosmological argument it is *a posteriori* in character, since it starts with the observed facts of adaptation to ends in the natural world. As we have seen, however, when referring to Plato, the teleological argument may be based upon the more general consideration of the order of the universe. The purposive character of the events of the world was a common topic of Stoic philosophers in connection with their doctrine of Providence. Here again we may turn to Thomas Aquinas for a succinct statement of the argument in its common form It is the fifth proof of the existence of God given by that philosopher —the proof from the *gubernatio* of things. "Some things which have no power of knowing, such as natural bodies, work for ends, as is manifest from their constantly, or at least frequently, working in the same way for the attainment of that which is best. . Now such things as have no power of knowing do not tend towards an end unless they are directed by some being which has knowledge and intelligence" (*Summa Theologica*, Pt I Quaest. ii. art. 3) It will be noticed that there are two elements in this argument (a) the observation of "working for ends"; (b) the inference from this to a directing Intelligence

The evidence for working for ends or the adaptation to purposes on which stress is laid has varied; at times the main emphasis has been on general adaptation of the Universe to the existence and well-being of men or, more abstractly, to the production of values; at other times the argument has turned chiefly upon special instances of apparent design as, *e.g.*, the human eye. The latter type of reasoning was prominent among the rationalist Theologians of the 18th and 19th centuries. Paley's *Natural Theology*, with its famous analogy between the eye and a watch, is a familiar example of this kind of presentation.

Before proceeding to a discussion of the present position of the teleological argument it will be well to note the objections and limitations which arise on a consideration of the argument itself. These again have been clearly stated by Kant. It is obvious that the argument by itself is not sufficient to demonstrate the existence of God. Even if it be admitted that there are evidences of design, it does not follow that they are due to one Mind. The facts

might be explained on the hypothesis of several intelligences. It is only when we have reached the conclusion on other grounds that the Source of Being is one, that the teleological argument may tend to show that Source to be intelligent. The argument again, tends to suggest an analogy with the carpenter or sculptor who makes the best of his material and thus to lead to the conception of God as the Architect of the Universe working upon alien material. It may be alleged further, that the argument is based upon purely subjective estimates, and implies an absurdly anthropocentric conception of the universe. It cannot be denied that the teleological conception has frequently been carried to ridiculous extremes, and attempts have been made to show that this is the "best of all possible worlds" in the sense that all its features minister to human convenience; but these extremes are no necessary part of the argument, and it may be observed that Kant himself, in the *Critique of Judgement*, allowed that the teleological judgment is necessary and inevitable in dealing with living beings and the appreciation of the beautiful.

A permanent difficulty for the teleological argument is the existence of evil, particularly of pain, waste, and the missing of apparent ends If stress is laid on the "working towards ends" which are good, stress should equally be laid upon the working towards ends which to us appear to be bad. Additional weight has been given to this objection by the evolutionary theory of the origin of species through the struggle for existence and the survival of the fittest. The Darwinian theory of evolution seems to make death, defeat, and their concomitant pain, a necessary part of the evolutionary process. On these and other grounds it has been held, by Guyau, Bertrand Russell and many others, that there is neither beneficent nor maleficent purpose in the world, but that Nature is indifferent to the hopes, aspirations and needs of man Some answer to these objections may be attempted It is argued, for example, that the amount of pain in the lower orders of creation has been greatly exaggerated by the tendency to interpret the experience of the lower animals in terms of our own, and by the neglect of the consideration that the pains of anticipation are absent in sub-human creatures. Suffering in human beings again may be supposed to serve spiritual ends (*see* James Martineau, *A Study of Religion*). The most conclusive answer attempted to the problem of evil as an objection to a teleologically ordered universe is that of Leibniz, who maintained that this is the "best of all possible worlds." Any other world would have contained more evil and less good than the actually existing one This view depends upon Leibniz's conception of the nature of possibility which, according to him, is determined, not by the arbitrary will of God, but by "eternal verities" which are absolutely valid for the Eternal Mind Thus out of an infinite number of possible worlds the Creator chose that which included the greatest sum of good, and the evils in it exist as necessary conditions for the greater sum of good. This theory has been somewhat unfairly summed up by F. H. Bradley in the epigram, "The world is the best of all possible worlds, and everything in it is a necessary evil."

We may remark here that our view of the teleological argument will be profoundly affected by our view of the meaning of "good" and "value" If we are "hedonists," believing that good means pleasure and the absence of pain, the teleological argument will have little weight The Universe is plainly not designed to afford the greatest possible degree of pleasurable feeling If on the other hand, we conceive that value means the development of spiritual and moral persons the argument will appear in a different and more favourable light.

The rise of the evolutionary concept has had another and even more important effect on the teleological argument. The principle of the adaptation of species to their environment by survival of those best adapted has removed the favourite examples of teleology, such as the eye, from the sphere of directly created things and offered a "natural" explanation of their delicate adjustment. The Darwinian and post-Darwinian theories of biological evolution seemed to destroy the basis of the most popular argument for Theism. It was evident that if the argument was valid at all it needed complete restatement. Post-evolutionary exponents of the teleological argument have consequently laid stress, not on particular instances of apparent design, but on the general trend of evolution which, it is maintained, can only be explained by the hypothesis of Divine Providence. A subtle statement of this line of thought is to be found in Lord Balfour's writings, the *Foundations of Belief* and *Humanism and Theism*, in which he urges that, unless there is some intelligent guidance of evolution, the values of truth and beauty cannot be maintained.

The philosophical analysis of the idea of evolution in the present century has led many thinkers to abandon a purely mechanical conception of its method The problem of newness and the development of values has engaged attention M Bergson has completely abandoned the mechanical view and substituted the idea of "creative evolution," new types of existence being in his theory the result of the effort of the *Élan Vital* to achieve freedom. Somewhat analogous is the conception of "emergent evolution" which has been worked out by Professor S Alexander and Professor C. Lloyd Morgan and adopted by several other English authorities. The "emergent" theory of evolution distinguishes between two types of effect, "resultants" which are the predictable outcome of previously existing conditions, and "emergents" which are specifically new and not completely predictable. New species, and in particular new types of being, such as life, consciousness and self-consciousness, would thus belong to the "emergent" type of effect. None of these writers would describe his view of evolution as definitely teleological, and Bergson is as much opposed to teleology as to mechanism, but it is obvious that such conceptions of evolution are leading in the direction of at least "immanent teleology"; and it may be argued that a purely immanent teleology is not by itself an intelligible conception. On the whole then, it may be said that the movement of thought is in favour of a restatement of the teleological argument

The inherent tendency of the human mind to think in the teleological mode suggests that there is really an *a priori* element in the argument The mind is irresistibly impelled to regard the Universe as rational, *i e*, as pervious to its categories and methods of thought. On this irresistible assumption or "act of faith" the whole structure of science is built It is one further step in the same process to regard the Universe as rational in the fullest sense, *i e*, as a teleological system which exists for an end which we can accept as reason for its existence—the production of values or of good

The Ontological Argument.—This is the only one among the traditional "proofs" which is explicitly *a priori* It is the inference from the idea of God to the existence of God, and does not employ any data derived from observation. The argument, though adumbrated by S. Augustine, was first clearly presented by S Anselm (1033–1109) in his work the *Proslogium* Even the fool "who says in his heart, there is no God" has the idea of God, otherwise he would not be able to deny His existence The idea of God is the idea of "that than which no greater can be conceived" (*id quo nihil majus cogitari potest*) Now this idea cannot be in the understanding alone, because if it were, it would not be the idea of that than which there can be nothing greater, for a Being who existed would be greater than a being who did not exist (It should be noticed that *majus* does not mean simply magnitude but includes value) In other words, the idea of the greatest conceivable implies the existence of that Greatest The obvious objection to this line of reasoning was raised by Gaunilo during Anselm's lifetime in his *Liber pro Insipiente* Gaunilo dissented from the passage from idea to existence, and adduced the famous illustration of the "perfect island," which he argued, on Anselm's principle, must exist. The essence of Anselm's reply to this objection is to draw a distinction between that which is the greatest conceivable absolutely and that which is the greatest only relatively as the member of a class. The idea of God is the idea of "that than which nothing greater can be conceived" absolutely, and to this idea alone the ontological argument applies

The subsequent history of the ontological argument has been curious. It has been rejected by many considerable thinkers as a patent fallacy and by others regarded as the foundation of constructive thought Descartes, who is sometimes held to be the

father of modern philosophy, adopted it in two forms as the corner stone of his system, the bridge by which he passed from universal doubt to confidence in the possibility of knowledge. Descartes places in the forefront the consideration of the possession by the mind of the idea of an infinite and perfect being, and the question how this idea can originate. I cannot derive it from myself, because I am certainly neither infinite nor perfect The idea then implies a really existent infinite and perfect Being as its source. Descartes adds an important element to the argument by distinguishing between the positively infinite and the merely "indefinite." The latter is a negative idea implying simply the absence of limits, the former is concrete, and is the idea of God Unless I were in possession of the positive idea of infinity and perfection I should not know myself to be finite and imperfect. Descartes also states the ontological argument very much in the form given to it by Anselm Though in all other instances it is possible to distinguish between essence and existence and to conceive of a being as not existing, this is not possible in the single case of the idea of God "The existence can no more be separated from the essence of God than the idea of a mountain from that of a valley. . . . It is not less impossible to conceive a God, that is, a being supremely perfect to whom existence is wanting, or who is devoid of a certain perfection than to conceive a mountain without a valley" (*Meditations* III and V) The ontological argument was also adopted by Leibniz, who made the addition to it that we need first to demonstrate that the idea of God is the idea of a possible existence

The great flaw in the argument in its traditional form was clearly shown by Kant, who pointed out that it implies existence to be an attribute of the same nature as other attributes the absence of which would constitute imperfection, whereas this is not the case, since every concept we form is of a being as existing in some sense. Kant's illustration however, of the "hundred thalers," which are the same in properties in the imagination as in the pocket though not the same in usefulness, seems to miss the point even more obviously than Gaunilo's perfect island The permanent value in the ontological argument has been emphasised by Hegel It is the necessary attempt to bridge the gulf between thought and things, between concept and reality In this sense it is really at the root of all thought. However we may express it, we are compelled to hold that what the mind necessarily thinks *qua* mind is real, that there is no impassable chasm between the *"ordo idearum"* and the *"ordo rerum"* All philosophies which distinguish between appearance and Reality on the ground that the irrational cannot be the real, rest upon something akin to the ontological argument Probably it would be better to say, "upon an ontological assumption" The ontological argument is, in truth, an attempt to put into the form of a train of reasoning a postulate without which the mind is helpless It may be questioned therefore whether the ontological argument or postulate leads us directly to the God of religious experience It leads rather to the conception of an absolute or rationally coherent system of being

Before leaving the famous "three proofs" a remark must be made on their value for modern Theism. Before Kant's drastic criticism they were taken to be demonstrative proofs of the existence of God at least by the rational theologians It is clear that as demonstrations they are unsatisfactory. This does not mean, however, that they are devoid of value The post-Kantian Theist would, in most cases, adopt a different approach to his problem The central question of constructive philosophy does not present itself to him in the form, given the idea of God as a belief, to find some rational proof of His existence Rather the problem presents itself as analogous to the scientific problem, given the universe as disclosed in experience, to find the most reasonable account of it Several hypotheses present themselves for consideration, among them Theism. The question before the mind of the philosopher, therefore, is to decide which of the possible hypotheses squares most adequately with the whole experience of the universe which is open to us. The Theist maintains that his hypothesis is the most rational in this sense The traditional arguments, on this view, call attention to various aspects of the universe which, when taken up into reflective thought, go to support the Theistic view. Thus in spite of their failure as demonstrative arguments they have great value as indicating lines of thought, suggested by experience, which tend to substantiate the Theistic theory. (For a fuller statement of this *see* W. R Sorley, *Moral Values and the Idea of God*, and W. R. Matthews, *Studies in Christian Philosophy.*)

The change in the method of approach to which we have referred in the preceding paragraph is reflected in the type of argument on which modern Theism has laid greatest stress Though not putting on one side the "rational" proofs, the main appeal in the philosophy of Theism has been to considerations drawn more directly from experience, and particularly from moral and religious experience

The Moral Argument.—Kant is the historical turning-point in the philosophy of religion His criticism of the Theistic proofs was not made in the interest of Atheism, and he was an agnostic only in the technical sense that he denied the possibility of arriving at a knowledge of God by the pure or speculative reason. Religion belongs to the sphere of moral faith, of the "practical reason" There are three postulates of the moral reason, God, Freedom and Immortality, these cannot indeed be proved in any scientific manner, but the consideration of the limits of theoretical knowledge leads us to see that the pure reason cannot disprove their validity. It remains neutral. We are therefore free to affirm the three ideas without which our moral experience of the authority of the moral law and the inexhaustible ideal of holiness could not be conceived as rational This is Kant's fundamental position The train of reasoning by which he seeks to establish the necessity of the postulate of God is less important, being complicated by his peculiar views of the nature of the moral experience The argument turns on the alleged moral demand that the highest holiness should ultimately coincide with the highest happiness

The moral argument has been presented in various forms by important writers of the 19th and 20th centuries Theories of ethics naturally fall into two classes, (1) those which take the fundamental concept in morals to be duty and the moral law, (2) those which take the idea of the Good to be fundamental From both of these standpoints Theistic conclusions have been defended James Martineau in his *Types of Ethical Theory* and *A Study of Religion* adopts on the whole the first, T H Green's *Prolegomena to Ethics* and W R Sorley's *Moral Values and the Idea of God* are salient representatives of the second, while Dr Hastings Rashdall's *Theory of Good and Evil* combines to some extent both points of view

There are three elements in the moral consciousness on which stress is laid in Theistic arguments (a) The authority which the conscience attributes to the moral ideal This unique authority cannot, it is urged, be explained on any view which does not allow us to find the moral law in some way built into the structure of the world, grounded in Reality Other possible accounts of the source of the sense of obligation really issue in an explaining away of the moral "ought," and hence in the consequence that the fully moral life is irrational Further, it is urged, the Theistic view is the view which most clearly enables us to hold that the moral law is not simply imposed externally but is the expression of the deepest self and also that it is no mere individual product, but of universal validity. (b) The "objectivity" of the moral ideal The conscience cannot be satisfied with the belief that the moral ideal is dependent upon opinion, whether of the individual or of groups. In spite of the obvious fact that moral ideas change, the moral life depends upon the conviction that the moral ideal itself is absolute Though men's apprehension of it may grow, their apprehension does not create it It may be argued that Theism gives us the most rational account of this aspect of the moral consciousness, since it suggests that the moral ideal may exist in the thought of God (c) The content of the moral ideal, particularly when viewed in its social aspect. Though we know what we mean by progress, we cannot conceive any temporal condition which would be the final goal of social progress Unless therefore we are prepared to allow that progress is towards an end which is inherently unattainable, we are led to the thought of an End which is beyond the temporal order Here again the

theistic hypothesis appears to offer the most reasonable view, since it would hold that perfect communion with God and herein with all rational beings, is the nature of the highest Good. The central thought of the moral argument in all its forms is this: given man's moral experience at its highest we have the choice of regarding it as rational and significant, or of explaining it away as partially founded on a mistake with the probable consequence of weakening its effectiveness. If we choose to regard it as rational and significant Theism is the view of the world which will most adequately fulfil our demands

The Argument from Values in General.—Strictly speaking the moral argument is a special case of the line of reasoning which sets out from the existence of values. The world manifests the character of having value, or of being the occasion of our apprehension of value. Truth, goodness and beauty are real in our experience. In every case however, we are led to the conception of an absolute value, a complete Truth, a perfect Good and Beauty The very fact that we recognise degrees of truth, goodness and beauty, implies that we tacitly presuppose an absolute standard towards which the partial values which we enjoy are approximations Nor again, can we suppose that in the end these values are opposed to one another, though in finite experience they may sometimes seem to conflict. On the contrary, the Ultimate values must form a Unity, or rather perhaps, be aspects or attributes of one Supreme Value, which is what we mean by God This is the line of thought which carries on the Platonist tradition in Christian philosophy and is impressively stated by Dr. W R Inge in his *Philosophy of Plotinus* and other writings

Religious Experience.—Among the ancient arguments for Theism should be enumerated the argument *e consensu Gentium,* from the agreement of the nations. The evidence to be derived from the fact that all men everywhere believed in the Divine was insisted on by the Stoics and has been held to show that the idea of God is "innate" in the human mind. Precisely in this form the reasoning is open to objection. Locke, in his polemic against "innate ideas" in general, pointed out that the argument collapsed when we asked, what idea of God is innate? for the conceptions of the divine held by savages differ profoundly from those of civilized nations. The study of Comparative Religions since the time of Locke has served to support in detail his contention; but on the other hand it has shown that religion is practically a universal phenomenon wherever the human race is found. A new and more profound approach to Theism, which has some affinity with the old argument *e consensu Gentium,* has been opened by this enlarged knowledge. It is now possible to study the religious experience of mankind as a whole. When this is done we can discern an upward movement of the experience and of the concepts of the Divine in which it finds expression This upward movement does not take place over the whole field, but certain principles of development may be noticed which are fully exemplified only where the religious impulse has free course. The primitive ideas of animism and polydaemonism, give place to polytheism, which in turn is displaced by monotheism either in the form of pantheism or ethical monotheism. It is always open to the critic to dismiss the whole religious experience of humanity as based on illusion and mistake; but such a drastic rejection of a universal type of consciousness is hard to justify If we base our knowledge of the Universe on experience, religious experience has a claim to be included. If further, we find that the religious experience tends to pass from obviously inadequate forms to forms which lend themselves to rational presentation, we shall be justified in regarding the later and higher as the nearest approximations so far to adequate discriminations of the Object with which all religious experience is concerned.

Parallel to this consideration of the general development of religious experience runs the evidence to be derived from a study of the great religious personalities, and particularly of the mystics. The mystical type of religious "genius" seems to enjoy an immediate contact with the Divine, and the statements made by such persons have some general agreement. Too much stress should not be laid on their testimony to the truth of Theism, since some of the evidence would support Pantheism rather than Theism, and there is a tendency among mystics to interpret their experience in terms of the religious imagery in which they have been brought up The witness of the mystics to the supernatural is impressive, and they may be linked with the general argument from religious experience as salient instances of its power at every level It is urged by several Christian writers that the definitely Theistic mysticism of the Christian mystics is a higher and more complete type of mysticism than any other (*See*, for example, W R Inge, *Christian Mysticism,* E. Underhill, *Mysticism,* and R Otto, *West Östliche Mystik*)

In concluding this summary of grounds of Theistic belief we must remark again that few philosophical Theists would rest their case on a direct demonstration or claim that they were in possession of an "apodeictic" argument; they would urge that the full force of the reasons in favour of Theism can only be appreciated when it is compared with other possible views of the Universe, and that several converging lines of thought form a cumulative argument which is difficult to resist

SOME PROBLEMS OF THEISM

The Theistic view of the world is naturally impelled to articulate itself by considering the problems of the nature of God and His relations with the world Some of the more important of these problems must now be briefly indicated.

Divine Personality.—Most Theists, if not all, would agree that God is, in some sense, personal, or at least not of a nature inferior to personality The latter tenet seems to be implied in the Theistic hypothesis, for otherwise God could not be thought of as the Supreme Value It is important however, to distinguish between the two propositions, "God is personal" and "God is a person." Though the second of these propositions has been held by many Theists, it is not an essential point Orthodox Christianity cannot be cited on behalf of the belief that God is a person, for the doctrine of the Trinity would suggest that the Godhead is a Unity of Persons. No one, of course, would maintain that God is a person in precisely the same sense as human beings are persons, and in view of this some would prefer to speak of the Divine Nature as Supra-Personal, others, on the contrary, as for example Lotze, would hold that God alone is the perfect person and that finite selves are "pale shadows" of His personality No very vital principle is involved in this difference, so long as those who prefer the term "supra-personal" are clear that it is not a polite phrase for "impersonal" Theistic religion is profoundly concerned to maintain that God is a being with whom personal relations are possible; if that be abandoned we shall be compelled to dismiss that religious experience, which Theists take to be the highest and most significant, as illusion The main theoretical ground for accepting Divine Personality is the contention that personality is the highest type of existence known to us, the "bearer," the discerner, and the creator of values, and also that personal life is the most conspicuous instance of multiplicity in unity, it is, as Plotinus called it, a πλῆθος ἕν : the category of personality would appear, in its ideal form, to suggest an ultimate solution of the problem of the One and the Many A difficulty has been raised concerning the attribution of personality to God on account of the alleged necessity of a "not-self" distinguishable from the self in all cases of self-consciousness. The discussion of this problem by Lotze in his *Microcosmus* (Bk. IX , Chap. IV), remains the classical authority It is noteworthy however, that this special difficulty does not press with such force upon the Trinitarian form of Theism. On any Theistic view it would appear that the created order must be in some sense a "not-self" with respect to God, since the identification of the created order with the Being of God would be Pantheism

Divine Attributes.—The Theistic doctrine of God has usually included an account of the Divine Nature under the title of "attributes," but the error must be carefully guarded against of conceiving the Divine Nature as the sum of the Divine Attributes They are rather different aspects from which the Divine Being may be viewed by us. The traditional division is into Metaphysical and Moral The Scholastic Theology considered the Metaphysical Attributes to be those which refer to God as He is in

Himself and the Moral Attributes those which refer to Him in relation with the world. It may be questioned however, whether the human mind is capable of having knowledge of God of that absolute character suggested by this definition of the Metaphysical Attributes. If the division be retained it is perhaps better to say simply that by Metaphysical Attributes we mean those which have a primarily intellectual importance, such as Unity and Infinity, while by Moral we mean those which have a directly practical bearing, such as Righteousness and Love. The classification, however, is of doubtful value, since even the attributes which are most evidently "metaphysical" have profound religious results, and those which are "moral" have metaphysical import.

Reflection upon the Being of God has followed along two paths—the *via negativa,* and the *via eminentiae.* The first of these methods turns on the conception of God as the Infinite and works with a negative conception of infinity. God, being infinite, cannot be described by any predicates which would imply limitation. All positive assertions, however, imply such a limitation It follows therefore that no positive quality can be affirmed of God, not even goodness or indeed even being, so that if we say that God is τὸ ὄν we must also say that He is equally τὸ μὴ ὄν. Clearly this method leads to a position which is hardly distinguishable from Agnosticism. The *via eminentiae* starts with the conception of God as the Ground and Source of all existence and with the postulate that the Ground must be adequate to the consequences. All positive qualities, therefore, which occur in created existence must be ascribed to God; but plainly not *"simpliciter";* they are, so to speak, raised to infinity. Knowledge is in God Omniscience, Will Omnipotence, Beauty perfect Loveliness. We must observe here that the *via eminentiae* really implies the view that evil is not positive being but privation or defect of being, a view which was held by Augustine and Aquinas; for if evil were a positive existence or quality of existence the argument of the *via eminentiae* would lead us to predicate evil of God.

The Divine Attributes have been the subject of much subtle and intricate speculation into which it is impossible to enter here Brief remarks on two must be made, since they are of great importance in Theistic theory Omniscience is the perfection of that quality of knowledge which is found imperfectly in some created beings Evidently the Divine knowledge cannot suffer from the imperfections of human knowing It is scarcely appropriate to imagine the Divine Intelligence engaged in "discursive" thought and pursuing trains of reasoning The most adequate human knowledge is that described by Spinoza as *scientia intuitiva,* intuitive knowledge in which grounds and conclusion are apprehended in one intellectual act. Of this kind, it would seem, the Divine knowledge must be. We are brought here to the recognition of one aspect of the Divine Infinity and Eternity Human knowing is a part of a temporal experience and therefore itself a temporal process. The Divine experience and knowledge cannot be temporal, or at least cannot be "in time." A recognition of this truth has important bearing on some of the puzzles of Christian and other Theologies connected with the Divine Foreknowledge If the Divine Experience is not successive but simultaneous, the expression "foreknowledge" is evidently misleading and indicates that in presenting to ourselves the Divine Nature and Experience we are compelled to make use of inadequate concepts derived from our own experience, and hence to encounter problems which are insoluble because we have not the terms in which to state them accurately.

The same remarks apply to the attribute of Omnipotence in which we attempt to indicate the nature of the Divine Will. Clearly a supra-temporal will is beyond our powers of adequate conception. This does not prove, as Spinoza held, that will is absent from God's experience, but it certainly shows that we cannot transfer ideas derived from our experience of finite acts of will directly to the Divine Will. The conception of Omnipotence gives rise to problems which are, in their nature, not completely soluble by human reason. Two possible meanings of the word have been suggested It has been held, on the one hand, that omnipotence implies not only the power to do all that is possible but also that the determination of the possible is due to the will of God, so that the fundamental laws of thought and of morality are fiats of the Divine Will and not limitations upon it. On the other hand, it is held that the will of God is determined by the principles of reason and goodness which are inherent in His Nature and that omnipotence means the power to do all that is possible. Of these two views the latter is to be preferred, since the former asks us to conceive of the Divine Will as arbitrary and not in any intelligible sense either rational or good. Even so, however, it cannot be pretended that all difficulty has been removed from the conception of omnipotence, and we may perhaps be content to say, with Schleiermacher, that both omnipotence and omniscience are ways of expressing the fundamental conviction of Theism that all things ultimately depend upon God.

Creation and Self-limitation.—Theism does not identify God and the world. It maintains indeed that God is immanent in creation but also transcendent, and it holds therefore that there is a real distinction between God and the world. This distinction is expressed in the idea of Creation. Theism on the whole has preferred the idea of creation to that of emanation, which is the idea adopted by systems which lead to Pantheism. Emanation implies that the world proceeds from the Divine Being by a kind of necessary process, a common figure being that of the sun and its rays. Creation, on the other hand, emphasizes the factor of will and implies that the world exists as a result of an act of choice. Creation does not necessarily involve a belief that the world began at a definite moment of time or that the creative act of God is single; it is perfectly compatible with the belief in a continuous creation which would be in harmony with modern theories of evolution.

Any belief in creation, and indeed any belief in the reality of freedom, seems clearly to necessitate some limitation of the omnipotence and perhaps of the omniscience of God. At the same time, Theism cannot admit that any portion of existence is absolutely independent of God. To meet this dilemma the thought of a divine "self-limitation" has been employed. Admittedly this is a thought which cannot be articulated in any detail We cannot know the conditions of such self-limitation. But the conception itself is required by the facts as they appear in religious and moral experience. We may urge that the idea is not really contradictory of omnipotence, for an omnipotence which could not limit itself would not be omnipotent And there is no inherent difficulty in the moral attributes of God, for it may be argued that the development of free moral persons who can enter into communion with God is the ultimate purpose of creation, and that this end could not be attained apart from a limitation of the divine power which makes freedom possible and with it both moral good and moral disaster.

A difference of opinion among Theists exists on the question whether creation is in any sense necessary to God On this point traditional Christian theology and some modern idealistic interpretations of Christianity (*e.g.,* Hegel's) are at variance. Christian theology on the whole has laid down that the world is in no way necessary to God and that its creation does not add to His perfection or satisfaction. The opposite view, which emphasises the Divine immanence, holds that the world is as necessary to God as God to the world. A distinction should be made between the active and passive sense of "creation." Thus it might be conceived that creation is an essential attribute of God and at the same time that the present universe is not necessary to God, that to create is an eternal activity of God but no product of that activity is eternal. A theory of this kind would avoid the difficulties which arise when we attempt to conceive a beginning of creation. (On this point *see* further, *Studies in Christian Philosophy* by W R. Matthews.)

A problem in Theistic philosophy closely connected with the foregoing is that of the place of suffering in the Divine Experience. Here again the weight of Christian thought is against the admission of anything which would seem to qualify the absolute self-sufficiency and perfection of the Divine Nature. Suffering arises through frustration and limitation, conditions which are hardly to be thought of in connection with the Supreme Being. Against this may be set some considerations arising from the problem of evil

and the moral perfection which we believe God to possess. It would seem difficult to think of Divine Sympathy with suffering if suffering could not enter into the Divine Experience; and it would seem strange to ascribe moral perfection to God if self-sacrifice, which involves voluntary pain, were excluded. On these grounds many writers on Theism and Christian Theologians in the present century have argued that suffering must enter into the Divine Consciousness, and some have urged that this is really an essential element in the Christian view of the world. (For a survey of opinion on this subject *see* J. K. Mozley, *The Impassibility of God.*) It must be observed, however, that Theism could not admit that suffering is the dominant note of the Divine Experience. To do so would be to fall back upon the conception of a "God" so limited and struggling that He may be ultimately defeated. Our experience, however, offers us an analogy which throws light upon the problem At the highest level of spiritual life a condition of "blessedness" has sometimes been attained which is far different from a condition of mere pleasure and absence of pain. Pain enters into it as an essential element, but the condition itself is not one of pain, rather it is one in which the self finds its truest satisfaction and which it would not exchange for any maximum of pleasant feeling. Of this kind, though in an infinitely higher degree, we may imagine the life of God to be.

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THEISS: *see* Tisa

THELEPTE, an ancient Roman city in western Tunisia, 35 m. S.W. of Sufetula (Sbeitla), 2,650 ft. above sea-level. The ruins are extensive, but most of the buildings are almost entirely destroyed, and only their ground plan can be recognized. To the south-west are some massive remains of baths.

THEMIS. (1) An ancient goddess, often identified with Ge, said to have been the occupier of Delphi in days before Apollo (*see* Oracles). She is the mother of Prometheus (*q.v.*). (2) A goddess of justice (*cf.* Nemesis). In Homer θέμις is used both as a common noun (doom, decree; *cf.* Greek Law) and as a proper name; Themis is the servant or companion of Zeus, her chief function being to summon the assemblies of both gods and men (*Odyssey*, ii. 68). In the Hesiodic theogony, she is the daughter of Uranus and Ge, and according to Pindar the wife of Zeus, by whose side she sits, assisting him with her advice, which is even better than that of any of the gods. She is the mother of the Horae and of the Fates (*q.v.*). Her opposite is Hybris (ὕβρις), insolent encroachment upon the rights of others. The exact relation between (1) and (2), save that they have in common the idea of stability (θέμις, root θε, place) is obscure. Orphic poetry makes her a daughter of Helios.

See R. Hirzel, *Themis, Dike, und Verwandtes* (1907); L. Weniger in Roscher's *Lexikon, s.v.* (bibliography).

THEMISTIUS (317–?387), named εὐφραδής ("eloquent"), statesman, rhetorician and philosopher, was born in Paphlagonia and taught at Constantinople, where, apart from a short sojourn in Rome, he resided during the rest of his life. Though a pagan, he was admitted to the senate by Constantius in 355. He was prefect of Constantinople in 384 on the nomination of Theodosius. His paraphrases of Aristotle's *Posterior Analytics, Physics* and *De Anima* are valuable; but the orations in which he panegyrizes successive emperors, comparing them to Plato's "true philosopher," and even to the "idea" itself, are servile and unworthy. Themistius's paraphrases of the *De Coelo* and of book Λ of the *Metaphysics* have reached us only through Hebrew versions. In philosophy Themistius was an eclectic.

See E. Zeller, *Philosophie der Griechen* (1881). *See* also H. Schenkl, *Beiträge zur Textgeschichte der Reden des Themistios* (Vienna, 1919).

THEMISTOCLES (*c.* 514–449 B.C.), Athenian soldier and statesman in some respects probably the ablest and most far-sighted whom Greece produced in the first half of the 5th century. He was the son of Neocles, an Athenian of no distinction and moderate means, his mother being a Carian or a Thracian. Hence according to the Periclean law ἐξ ἀμφοῖν ἀστοῖν he would not have been a free Athenian at all (*see* Pericles). Thucydides observes that, though he lacked the culture typical of the Periclean age, he displayed a marvellous power of analysing a complex situation together with a genius for rapid action. Plutarch similarly enlarges on his consuming ambition for power both personal and national, and the unscrupulous ability with which he pursued his ends. Of his early years little is known. He may have been strategus of his tribe at Marathon.

At all events the death of Miltiades left the stage to Aristeides and Themistocles. It is sufficiently clear that their rivalry turned largely on the fact that Themistocles was the advocate of a policy of naval expansion. This policy was unquestionably of the highest importance to Athens and indeed to Greece. Athens was faced by the equal if not superior power of Aegina, while the danger of a renewed Persian invasion loomed large. Themistocles persuaded his countrymen to put in hand the building of 200 triremes, and to fortify the three natural harbours of Peiraceus (*see* E. Gardner, *Ancient Athens*, 562 f.) in place of the open roadstead of Phalerum. For the building of the ships Themistocles persuaded the Athenians to allocate 100 talents obtained from the new silver mines at Laureium (*Ath. Pol.* 22) which were about to be distributed to the citizens (10 drachmae each). One hundred of the proposed 200 were built.

He may or may not have been archon in 483, according to the *Ath. Pol.*, when this programme began. Dionysius of Halicarnassus places his archonship in 493–92, in favour of which are several considerations. In 487 the office lost much of its importance owing to the substitution of the lot for the election; the chance that the lot would at the particular crisis of 483 fall on Themistocles was obviously remote. In any case, the chief men of the other side disappear one by one—culminating in the ostracism of Aristeides in 482, and the year prior to the invasion of Xerxes found Themistocles the chief man in Athens if not in Greece. Though the Greek fleet was nominally under the control of the Spartan Eurybiades, it was Themistocles who forced the indecisive battle of Artemisium, and by his threat that he would lead the Athenian army to found a new home in the West, and by his treacherous message to Xerxes, precipitated the engagement at Salamis (*see* P. W. Dodd in *Class. Rev.* 27, p. 117). The retirement of the Persians left the Athenians free to restore their ruined city (*see* Athens). Sparta opposed the rebuilding of the walls, but Themistocles by a subterfuge got the walls built high enough to be defensible. He also carried out his original plan of making Peiraceus a harbour and fortress for Athens. Athens thus became the finest trade centre in Greece, and this fact, coupled with Themistocles' remission of the alien's tax (μετοίκιον) induced many foreign business men to settle in Athens.

After the crisis of the Persian invasion Themistocles and Aristeides appear to have composed their differences. But Themistocles soon began to lose the confidence of the people, partly owing to his boastfulness (it is said that he built near his own house a sanctuary to Artemis Aristoboulē "of good counsel") and partly to his alleged readiness to take bribes. Diodorus (xi. 54) and Plutarch (*Themist.* 23) both refer to some accusation levelled against him. There is, however, much difficulty regarding this accusation; it may be simply a misunderstanding of his ostracism. Some time between 476 and 471 he was ostracized. He took refuge eventually in Asia Minor, and was proclaimed a traitor in Athens. He was well received by the Persians and was allowed to settle in Magnesia on the Maeander. He died at Magnesia at the age of 65, and a splendid memorial was raised by the people of the town, though it is said that his bones were secretly transferred to Attica. He was worshipped by the Magnesians as a god, as we find from a coin on which he is shown with a patera in his hand and a slain bull at his feet (hence perhaps the legend that he died from drinking bull's blood: *cf.* Aristoph. *eq.* 83;

Diod xi. 58; Plut. *Them.* 31).

Though his end was discreditable, though his great wealth can hardly have been obtained by loyal public service, there is no doubt that his services to Athens and to Greece were great. He created the Athenian fleet and with it the possibility of the Delian League (*q v*) which became the Athenian empire, and there are many indications (*e g.*, his well-attested plan of expansion in the west) that the later imperialist ideal originated in his fertile brain

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THÉNARD, LOUIS JACQUES (1777–1857), French chemist, was born on May 4, 1777, at Louptière (Aube), the son of a poor peasant, who made great sacrifices for his son's education. He worked in a humble capacity in the laboratory of L N Vauquelin, who procured for him various teaching posts In 1804, when Vauquelin retired from the chair of chemistry at the Collège de France, he used his influence to secure Thénard's succession to the post Later, Thénard held the chair of chemistry at the Ecole Polytechnique and at the Sorbonne He was a member of the Academy, a peer of France (1832), deputy for Yonne (1827–30), and a member of the council of education. He died in Paris on June 21, 1857, and the name of his native village was changed (1865) to Louptière-Thénard in his honour.

Thénard was a great teacher, and his *Traité de chimie élémentaire* (4 vols, 1813–16), which was the standard text-book for a quarter of a century, did more, perhaps, than even his many important original discoveries to advance the cause of science With his lifelong friend, Gay-Lussac (*q v*), he carried out many researches His researches on esters (1807), sebacic acid (1802) and on bile (1807), his discovery of peroxide of hydrogen (1818) and his work on organic phosphorus compounds (1846) deserve mention The substance known as "Thénard's blue," he prepared in 1799 in response to a peremptory demand by J. A Chaptal for a cheap colouring matter, as bright as ultramarine and capable of standing the heat of the porcelain furnace

A list of Thénard's memoirs may be found in the Royal Society's *Catalogue of Scientific Papers*

THEOBALD (d 1161), archbishop of Canterbury, was of Norman parentage, but the date of his birth is unknown Early in life he entered the abbey of Bec, of which he became prior in 1127 and abbot ten years later. In 1138 he was elected to the see of Canterbury, and as archbishop he behaved with a moderation which is in striking contrast to the conduct of his rival, Henry of Blois, bishop of Winchester During the struggle between Stephen and Matilda it was Bishop Henry who fought for the privileges of the Church; Theobald, while showing a preference for Stephen's title, made it his rule to support the *de facto* sovereign But as Stephen's cause gained ground the archbishop showed greater independence. He refused to consecrate the king's nephew to the see of York, and in 1148 attended the papal council of Reims in defiance of a royal prohibition. This quarrel was ended by the intercession of the queen, Matilda of Boulogne, but another, of a more serious character, was provoked by Theobald's refusal to crown Count Eustace, the eldest son of Stephen, the archbishop pleading the pope's orders as the excuse for this contumacy In 1153 Theobald succeeded in reconciling Stephen with Henry of Anjou, and in securing for the latter the succession to the throne. He placed the interests of the Church in the hands of Thomas Becket, his archdeacon. Theobald died on April 18, 1161.

In history Theobald lives chiefly as the patron of three eminent men: Becket, who began life as a clerk in his household; Master Vacarius, the Italian jurist, who was the first to teach Roman law in England; and John of Salisbury, the learned scholar. Theobald's household was a university in little; and in it were trained many leading prelates of the next generation.

See the *Vita Theobaldi* printed in J. A Giles, *Lanfranci Opera*, vol. i. (Oxford, 1844); W. Hook, *Lives of the Archbishops of Canterbury*, ii. c. vi (London, 1862); and K Norgate, *England under the Angevin Kings*, vol. i. (London, 1887). (H. W. C. D)

THEOBALD, LEWIS (1688–1744), English man of letters, playwright and Shakespearian commentator, the son of an attorney, was born at Sittingbourne, Kent. He was baptized on April 2, 1688, and was educated for the law. He translated the *Phaedo* of Plato in 1713, in 1714–15 the plays of Sophocles and of Aristophanes, and in 1716 the first book of the *Odyssey*. Meanwhile he had got into trouble in 1716 on a charge of plagiarism in his play *The Perfidious Brother*. But Theobald is remembered neither as translator, nor as original author, but for his work on the text of the Shakespeare plays.

In 1726 he produced *Shakespeare Restored, or a Specimen of the many Errors as well Committed as Unamended by Mr. Pope in his late edition of this Poet; designed not only to correct the said Edition, but to restore the true Reading of Shakespeare in all the Editions ever published* (1726). Some of his happiest emendations are to be found in this work, which conclusively proved Pope's incompetence as a Shakespearian editor

In 1731 Theobald undertook to edit Shakespeare for Tonson the publisher The work appeared in seven volumes in 1734, and completely superseded Pope's edition. Subsequent editors reaped, in many cases without acknowledgment or with actual scorn, the fruit of Theobald's painstaking labour, his wide learning and his critical genius.

His correspondence with Matthew Concanen, Styan Thirlby and William Warburton is to be found in Nichols's *Illustrations of Literature* (ii 204–654), which also gives the fullest account of his life *See* also R. F Jones, *Lewis Theobald, his contribution to English Scholarship* (N Y. 1919).

THEOCRITUS, the creator of pastoral poetry, flourished in the 3rd century B C. Little is known of him beyond what can be inferred from his writings We must, however, handle these with some caution, since some of the poems ("Idylls") commonly attributed to him have little claim to authenticity It is clear that at a very early date two collections were made, one of which included a number of doubtful poems and formed a *corpus* of bucolic poetry, while the other was confined to those works which were considered to be by Theocritus himself The record of these recensions is preserved by two epigrams, one of which proceeds from Artemidorus, a grammarian, who lived in the time of Sulla and is said to have been the first editor of these poems He says, "Bucolic muses, once were ye scattered, but now one byre, one herd is yours" The second epigram is anonymous, and runs as follows —"The Chian is another. I, Theocritus, who wrote these songs, am of Syracuse, a man of the people, the son of Praxagoras and famed Philina. I never sought after a strange muse" The last line may mean that he wrote nothing but bucolic poems, or that he only wrote in Doric The statement that he was a Syracusan is confirmed by allusions in the "Idylls" (xi 7, xxviii 16–18). A larger collection, possibly more extensive than that of Artemidorus, and including poems of doubtful authenticity, was known to Suidas, who says. "Theocritus wrote the so-called bucolic poems in the Dorian dialect. Some persons also attribute to him the following. *Daughters of Proetus, Hopes, Hymns, Heroines, Dirges, Lyrics, Elegies, Iambics, Epigrams*" The first of these may have been known to Virgil, who refers to the *Proetides* in the *Eclogues* (*Ecl.* vi., 48). The spurious poem xxi may have been one of the *Hopes* (*cf.* 1 66, ἐλπὶς τῶν ὕπνων), and poem xxvi may have been one of the *Heroines* (*cf.* 1 36, ἡρωῖναι): elegiacs are found in viii. 33–60, and the spurious epitaph on Bion may have been one of the *Dirges*. The other classes are all represented in the larger collection which has come down to us

The poems which are generally held to be authentic may be classified thus.—

I. Bucolics and Mimes.—The distinction between these is that the scenes of the former are laid in the country and those of the latter in a town. The most famous of the *Bucolics* are i., vii, xi. and vi. In i. Thyrsis sings to a goatherd how Daphnis, the mythical herdsman, having defied the power of Aphrodite, dies rather than yield to a passion with which the goddess had

inspired him. In xi. Polyphemus is depicted as in love with the sea-nymph Galatea and finding solace in song. in vi. he is cured of his passion and naively relates how he repulses the overtures now made to him by Galatea. The monster of the *Odyssey* has been "written up to date" after the Alexandrian manner and has become a gentle simpleton. Idyll vii., the "Harvest Feast" (Θαλύσια), is the most important of the bucolic poems The scene is laid in the isle of Cos The poet speaks in the first person and is styled Simichidas by his friends Other poets are introduced under feigned names Thus ancient critics identified Sicelidas of Samos (l. 40) with Asclepiades the Samian, and Lycidas, "the goatherd of Cydonia," may well be the poet Astacides, whom Callimachus calls "the Cretan, the goatherd" Theocritus speaks of himself as having already gained fame, and says that his lays have been brought by report even unto the throne of Zeus (possibly Ptolemy: *cf.* Horace, *Ep.* i. 19, 43, *Iovis auribus ista Servas,* where *Iuppiter*=Augustus). He praises Philetas, the veteran poet of Cos, and criticizes "the fledgelings of the Muse, who cackle against the Chian bard and find their labour lost"

The other bucolic poems need not be further discussed Several of them consist of a singing-match, conducted according to the rules of amoebean poetry, in which the second singer takes the subject chosen by the first and contributes a variation in the same air It may be noted that the peasants of Theocritus differ greatly in refinement Those in v. are low fellows who indulge in coarse abuse. This Idyll and iv are laid in the neighbourhood of Croton, and we may infer that Theocritus was personally acquainted with Magna Graecia Suspicion has been cast upon poems viii. and ix. on various grounds An extreme view holds that in ix. we have two genuine Theocritean fragments, ll 7–13 and 15–20, describing the joys of summer and winter respectively, which have been provided with a clumsy preface, ll 1–6, while an early editor of a bucolic collection has appended an epilogue in which he takes leave of the Bucolic Muses On the other hand, it is clear that both poems were in Virgil's Theocritus, and that they passed the scrutiny of the editor who formed the short collection of Theocritean Bucolics

The mimes are three in number, viz, ii, xiv, xv. In ii. Simaetha, deserted by Delphis, tells the story of her love to the moon; in xiv. Aeschines narrates his quarrel with his sweetheart, and is advised to go to Egypt and enlist in the army of Ptolemy Philadelphus; in xv Gorgo and Praxinoe go to the festival of Adonis. It may be noticed that in the best mss. ii comes immediately before xiv, an arrangement which is obviously right, since it places the three mimes together. The second place in the mss. is occupied by Idyll vii, the "Harvest Feast" These three mimes are wonderfully natural and lifelike. There is nothing in ancient literature so vivid and real as the chatter of Gorgo and Praxinoë, and the *voces populi* in xv

It will be convenient to add to the *Bucolics* and *Mimes* three poems which cannot be brought into any other class, viz., xii. (Ἀΐτης), a poem to a beautiful youth, xviii., the marriage-song of Helen (Ἐπιθαλάμιος); and xxvi, the murder of Pentheus (Λῆναι). The genuineness of the last has been attacked by U. von Wilamowitz-Mollendorff on account of the crudity of the language, which sometimes degenerates into doggerel It is, however, likely that Theocritus intentionally used realistic language for the sake of dramatic effect, and the mss evidence is in favour of the poem Eustathius quotes from it as the work of Theocritus.

II. Epics.—Three of these are Hymns, viz, xvi, xvii and xxii. In xvi. the poet praises Hieron II of Syracuse, in xvii Ptolemy Philadelphus, and in xxii the Dioscuri The other poems are xiii, the story of Hylas and the Nymphs, and xxiv. the youthful Heracles. It cannot be said that Theocritus exhibits signal merit in his *Epics.* In xiii. he shows some skill in word-painting, in xvi. there is some delicate fancy in the description of his poems as "Graces" (Χάριτες), and a passage at the end, where he foretells the joys of peace after the enemy have been driven out of Sicily, has the true bucolic ring. The most that can be said of xxii. and xxiv. is that they are very dramatic. Otherwise they differ little from work done by other poets, such as Callimachus and Apollonius Rhodius. The flattery heaped upon Ptolemy is somewhat nauseous. From another point of view, however, these two poems xvi. and xvii. are supremely interesting, since they are the only ones which can be dated In xvii Theocritus celebrates the incestuous marriage of Ptolemy Philadelphus with his sister Arsinoë This marriage is held to have taken place in 277 B.C, and Arsinoë died in 270. This poem, therefore, together with poem xv., which Theocritus wrote to please Queen Arsinoë (*Schol.* χαριζόμενος τῇ βασιλίδι) must fall within this period. The encomium upon Hiero II would from internal reasons seem prior to that upon Ptolemy, since in it Theocritus is a hungry poet seeking for a patron, while in the other he is well satisfied with the world. Now Hieron first came to the front in 275 B.C. when he was made "General" (στρατηγός): Theocritus speaks of his achievements as still to come, l. 73, and the silence of the poet would show that Hieron's marriage to Philistis, his victory over the Mamertimes at the Longanus and his election as "King" (βασιλεύς), events which are ascribed to 270 B C, had not yet taken place. If so, xvii and xv. can only have been written within 275 and 270.

III. Lyrics.—Two of these are certainly by Theocritus, viz, xxviii. and xxix. The first is a very graceful poem presented together with a distaff to Theugenis, wife of Nicias, a doctor of Miletus, on the occasion of a voyage thither undertaken by the poet. The theme of xxix is similar to that of xii A very corrupt poem, only found in one very late ms, was discovered by Ziegler in 1864 As the subject and style very closely resemble that of xxix, it is assigned to Theocritus by recent editors.

IV. The Epigrams.—These do not call for detailed notice. They do not possess any special merit, and their authenticity is often doubtful It remains to notice the poems which are now generally considered to be spurious They are as follows:—

xix "Love stealing Honey" (Κηριοκλέπτης). The poem is anonymous in the mss. and the conception of Love is not Theocritean.

xx. "Herdsman" (Βουκολίσκος), xxi. "Fishermen" (Ἁλιεῖς), xxiii "Passionate Lover" (Ἐραστής). These three poems are remarkable for the corrupt state of their text, which makes it likely that they have come from the same source and possibly are by the same author The "Fishermen" has been much admired It is addressed to Diophantus and conveys a moral, that one should work and not dream, illustrated by the story of an old fisherman who dreams that he has caught a fish of gold and narrates his vision to his mate. As Leonidas of Tarentum wrote epigrams on fishermen, and one of them is a dedication of his tackle to Poseidon by Diophantus, the fisher (*Anth Pal* vi 4, 7), it is likely that the author of this poem was an imitator of Leonidas. It can hardly be by Leonidas himself, who was a contemporary of Theocritus, as it bears marks of lateness

xxv. "Heracles the Lion-slayer" (Λεοντοφόνος). This is a long poem consisting of two episodes, viz, the interview of Heracles with the bailiff of Augeas and his recital to Phyleus, son of Augeas, of the story of the Nemean lion. The composition is not unworthy of Theocritus. It is, however, anonymous in the mss and comes next to another anonymous poem called "Megara, the wife of Hercules." It is probable from some metrical and linguistic peculiarities that xxv and the "Megara" are by the same author

xxvii. "The wooing of Daphnis" (Ὀαριστύς) is also anonymous It contains imitations of Theocritus, but the tone and the language betray a later writer.

We have no sure facts as to the life of Theocritus beyond those supplied by Idylls xvi. and xvii It is quite uncertain whether the bucolic poems were written in the pleasant isle of Cos among a circle of poets and students, or in Alexandria and meant for dwellers in streets. The usual view is that Theocritus went first from Syracuse to Cos, and then, after suing in vain for the favour of Hiero, took up his residence permanently in Egypt. Some have supposed on very flimsy evidence that he quarrelled with the Egyptian court and retired to Cos, and would assign various poems to the "later-Coan" period. Wilamowitz-Möllendorff, laying stress on the fact that in the best ms the poem to Ptolemy (xvii) comes before that to Hieron (xvi.), puts the Egyptian period first and supposes it to have been of very short duration (*i e*, 277 to 275), and then makes the poet, after his unsuccess-

ful appeal to Hieron, retire to Cos for the rest of his life. This view would enable us to see a reference to Ptolemy in vii 93, and even to Apollonius Rhodius in 47–48 of the same poem.

The poems of Theocritus were termed *Idylls* (εἰδύλλια), by the grammarians The word is a diminutive from εἶδος, and is supposed to mean "little poems." The use of εἶδος in the sense of "poem" is somewhat doubtful, and so some have referred εἰδύλλια to εἶδος in its usual sense of "form" or "type." Thus εἶδος βουκολικόν, ἐπικόν, λυρικόν might be used to classify various kinds of poetry, and these poems might be called εἰδύλλια, since they include so many types

Language and Metre.—Theocritus wrote in various dialects according to the subject. The Lyrics xxviii., xxix (and xxx) are in Aeolic, that being the traditional dialect for such poems Two poems, xii (Ἀΐτης) and xxii. ("To Castor and Pollux"), were written in Ionic, as is stated in titles prefixed to them, though a number of Doric forms have been inserted by the scribes The epics in general show a mixture of Homeric, Ionic and Doric forms The *Bucolics*, *Mimes*, and the "Marriage-song of Helen" (xviii) are in Doric, with occasional forms from other dialects

The metre used by Theocritus in the *Bucolics* and *Mimes*, as well as in the *Epics*, is the dactylic hexameter A feature in his versification which has attracted much attention is the so-called bucolic caesura The rule is that, if there is a pause at the end of the fourth foot, this foot must be a dactyl This pause is no new invention, being exceedingly common in Homer Theocritus uses it so frequently in the *Bucolics* that it has become a mannerism. In the *Epics* his practice agrees with that of Homer

We always think of Theocritus as an original poet, and as the "inventor of bucolic poetry" he deserves this reputation At the same time he had no scruple about borrowing from predecessors or contemporaries; in fact he did so in the most open manner. Thus xxix begins with a line of Alcaeus, and xvii , as the Scholiast points out, with words used by Aratus at the beginning of the *Phenomena* The love of the Cyclops for Galatea had been treated by Philoxenus, and fragments quoted from this show that Theocritus copied some of his phrases closely. In the mimes Theocritus appears to have made great use of Sophron Idyll ii is modelled upon a mime of this writer which began in a very similar way The Scholiast thought that Theocritus showed want of taste in making Thestylis a *persona muta,* instead of giving her a share in the dialogue as Sophron had done The famous poem about Gorgo and Praxinoe at the feast of Adonis was modelled on one by Sophron about women looking on at the Isthmian games (Ἰσθμιάζουσαι), and fragments quoted from this are closely imitated by Theocritus It is extremely interesting to find a similar poem in the recently discovered mimes of Herondas, the fourth of which is termed "Women making offerings to Aesculapius" (Ἀσκληπιῷ ἀνατιθεῖσαι καὶ θυσιάζουσαι). The relation of Theocritus to Herondas is a subject of great interest Herondas must have been a contemporary, as he refers to Ptolemy Philadelphus (l. 30) and was a native of Cos, so that he and Theocritus must have been acquainted There are some curious parallels in the language and idioms of the two poets, but which of them copied the other it is impossible to determine

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THEODOLITE, a surveying instrument consisting of two graduated circles placed at right angles to each other, for the measurement of horizontal and vertical angles, a telescope, which turns on axes mounted centrically to the circles, and an alidade for each circle, which carries two or more verniers. The whole is supported by a pedestal resting on footscrews, which are also employed to level the instrument.

Theodolites are designed to measure horizontal angles with greater accuracy than vertical, because it is on the former that the most important work of a survey depends; measures of vertical angles are liable to be much impaired by atmospheric refraction, more particularly on long lines, so that when heights have to be determined with much accuracy the theodolite must be discarded for a levelling instrument. When truly adjusted the theodolite measures the horizontal angle between any two objects, however much they may differ in altitude, as the pole star and any terrestrial object. The instrument is made in many forms and modern surveying has introduced a great degree of accuracy. For the uses of the theodolite and other details *see* SURVEYING The name has been a puzzle to etymologists. Various ingenious explanations have been given, all based on the apparent Greek form of the word, thus it has been derived from θεᾶσθαι, to see, ὁδός, way, and λιτός, smooth, plain; from θεῖν, to run, and δολιχός, long, and in other ways equally fanciful. Another imaginary origin has been suggested in a corruption of "the O deleted," *i e* , crossed out, the circle being crossed by diameters to show the degrees, others have found in it a corruption of "the alidade" (*q v.*) It would appear, however, to be taken from the O Fr. *theodolet* or *theodelet,* the name of a treatise by one Theodulus, probably a mathematician (see *Notes and Queries*, 3rd series, vii 337, 428, etc. Skeat, *Etym Dict.*, 1910).

THEODORA, the wife of the emperor Justinian (*q.v*), was born probably in Constantinople, though according to some in Cyprus, in the early years of the 6th century, and died in 547. According to Procopius, our chief but by no means a trustworthy authority for her life, she was the daughter of Acacius, a bear-feeder of the amphitheatre at Constantinople, and while still a child appeared on the stage Becoming a noted courtesan, she accompanied a certain Hecebolus to Pentapolis (in North Africa), of which he had been appointed governor, and, having quarrelled with him, betook herself first to Alexandria, and then back to Constantinople through the cities of Asia Minor In Constantinople she attracted the notice of Justinian. He desired to marry her, but could not overcome the opposition of his aunt, the empress Euphemia After her death (usually assigned to the year 523) the emperor yielded, and as a law forbade the marriage of senators with women who had followed the stage, this law was repealed Thereupon Justinian married Theodora They were some time after (527) admitted by Justin to a share in the sovereignty, and, on his death four months later, Justinian and Theodora became sole rulers of the Roman world. He was then about forty-four years of age, and she some twenty years younger Procopius relates in his unpublished history (Ἀνέκδοτα) many repulsive tales regarding Theodora's earlier life, but his evident hatred of her, though she had been more than ten years dead when the *Anecdota* were written, and the extravagances which the book contains, oblige us to regard him as a very doubtful witness. James Bryce discovered in Rome what is believed to be the only ms. of this so-called life of Justinian, he considered it worthless as an authority (*See* THEOPHILUS)

Theodora speedily acquired unbounded influence over her husband She had a right to interfere, for she was not merely his consort, but empress regnant. In the most terrible crisis of Justinian's reign, the great Nika insurrection of 532, her courage and firmness in refusing to fly when the rebels were attacking the palace saved her husband's crown, and no doubt strengthened her command over his mind. Officials took an oath of allegiance to her as well as to the emperor (*Nov.*, viii). Procopius describes her as acting with the greatest cruelties. The city was full of her spies, who reported to her everything said against herself or the administration. She surrounded herself with ceremonious pomp, and required all who approached to abase themselves in a manner new even to that half-Oriental court. She constituted herself the protectress of faithless wives against outraged husbands, yet professed great zeal for the moral reformation of the city, enforcing severely the laws against vice, and immuring in a "house of repentance" on the Asiatic side of the Bosphorus five hundred courtesans whom she had swept out of the streets of the capital. How much of all this is true we have no means of determining,

for it rests on the sole word of Procopius. But there are slight indications in other writers that she had a reputation for severity.

In the religious strife which distracted the empire Theodora took part with the Monophysites. As Justinian was a warm upholder of the decrees of Chalcedon, this difference of the royal pair excited much remark and indeed much suspicion, and if it is true that Theodora disapproved of Justinian's western conquests, her judgment must be acknowledged to have been correct. In other matters also the wife spoke and acted very differently from the husband; but their differences do not seem to have disturbed either his affection or his confidence.

Theodora bore to Justinian no son, but one daughter—at least it would seem that her grandson, who is twice mentioned, was the offspring of a legitimate daughter, whose name, however, is not given. According to Procopius, she had before her marriage become the mother of a son, who when grown up returned from Arabia, revealed himself to her, and forthwith disappeared for ever; but this is a story to be received with distrust. That her behaviour as a wife was irreproachable may be gathered from the fact that Procopius mentions only one scandal affecting it, and that with some hesitation, the case of Areobindus. Her health was delicate, and, though she took all possible care of it, frequently quitting the capital for the seclusion of her villas on the Asiatic shore, she died comparatively young. Theodora was small in stature and rather pale, but with a graceful figure, beautiful features, and a piercing glance There remains in the apse of the famous church of S Vitale at Ravenna a contemporaneous mosaic portrait of her, to which the artist, notwithstanding the stiffness of the material, has succeeded in giving some character.

Nearly all the evidence against Theodora is derived from the violently-written *Anecdota* of Procopius, and has therefore been suspected. (*See* esp Débidour's *L'Impératrice Théodora.*) Modern researches, particularly those of Panchenko, the Russian scholar, have vindicated the general credibility of Procopius Of course, he can frequently be convicted of unfairness; he always attributes the worst motives His description of the profligacy of Theodora only proves his familiarity with the pornography of Constantinople. But it rests on the solid witness of John of Ephesus that Theodora's youth was disreputable We gather too from other writers that she was harsh and tyrannical, as, for instance, from the references to her in the lives of the popes in the *Liber Pontificalis* (which used to pass under the name of Anastasius, the papal librarian). Her threat to the person whom she commanded to bring Vigilius to her was "nisi hoc feceris, per Viventem in saecula excoriari te faciam" Much of what we find in these lives is legendary, but they are some evidence of Theodora's reputation. Again, (3) the statute (*Cod*, v 4, 23) which repeals the older law so far as relates to *scenicae mulieres* is now generally attributed to Justin, and agrees with the statement of Procopius that an alteration of the law was made to legalize her marriage. There is therefore reason for holding that she was an actress. About the beauty, the intellectual gifts, and the imperious will of Theodora there can be no doubt She was evidently an extraordinary person, born to shine in any station of life.

Her fortunes have employed many pens. Among the later serious works dealing with them may be mentioned M. Antonin Débidour's *L'Impératrice Théodora: Étude Critique* (1885), which endeavours to vindicate her from the aspersions of Procopius; and among more imaginative writings are Sir Henry Pottinger's interesting romance *Blue and Green* (1879), M. Rhangabé's tragedy *Θεοδώρα* (Leipzig, 1884), and M. Sardou's play *Théodora,* produced in Paris in 1884. *See* also Dr. F. Dahn's *Prokopios von Cäsarea* (1865) and B. Panchenko in "Vizant Vremennik" vols. ii, iii and, in addition, the works cited under JUSTINIAN.

THEODORE, the name of two popes. Theodore I., pope from November 642 till May 649, succeeded John IV. He was the son of a bishop, and was born in Jerusalem. A zealous opponent of monothelitism, in the course of the protracted controversy he in a Roman synod excommunicated Pyrrhus, patriarch of Constantinople, and signed the document with ink mingled with consecrated wine. Theodore II. had a pontificate of only twenty days (Nov-Dec. 897).

THEODORE I. (1557-1598), tsar of Russia, the son of Ivan the Terrible and Anastasia Romanova, nominally succeeded his father in 1584, but being of weak intellect was governed throughout his reign by the boyar, Boris Godunov, whose sister Irene he married in 1580. On his death-bed he is said to have left the throne to his consort, with the Patriarch Job, Boris Godunov, and Theodore Romanov, afterwards the Patriarch Philaret, as her chief counsellors. Irene, however, retired into a monastery and her brother Boris stepped into her place

THEODORE II. (1589–1605), tsar of Russia, was the son of Tsar Boris Godunov and one of the daughters of Malyuta-Skuratov, the infamous favourite of Ivan the Terrible Passionately beloved by his father, he received the best available education for those days, and from childhood was initiated into all the *minutiae* of government, besides sitting regularly in the council and receiving the foreign envoys He seems to have been precociously intelligent, and the first map of Russia by a native, still preserved, is by his hand. On the sudden death of Boris he was proclaimed tsar (April 13, 1605). On July 10, he was murdered in his apartments in the Kreml

THEODORE III. (1661–1682), tsar of Russia, was the eldest surviving son of Tsar Alexius and Maria Miloslavskaya. In 1676 he succeeded his father. He had received an excellent education at the hands of Simeon Polotsky, the most learned Slavonic monk of the day, knew Polish, and even possessed the unusual accomplishment of Latin; but, disfigured and half paralyzed by disease, he had been an invalid from his birth. In 1679 he married his first cousin Agatha and assumed the sceptre His native energy was not crushed by his disabilities; and he soon proved as thorough a reformer as a man incompetent to lead armies and obliged to issue his orders from his litter, or his bed-chamber, could be His consort, Agatha, shared his progressive views On her death (July 4, 1681) Theodore married Martha Apraksina. He died on April 27, 1682, without issue.

THEODORE (602–690), seventh archbishop of Canterbury, was born at Tarsus in Cilicia in 602. On the death of Wighard, who had been sent to Pope Vitalian by Ecgberht of Kent and Oswio of Northumbria in 667, apparently for consecration as archbishop, Theodore, who had become prominent in the Eastern work of the church, was recommended by Hadrian of Niridanum to fill the vacant see. Vitalian consecrated Theodore in April 688 on condition that Hadrian, afterwards abbot of St. Peter's, Canterbury, should go with him Hadrian was detained for some time by Ebroin, the Neustrian mayor of the palace, but Theodore reached England in May 669. According to Bede's account he made a tour of the whole of Anglo-Saxon England, reforming abuses and giving instruction as to the monastic rule and the canonical Easter Bede also declares that he was the first archbishop to whom all the "church of the Angles" submitted

In 673 Theodore presided at the first synod of the clergy in England which was held at Hertford Various disciplinary regulations were emphasized, and an annual meeting arranged at a place called Cloveshoe After this council Theodore revived the East Saxon bishopric, to which he appointed Earconwald Soon after the first expulsion of Wilfrid in 678 he divided the Northumbrian diocese, appointing Trumwine bishop to the Picts This led to a quarrel with Wilfrid which was not finally settled until 686–687. In 679 Theodore intervened to make peace between Ecgfrith of Northumbria and Aethelred of Mercia. He presided at other synods held in 680 at Hatfield and in 684 at Twyford, and died in 690 A penitential composed under Theodore's direction is still extant.

See Bede, *Hist Eccl*, edited by C. Plummer (Oxford, 1896); Eddius, *Vita Wilfridi* in J Raine's *Historians of the Church of York*, vol i (London, 1879); *Anglo-Saxon Chronicle*, edited by Earle and Plummer (Oxford, 1899), Haddan and Stubbs, *Councils and Ecclesiastical Documents* (Oxford, 1869–78), iii. 173–213

THEODORE LASCARIS (d 1222), emperor of Nicaea, was born of a noble Byzantine family He became the son-in-law of the Emperor Alexius III. and distinguished himself during the sieges of Constantinople by the Latins (1203–04). After the capture of the city he gathered a band of fugitives in Bithynia and established himself in the town of Nicaea Relieved of the danger of invasion, owing to an incursion of Bulgarians into the Latin empire, he set to work to form a new Byzantine state in

Asia Minor, and in 1206 assumed the title of emperor. He defended himself stubbornly against the Latin emperor Henry, defeated his rival Alexius Comnenus of Trebizond, and carried out a successful counter-attack upon Gayath-ed-din, the sultan of Koniah. His crowning victory was gained in 1210, when in a battle near Pisidian Antioch he captured the deposed emperor Alexius III. and wrested the town itself from the Turks.

See A Meliarakes,'Ἱστορία τοῦ Βασιλείου τῆς Νικάιας καὶ τοῦ Δεσποτάτου τῆς 'Ηπείρου (Athens, 1898).

Theodore's grandson, Theodore II. (Lascaris), emperor from 1254 to 1258, is chiefly noticeable for two brilliant campaigns by which he recovered Thrace from the Bulgarians (1255–56). His ill-health and early death prevented his making full use of his ability as a ruler.

THEODORE OF MOPSUESTIA (*c.* 350–428/9), early Christian theologian, the most eminent representative of the so-called school of Antioch, was born at Antioch about the middle of the 4th century and was a friend of John Chrysostom; in rhetoric the celebrated Libanius was his teacher. Soon, however, he attached himself to the school of the great exegete and ascetic, Diodorus, a presbyter in Antioch, and with only a transitory period of vacillation, from which he was won back by Chrysostom, he remained faithful to the theology and ascetic discipline of this master Under Diodorus he became a skilful exegete, and ultimately outstripped his master in biblical learning. About 383 Theodore became a presbyter in Antioch, and began to write against Eunomius the Arian and against the christology of Apollinaris. Soon after 392 he became bishop of Mopsuestia in Cilicia (the modern Missis near Adana). As such he was held in great respect, and took part in several synods, with a reputation for orthodoxy that was never questioned. It was greatly to his advantage that in the Eastern Church the period between the years 390 and 428 was one of comparative repose. He was on friendly terms even with Cyril of Alexandria. He died in 428 or 429.

Theodore wrote commentaries on almost every book of the Old and New Testaments, of which, however, only a small proportion is now extant, as at a later period he lost credit in the church. We still possess in Greek his commentary on the Minor Prophets, in a Syriac version his commentary on St John[1], and, in Latin translations, commentaries on the shorter Pauline epistles, besides very many fragments, especially on the epistle to the Romans. Theodore's importance as an exegete lies in two characteristics. (1) in opposition to the allegorical method he insists on getting at the literal meaning, and adheres to it when found; (2) in his interpretation of the Scriptures he takes into account the historical circumstances in which they were produced, and substitutes the historical-typological for the pneumatico-christological interpretation of prophecy, in other words, he interprets all Old Testament passages historically in the first instance, and sees the fulfilment of Old Testament prophecy in the history of Christ and His church only in so far as the entire Old Testament is a "shadow of things to come."

Theodore also was the author of a special dissertation against the allegorists, *i e*, against Origen and his followers, which, however, has unfortunately perished. The comparative freedom of Theodore's view of inspiration is also noteworthy. He discriminates between historical, prophetical and didactic writings, and in accordance with this distinction assumes varying degrees of inspiration. Finally, he entertained very bold opinions about the canon and several of the books included in it He esteemed very lightly the Solomonic writings and the book of Job, Canticles he explained as a nuptial poem of Solomon's; the book of Job appeared to him in many places hardly worthy of its subject, and he censures the writer sharply; Chronicles, Ezra and Nehemiah he entirely rejected; he denied the accuracy of the titles of the Psalms, anticipated the hypothesis that many of them belong to the Maccabean age, and referred the so-called Messianic element almost invariably to the kings of Israel; he even criticized the Catholic epistles and rejected the epistle of James. Characteristics such as these bring Theodore, of all patristic writers, nearest to the modern spirit.

[1]Ed P. B Chabot (Paris, 1897)

Literature.—Migne, *Patrol.*, ser. Gr., lxvi. The Greek fragments of Theodore's New Testament commentaries have been collected by O. Fr. Fritzsche (*Theod. Mops. in N T. Comm.*, Turin, 1847). The commentaries on the Pauline epistles (Pitra, *Spicilegium Sotesmense*, Paris, 1852, i. 49 *seq*) have been edited by H. B. Swete (*Theod. Mops. in Epp. B. Pauli Comm.*, i, ii., Cambridge, 1880–82), along with the Greek fragments and the fragments of the dogmatical writings; on this edition, *see* E. Schürer, *Theol. Lit. Ztg.*, 1880–82. The commentary on the Minor Prophets will be found in Mai's *Nov. Patr. Biblioth.*, vii. 1854 (Berlin, 1834; Mai, *Script. Vet. Nov. Coll.*, vi., 1832). *See* also E. Sachau, *Theod. Mops. Fragm. Syriaca* (Leipzig, 1869); Fr. Bäthgen, "Der Psalmencommentar des Theod. v. Mops. in Syr. Bearbeitung," in *Ztschr. f. Alt-Test. Wissensch.*, v. 53 *seq.*, vi., 261–288, vii. 1–60; and H. Lietzmann in *Sitzungsberichte der Kgl preuss. Akad. der Wissensch, zu Berlin*, 1902, pp. 334 *seq.* Extracts from the writings of Theodore occur in the *Catenae* of Marius Mercator, in the *Acta* of the third and fifth oecumenical councils in Facundus, Liberatus, and Theodore's chief adversary Leontius Byzantinus E. von Dobschutz, in *Amer. Journ. of Theol.*, ii. 353–387, published the Greek prologue of a commentary on *Acts* that is probably the work of Theodore.

The principal monograph on Theodore, apart from the prolegomena of Swete, and the same writer's article in *Dict. Christian Biog*, iv. (1887), is that of H. Kihn (*Th. v. Mops. u. Junilius Afric. als Exegeten*, Freiburg, 1880). On his importance for the history of dogma *see* the works of Baur, Dorner, Harnack, Loofs and Seeberg Literary and biographical details will be found in O. Fr. Fritzsche, *De Theod. Mops Vita et Scriptis* (Halle, 1836), Fr A. Specht, *Theod. v. Mops u. Theodoret* (Munich, 1871), H. Kihn in the *Tub Quartalschr*, 1879; E Nestle in *Theol. Stud aus Wurtemb*, ii. 210 *seq*; P Batiffol, "Sur une Traduction Latine de Th. de Mops," in *Ann de Philos. Chrét*, 1885; Th. Zahn, "Das N T. Theodors von Mop.," in *Neue Kirchl Zeitschr*, xi. 788–806, W. Wright, *Syriac Literature* (London, 1894), R. Duval, *La littérature syriaque* (Paris, 1899). (A Ha.; X.)

THEODORET, bishop of Cyrrhus, an important writer in the domains of exegesis, dogmatic theology, church history and ascetic theology, was born in Antioch, Syria, about 386 At an early age he entered the cloister; and in 423 he became bishop of Cyrrhus, a small city in a wild district between Antioch and the Euphrates, where, except for a short period of exile, he spent the remainder of his life The date of his death is uncertain, but it must have been not earlier than 457

Commentaries.—As an exegete Theodoret belongs to the Antiochene school, of which Diodorus of Tarsus and Theodore of Mopsuestia were the heads He was not actually the personal disciple of either, but he adopted their methods, though without the consistency and boldness of the first-named His extant commentaries (those on Canticles, on the Prophets, on the book of Psalms and on the Pauline epistles) are brief.

Dogmatic Works.—Theodoret's chief importance is as a dogmatic theologian, as the most considerable opponent of the views of Cyril and Dioscurus of Alexandria For more than twenty years he maintained the struggle against the Alexandrian dogmatic and its formulae (θεοτόκος, ἕνωσις καθ' ὑπόστασιν, μία ὑπόστασις ἕνωσις φυσική, and the like), and taught that in the person of Christ we must strictly distinguish two natures (*hypostases*), which are united indeed in one person (*prosopon*), but are not amalgamated in essence For these years his history coincides with that of the Eastern Church from 430 to 451, and for this very reason it is impossible to sketch it even briefly here. (*See* Hefele, *Conc-gesch*, vol. ii.) The issue was not unfavourable to Theodoret's cause, but melancholy enough for Theodoret himself. the council of Chalcedon condemned monophysitism, but he unhappily yielded to pressure so far as also to take part in pronouncing "anathema upon Nestorius, and upon all who call not the Holy Virgin Mother of God, and who divide the one Son into two"

Some of Theodoret's dogmatic works are no longer extant: of his five books Περὶ ἐνανθρωπήσεως, for example, directed against Cyril after the council of Ephesus, we now possess fragments merely. A good deal of what passes under his name has been wrongly attributed to him. Certainly genuine are the refutation ('Ανατροπή) of Cyril's twelve ἀναθεματισμοί of Nestorius, and the 'Ερανίστης, or Πολύμορφος (written about 446), consisting of three dialogues, entitled respectively Ἄτρεπτος, 'Ασύγχυτος, and 'Απαθής, in which the monophysitism of Cyril is opposed, and its Apollinarian character insisted on. Among

the apologetico-dogmatic works of Theodoret must be reckoned his ten discourses Περὶ προνοίας.

Other Works.—The thirty ascetic biographies of his *Φιλόθεος ἱστορία,* which has been widely read, form a pendant to the *Historia Lausiaca* of Palladius and the monkish tales of Sozomen. For the East it has had the same importance as the similar writings of Jerome, Sulpicius Severus and Cassian for the West.

BIBLIOGRAPHY.—The edition of Sirmond (Paris, 1642) was afterwards completed by Garnier (1684), who has also written dissertations on the author's works. Schulze and Nosselt published a new edition (6 vols, Halle, 1769–74) based on that of their predecessors; a glossary was afterwards added by Bauer. The reprint will be found in vols. lxxx.–lxxxiv. of Migne, and considerable portions occur in Mansi. The church history has been published frequently in connection with the histories of Socrates, Sozomen and others, *e.g.*, by Valesius (1693) and Reading (1720). There is an English translation of the history by Bloomfield Jackson in the *Nicene and Post-Nicene Fathers,* series ii, vol. iii., the translation including also the dialogues and letters.

Besides the earlier labours of Tillemont, Ceillier Oudin, Du Pin and Fabricius and Harless, *see* Schrockh, *Kirchengesch*, vol. xviii; Hefele, *Conc-gesch*, vol ii, Richter, *De Theodoreto Epp Paul. Interprete* (Leipzig, 1822); Binder, *Études sur Théodoret* (Geneva, 1844); Staudlin, *Gesch u Lit der Kirchengesch.* (Hanover, 1827); Kihn, *Die Bedeutung der antioch Schule* (1866); Diestel, *Das A T. in der christl Kirche* (Jena, 1869); Specht, *Theodor v. Mopsvestia u. Theodoret v Cyrus* (Munich, 1871); Roos, *De Theodoreto Clementis et Eusebii Compilatore* (Halle, 1883), Nolte in the *Tubing Quartalschr* (1859), p 302 *seq*; Moller, art. "Theodoret," in Herzog-Hauck's *Realencykl*; Venables's article in Smith and Wace's *Dict. of Christian Biography;* also Bardenhewer's *Patrologie*, p 345 ff. (A. HA.; X.)

THEODORIC, king of the Ostrogoths (*c.* 454–526). Referring to the article GOTHS for a general statement of the position of this, the greatest ruler that the Gothic nation produced, we add here some details of a more personal kind Theodoric was born about the year 454, and was the son of Theudemir, one of three brothers who reigned over the East Goths, at that time settled in Pannonia The name of Theodoric's mother was Erelieva, and she is called the concubine of Theudemir. The Byzantine historians generally call him son of Walamir, apparently because the latter was the best known member of the royal fraternity. At the age of seven he was sent as a hostage to the court of Constantinople, and there spent ten years of his life. Soon after his return to his father he secretly attacked the king of the Sarmatians, and wrested from him the important city of Singidunum (Belgrade) Theodoric took the chief part in an expedition into Moesia and Macedonia, the result of which was to settle the Ostrogoths as *foederati* in the heart of the empire About 474 Theudemir died, and for the fourteen following years Theodoric was chiefly engaged in a series of profitless wars, partly against the emperor Zeno, but partly against a rival Gothic chieftain, another Theodoric, son of Triarius In 488 he set out, with the sanction of the emperor, to win Italy from Odoacer. The invasion and conquest of Italy occupied more than four years (488–493) Theodoric, who marched round the head of the Venetian Gulf, had to fight a fierce battle with the Gepidae, probably in the valley of the Save. At the Sontius (Isonzo) he found his passage barred by Odoacer, over whom he gained a complete victory (28th of August 489). A yet more decisive victory followed on the 30th September at Verona Odoacer fled to Ravenna, and it seemed as if the conquest of Italy was complete. At length (26th of February 493) the long and severe blockade of Ravenna was ended by a capitulation, the terms of which Theodoric disgracefully violated by slaying Odoacer with his own hand (15th of March 493). (*See* ODOACER.)

The thirty-three years' reign of Theodoric was a time of unexampled happiness for Italy. Unbroken peace reigned within her borders (with the exception of a trifling raid made by Byzantine corsairs in 508). The venality of the Roman officials and the turbulence of the Gothic nobles were sternly repressed Marshes were drained, harbours formed, the burden of the taxes lightened, and the state of agriculture so much improved that Italy, from a corn-importing, became a corn-exporting country. Moreover Theodoric, though adhering to the Arian creed of his forefathers, was during the greater part of his reign conspicuously impartial in religious matters. At the time of the contested papal election between Symmachus and Laurentius (496–502), Theodoric's mediation was welcomed by both contending parties. Unfortunately, at the very close of his reign (524), the emperor Justin's persecution of the Arians led him into a policy of reprisals. He forced Pope John to undertake a mission to Constantinople to plead for toleration, and on his return threw him into prison, where he died. Above all, he sullied his fame by the execution of Boetius and Symmachus. (*See* BOETIUS). Theodoric's death, which is said to have been hastened by remorse for the execution of Symmachus, occurred on the 30th of August 526. He was buried in the mausoleum which is still one of the marvels of Ravenna (*q v.*), and his grandson Athalaric, a boy of ten years, succeeded him, under the regency of his mother Amalasuntha

AUTHORITIES—The most important source for Theodoric's life reign (ed in *Monumenta Germaniae Historica,* vol. xii.) is the *Variae* (state-papers) of Cassiodorus, chief minister of Theodoric The most modern work is Hartmann's *Geschichte Italiens im Mittelalter,* vol i. (Stuttgart, 1923) The English reader may consult Gibbon's *Decline and Fall,* chap. xxxix., and Hodgkin's *Italy and her Invaders,* vol iii. (1885), his introduction to *Letters of Cassiodorus* (1886) and *Theodoric the Goth* (London and New York, 1891).

THEODORUS STUDĪTA [Theodore of the Studion] (A D. 759–826), abbot of the monastery of the Studion, Constantinople, succeeded his uncle Plato, as head of the monastery of Saccudium in Bithynia in 794. He was banished to Thessalonica in connection with the marriage of Constantine VI After the emperor's death in 797 he was recalled and removed with his monks to the monastery of the Studion in Constantinople, where he carried on a vigorous campaign in favour of asceticism and monastic reform In 809 he was again banished in consequence of his refusal to hold communion with the patriarch Nicephorus, who had pardoned the priest Joseph for his part in the marriage of Constantine and Theodotē. In 811 he was recalled by Michael Rhangabes, and again banished in 814 for his opposition to Leo the Iconoclast. He was liberated in 821 by the Emperor Michael the Stammerer (Balbus). In 824 he violently attacked Michael for iconoclasm and was forced to leave Constantinople He lived at various monasteries until his death on Nov. 11, 826 He was buried at Chalcitis, but his body was afterwards (Jan 26, 844) removed to the Studion He subsequently received the honours of canonization. Of his extant works the following are the most important.—The three λόγοι ἀντιρρητικοί and other works in defence of images and his *Letters* He was also the composer of hymns, many of which are still extant Like all the monks of the Studion, Theodore was famous for his calligraphy and industry in copying mss

BIBLIOGRAPHY—General edition of his works in J. P. Migne, *Patrologia Graeca,* xcix, to be supplemented (for the *Letters*) by J Cozza-Luzzi, *Patrum Nova Bibliotheca,* viii (1871), hymns in J B. Pitra, *Analecta Sacra,* i (1876) *See* also Alice Gardner, *Theodore of Studium: his Life and Times* (1905) For further bibliographical details *see* C Krumbacher, *Gesch der byz Lit* (2nd ed, 1897) and article by Von Dobschutz in Herzog-Hauck's *Realencyclopädie für protestantische Theologie,* xix. (1907).

THEODOSIA, formerly Kaffa, a seaport and watering-place of South Russia, on the east coast of the Crimea, in 45° 3′ N., 35° 22′ E, and on the railway. It has an excellent modern harbour, which is never frozen and has a floating crane lifting 40 to 50 tons Pop (1926) 27,347.

The ancient Theodosia, the native name of which was Ardabda, was a colony founded from Miletus. Archaic terra-cottas show it to have been inhabited in the 6th century B C., but it is first heard of in history as resisting the attacks of Satyrus, ruler of the Cimmerian Bosporus, *c* 390 B C His successor Leucon took it and made it a great port for shipping wheat to Greece, especially to Athens. This export of wheat continued until the days of Mithradates VI of Pontus, against whom the city revolted Later it became a special part of the Bosporan kingdom with its own governor. In the 3rd century A D. it was still inhabited, but seems to have been deserted not long afterwards. Besides the terra-cottas and pottery, very beautiful Greek jewellery has been found near Theodosia. It coined silver and copper during the 5th and 4th centuries B C. The name Kaffa (Genoese *Capha*, Turk *Kefe*) is first mentioned in the 9th century. The Genoese established themselves on the site shortly after 1266, and the settlement flourished exceedingly, being the depôt of a trade route reaching

to China. It became the head of the Genoese establishments in Gazaria, the see of a bishop, and the chief port on the northern shore of the Black sea, surpassing the Venetian Tana When the Turks took Constantinople the colony was almost cut off from the mother city, which handed it over to the enterprising bank of St. George; but it could not be saved and fell in 1475 to the Turks, who sometimes called it Kuchuk-Stambul (Little Stambul) or Constantinople, or Krym-Stambul (Stambul of Crimea). In 1771 it was taken by the Russians, and in 1783 annexed by them, whereupon the greater part of its population deserted it.

See E. von Stern, *Theodosia* (German and Russian, 1906); E. H. Minns, *Scythians and Greeks* (1909); M Rostovtzeff, *Iranians and Greeks in South Russia* (1922), for the history of Kaffa, *see* Heyd, *Histoire du commerce du Levant au moyen âge* (1886).

THEODOSIUS, the name of three Roman emperors of the East.

THEODOSIUS I, "the Great," son of Theodosius, Valentinian's great general, who in 368–69 saved Britain from the Picts, and suppressed the revolt of Firmus in Mauretania (372) Shortly after (376), the elder Theodosius was put to death, perhaps by order of Valens. The younger Theodosius was born about the year 346. He was a native of Spain, but the exact place of his birth is uncertain. He accompanied his father into Britain (368), and a little later defeated the Sarmatians who had invaded Moesia (374). On his father's death he retired to his native place, where he lived quietly till after the great battle of Adrianople (Aug. 9, 378), when Gratian summoned him to share the empire. After gaining some fresh victories over the Sarmatians, Theodosius was made Augustus at Sirmium on Jan 19, 379, and was assigned all the eastern provinces, including part of Illyricum. In 379 Theodosius, after reorganizing the army at Thessalonica, carried on a successful campaign of skirmishes along the Danube and induced numerous Gothic bands to give in their allegiance, his lieutenant Modares, a Gothic refugee, defeated the invaders severely in Thrace. In 381 he was called upon to meet two armies of invaders. He conducted in person the war against the Visigoths under Fritigern, this campaign, being only ended by Fritigern's death. The defence of the Danube against the Ostrogoths under Alatheus and Safrax was entrusted to the general Promotus, who severely defeated the enemy in an attempt to cross the river. Theodosius attained even greater successes by his diplomacy. He persuaded the fugitive Visigoth king Athanaric to enter his service, and enlisted 40,000 of his former enemies as *foederati,* providing them with settlements in various parts of the realm

In 383 Theodosius created his eldest son Arcadius Augustus. The same year saw the revolt of Maximus in Britain and the murder of Gratian. For five years Theodosius consented to accept the usurper as his colleague; but when Maximus attempted a few years later to make himself master of Italy Theodosius advanced against the invader and overthrew him near Aquileia (July 28, 388). This victory was followed by the murder of Maximus and his son Victor, after whose death Theodosius conferred upon Valentinian II all that part of the empire which his father had held. After celebrating a triumph in Rome (389) he stayed to arrange the government of Italy for another two years. If we may trust the evidence of Zosimus, from the end of the year 388 Theodosius resigned himself to gluttony and voluptuous living, from which he was only roused by the news that in the Western empire Arbogast had slain the young Emperor Valentinian and set up the grammarian Eugenius in his stead (May 15, 392).

Theodosius at once marched out against Eugenius. The armies met near the river Frigidus, some thirty-six miles distant from Aquileia On the first day Theodosius' barbarians, engaging with those of the hostile army, were almost destroyed, and the victory seemed to be with Eugenius After a night of prayer, towards cockcrow the emperor was cheered by a vision of St. Philip and St. John, who, mounted on white steeds, promised him success. On the second day the issue was doubtful till, if we may trust the concurrent testimony of all the contemporary church historians, a sudden gust of wind blew back the enemy's arrows on themselves. This was the turning-point of the battle: Eugenius was slain by the soldiers; and two days later Arbogast committed suicide (Sept. 5–9, 394). From the north-eastern parts of Italy Theodosius passed to Rome, where he had his son Honorius proclaimed emperor under the guardianship of Stilicho. Thence he retired to Milan, where he died of dropsy (Jan. 17, 395), leaving the empire to be divided between his two sons Honorius and Arcadius

The chief authorities for the age of Theodosius are Ammianus Marcellinus, Zosimus, Eunapius and the ecclesiastical historians (Socrates, Sozomen, Theodoret). Much information may also be gleaned from the writings of St Ambrose, St. Gregory of Nazianzus, Isidore of Seville, and the orators Pacatus, Libanius, Themistius. Among modern authorities see: E Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, 1909), chaps. 25 and 27; T. Hodgkin, *Italy and her Invaders* (Oxford, 1892), chaps. 5, 6, 8–11; A. Güldenpenning and J. Ifland, *Der Kaiser Theodosius der Grosse* (Halle, 1878); G. R. Sievers, *Studien zur Geschichte der romischen Kaiser* (Berlin, 1870), pp. 283–333, and Van Ortroy, *St. Ambroise et l'Empereur Théoduse,* Analecta Bollandiana (1904).

THEODOSIUS II. (401–450) succeeded his father Arcadius as emperor of the East in 408 During his minority the empire was ably ruled by the praetorian prefect Anthemius and Pulcheria, who became her brother's guardian in 414. Under his sister's care the young emperor grew up into a weak though amiable character. Through his generals Ardoburius and Aspar he waged two fairly successful wars against the Persians (421 and 441), and after the failure of one expedition (431) by means of a gigantic fleet put an end to the piracies of the Vandal Genseric. A Hunnish invasion in 408 was skilfully repelled, but from 441 the Balkan country was repeatedly overrun by the armies of Attila, whose incursions Theodosius feebly attempted to buy off with ever-increasing payments of tribute. His internal administration was upright and thoughtful. Among its chief events may be mentioned the council of Ephesus (434) and the publication of the *Codex Theodosianus* (438), a collection of imperial constitutions for the benefit of public officials Theodosius died in 450.

See E. Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, London, 1909) 406–414; 440–470, J B Bury, *Later Roman Empire,* vol. i (1923), A Güldenpenning, *Geschichte des ostromischen Reiches unter den Kaisern Arkadius und Theodosius II* (Halle, 1885), pp. 172 *sqq.;* T. Mommsen and P. Meyer, *Theodosii libri XVI* (Berlin, 1904–05; in course of revision by E Kiegel, 1926).

THEODOSIUS III., emperor of the East (716–717), was a financial officer whom a Byzantine army rebelling against Anastasius III unexpectedly proclaimed monarch in his stead He captured Constantinople after a six months' siege and deposed Anastasius, but in the following year was himself forced to resign by a new usurper, Leo III (*q v*) Theodosius ended his life in a monastery.

See G Finlay, *History of Greece* (ed. 1877, Oxford), i p. 396).

THEODOSIUS, Greek geometer and astronomer, was the author of three works included in the collection of treatises known as the "Little Astronomy" or "Astronomer" (ὁ μικρὸς ἀστρονούμενος or ἀστρονόμος). He was not "of Tripolis," but came from Bithynia, as we gather from Strabo, who mentions, among natives of Bithynia famous for their learning, "Hipparchus, Theodosius and his sons, mathematicians"; he is also evidently the Theodosius mentioned by Vitruvius as the inventor of a universal sun-dial (*horologium* πρὸς πᾶν κλίμα). He lived, therefore, not later than the 1st century B.C.

His chief work, the *Sphaerica,* in three books, is a tolerably complete treatise on the pure geometry of the sphere, and was still the classical book on the subject in Pappus's time. It does not contain (except for a faint suggestion in iii. 11–12) any trace of spherical trigonometry, which, on the other hand, was the special subject of the work with the same title by Menelaus of Alexandria, who lived at the end of the 1st century.

From the fact that both Autolycus of Pitane in his *Moving Sphere* and Euclid in his *Phaenomena* assume without proof various propositions given by Theodosius, we conclude that already in the 4th century B.C. there existed a textbook on *Sphaerica* scarcely differing, in its essential contents, from Theodosius's work; the rôle of Theodosius was therefore mainly that of editor and elaborator of previously existing material The *Sphaerica* was translated into Arabic in the 9th century, in part by Qusṭa b. Lūqā, and

in part by Thâbit b. Qurra. Latin translations were made from the Arabic in the 12th century by Plato of Tivoli (Tiburtinus) and Gherard of Cremona, and various editions in Latin appeared from 1518 onwards, including one by Barrow (*Theodosii Sphaerica, Methodo Novo Illustrata et Succincte demonstrata*, London, 1675). We now have a definitive Greek text (with Latin translation) by J. L. Heiberg (Berlin, 1927).

The two other works of Theodosius which have come down to us were first published in a Latin translation by Joseph Auria, *On Days and Nights*, in two books (with scholia, etc.) in 1591, and the tract *On Habitations* (Περὶ οἰκησέων) in 1587 (Rome); a critical edition of the Greek text of both (with Latin translation) by Rudolf Fecht appeared in Berlin in 1927. (T. L. H.)

THEODULF, bishop of Orleans, was born about the middle of the 8th century, of a noble family of Gothic extraction, probably in Spain. He was made abbot of Fleury and of Saint-Aignan, and in 781 became bishop of Orleans. He supported Charlemagne's principles of government and educational reforms; he established schools, and was a member of the learned circle which graced the Carolingian court. In 798 he was appointed *missus dominicus*, and two years later performed so great services for Leo III as judge in the cause between the pope and his enemies, that he returned from Rome with the pallium. After the death of Alcuin he became the king's principal theological adviser, it was he who made, on Charlemagne's request, a collection of the opinions of the fathers on the much-disputed point of the procession of the Holy Ghost. After the death of Charlemagne, he was accused, probably quite unjustly, of having taken part in the conspiracy of Bernard of Italy, and in 818 was deposed and imprisoned in a monastery at Angers. He died in prison, probably from poison, in 821.

The complete works of Theodulf are in J. P. Migne, *Patrol. Lat.*, vol. 105 (Paris, 1851). The best edition of his poetry is that of E. Dümmler in the *Mon. Germ. Hist. Poetae latini aevi carolini*, vol. i. (Berlin, 1881).

See C. Cuissard, *Théodulphe évêque d'Orléans, sa vie et ses oeuvres*, (Orleans, 1892), and a critical study of the writings by M. Manitius in *Neues Archiv der Ges. fur a. deutsche Gesch.* xi. (1886).

THEOGNIS OF MEGARA (6th century B.C.), Greek poet. More than half the elegiac poetry of Greece before the Alexandrian period is included in the 1,400 lines ascribed to Theognis. This collection contains several poems acknowledged to have been composed by Tyrtaeus, Mimnermus and Solon; with two exceptions (T. W. Allen in *Classical Review*, Nov. 1905, and E. Harrison) modern critics unanimously regard these elegies as intruders, that is, not admitted into his works by Theognis himself; for this and other reasons they assume the existence of further interpolations which we can no longer detect.

The best-attested elegies are those addressed to Cyrnus, the young friend to whom Theognis imparts instruction in the ways of life, bidding him be true to the "good" cause, eschew the company of "evil" men (democrats), be loyal to his comrades, and wreak cruel vengeance on his foes. Theognis lived at Megara on the Isthmus of Corinth during the democratic revolution in the 6th century B.C.; some critics hold that he witnessed the "Persian terror" of 590 and 580; others, including the present writer, place his *floruit* in 545 B.C.

There is neither profound thought nor sublime poetry in the work of Theognis; but it is full of sound common-sense embodied in exquisitely simple, concise and well-balanced verse. In his day verse was the recognized vehicle for political and ethical discussion, and the gnomic poets were in many ways the precursors of the philosophers and the sophists, who indeed often made their discourse turn on points raised by Theognis and his fellow-moralists. For many generations Theognis was to the Greeks the moralist *par excellence;* Isocrates says that Hesiod, Theognis and Phocylides were admitted to be the best teachers of practical morality; and the Emperor Julian in his defence of paganism asks whether "the most wise Solomon is equal to Phocylides or Theognis or Isocrates."

Besides the elegies to Cyrnus the Theognidea comprise much miscellaneous verse that may well have come from Theognis.

Editions by Imm. Bekker (1815, 2nd ed. 1827); F. G. Welcker (1826); both these are epoch-making books which no serious student can ignore; Th. Bergk (1843, 4th ed. 1882, re-edited by E. Hiller, 1890, and O. Crusius, 1897), J. Sitzler (1880); E. Harrison, *Studies in Theognis*, with text (1902); T. Hudson-Williams (1910). For further bibliographical references *see* the two last-mentioned books. There is a prose translation by J. Banks in Bohn's Classical Library (1856), which also includes verse translations by J. Hookham Frere.

(T. H. W.; X.)

THEOLOGICAL ARTICLES: *see* RELIGION, ARTICLES ON.

THEOLOGY, in the comprehensive sense of the name, embraces so much of philosophy as is concerned with explanation of the world in terms of a supreme mind or spirit, with the being and attributes of the Deity and His relation to Nature and man and with the grounds and the limits of knowledge or belief as to such matters. It also includes the comparative study of religions and the psychology of religious experience. Specifically Christian theology, which is often what is denoted by the word "theology," sets forth the contents and implications of the revelation in Christ. It consists of a systematic exposition of doctrine and of the course of its development (*dogmatic theology* or *dogmatics*), the historical, critical and exegetical study of the Bible, and the history of the Church, its institutions, etc. Thus theology is a science, or a group of connected sciences, that, on the one hand, is in touch with general philosophy—as is indicated by the name of the department called "philosophy of religion," or "philosophical theology"—and, on the other hand, is more or less isolable in that it deals with the deliverances of distinctively religious experience and its pre-eminent manifestations.

The Relation of Theology to Religious Experience.—It is commonly held that religious experience contains data other than those of natural knowledge, enabling it to possess insight into reality otherwise unattainable. And we may first note the implications of this belief in their bearing on the position of theology amongst other departments of thought such as natural science and philosophy. All natural knowledge, *i.e.*, knowledge of the physical world and mankind, is now generally believed by philosophers to be derived originally from the impressions of sense, between which the understanding establishes relations. Out of these relations are constructed the body of common-sense knowledge, the sciences and metaphysics. Sensory perception in the first instance, and then ideas distilled from percepts, evoke the feelings, desires and valuations, of which aesthetic and ethical sentiments and principles are the outcome. According to this science or theory of knowledge, then, religious beliefs and theological doctrines can only be mediated by reflection on the sensible world, the mind of man and human history. On the other hand it is often claimed by theologians that religious experience is founded on apprehension of another species of the objective than the sensory or the sense-derived, and on feelings, etc., induced thereby. This objective datum, evocative of unique emotional states and dispositions, is asserted to be apprehended with the same immediateness as is the sensory and so to afford a basis of knowledge about ultimate reality, independent of that on which the natural sciences are built.

If this view were beyond criticism, it would suffice to explain the uniqueness of religious experience and consequently the special characteristics of theology. And one ingredient in it certainly seems to be beyond reasonable doubt. This is that whatever there is, on the affective or emotional side of religious experience, that renders it an experience *sui generis*, or distinct from cognate kinds of experience, that peculiarity must be accounted for by the distinctiveness of the object or objects eliciting the subjective response. Religious experience, on its affective side, comprises sentiments such as loyalty and love, awe and adoration, none of which is peculiar to religion, but each of which differs somewhat from other instances of love, reverence, etc., solely in virtue of the object—deity—towards which the religious emotion is a response. Even those who incline to the opinion that there is one kind of valuation, viz., appreciation of sacredness, that is peculiar to religion throughout all the stages of its development, ascribe its peculiarity and its forthcomingness to the unique object that evokes it. But doubtfulness attaches to the

further representations that this sacred, numinous or supernatural object is immediately apprehended as such; that it is irreducibly different in psychological nature from the sensory, or rather from the image or the idea which are derived from the sensory, and that its apprehension involves a special faculty, not included among those known to ordinary psychology In the primitive stages of religion the supernatural object seems always to be lodged in some natural object or phenomenon, which inspired emotion such as awe, as is evinced in the notions of clean and unclean, worship of animals, the dead, etc. Thus the numinous, or divine, reality, devoid of the concrete particularity that characterizes an immediate sensation or percept, and capable of entering into diverse mythologies and religions, seems rather to be of the nature of the vague generic image, derived by human imagination and idealization from impressive phenomena And it is not enough to point to the indubitable objectivity (in the psychological sense) of this alleged numinous reality. For images and ideas, as well as percepts, are also objective; and they are as potent as actualities or real things in eliciting valuation and emotional response, provided that belief in their reality is entertained. Immediacy is a conception which plays important parts in connection with religion and theology; and attention may here be called to the ambiguity which lurks in it and is wont to be overlooked At the moment when a particular experience, such as perceiving a familiar thing, takes place, we are not aware of performing any synthetic activities; the percept has the unity and the instantaneousness of a flash-photograph, and the whole act of perceiving seems as if unanalysable and unconditioned by previous experiences. From the standpoint of such an experience, the perception is immediate. But from the standpoint of subsequent reflection on that experience, especially if we happen to be versed in the science of psychology, the perception in question was not immediate It was not a simple, unanalysable, unity nor unconditioned by previous mental processes and present interpretation. Its immediacy thus resolves into our unawareness, at the moment, of real mediation. Now in order to maintain that religious experience, as illustrated by the primitive instance that has been mentioned consists in immediate apprehension of a spiritual environment or a supernatural beyond, that is real or actual and not imaginal or ideal, it is essential that the immediacy involved be accounted such from the latter of the two points of view that have just been distinguished Yet it is from the former of them alone that it can be vouched for by the religious experient, appealing only to his religious experience. Thus it is doubtful, on more than one ground, whether apprehension of the sacred and supernatural is essentially different from sensory knowledge, eked out with interpretative notions derived from human analogy, constructive imagination and idealization. It may be that the primitive notion of a god, precursor of the later conception of God, was derived by such processes from current knowledge of man, and read into some impressive natural object, constituting it numinous and capable of eliciting religious emotion

If this view be adopted, religious experience, on its first emergence in mankind, will, *mutatatis mutandis,* have been grounded in a way similar to that in which theistic belief is grounded by the philosopher. It was the outcome of what may be called primitive philosophizing on Nature and man, and not of the exercise of an alleged transcendent faculty of intuition. Indeed it would seem that such direct touch of God upon the human soul as religion and theology imply does not admit of being discerned with real immediacy. it is a case of causal activity, which admittedly is never perceptible. And as for the rest that has been said above, its gist is contained in the generally endorsed dictum, "no man hath seen God at any time." The mystic, it is true, claims to be an exception. But it is not necessary here to weigh his testimony, partly because he can only assert, on the strength of his peculiar experiences, the specious kind of immediacy which has already been shown to be irrelevant, and partly because mystical experience seems never to have issued in theological insight and doctrine that was unknown before and otherwise. Knowledge of God would seem to be in the same case with knowledge of our own souls and of other selves, as distinct from their material bodies. In each of these instances the object is not apprehended with directness, but read in analogically; and the reading or interpretation is justified or verified (never logically certified) by cumulative practical success. There well may have been, from the infancy of our race, a touching of man by God, even before man arrived at belief in the daemonic or the divine; but such *rapport* would not be religion until man had come to believe in such beings as gods. "He who cometh to God must believe that He is." That is to say, religion or religious experience presupposes, and is constituted distinctive, by a theological notion or concept. This concept cannot be in the first instance derived from religious experience, because religious experience cannot exist till the idea is forthcoming

It is very generally taught that theology presupposes religious experience and is but the explication of it. But it is all a matter of where, in a long chain of development, we fix our starting point for consideration. In the series of natural numbers, every odd number precedes an even number and every odd number also succeeds an even number until we work back to 1. Similarly, the "Athanasian" creed presupposes much Christian experience while the religious experience of Paul the Apostle differed from that of Paul the Rabbi in virtue of his acquired doctrinal belief as to the Person of Christ But if we go back to the beginning of the series in which theology determines religious experience and in turn is determined by such experience, pursuing psychological beginnings since historical origins are beyond our ken, it would seem that, originally, some crude equivalent to natural theology must have preceded and caused the emergence of distinctively religious experience. But religious experience once having arisen in this way, it will determine theological thought; and the new thought will render possible a further advance in religious experience, and so on Thus there is as much truth in the statement that theological doctrine determines the quality of religious experience as in the statement that religious experience and faith are presupposed by theological dogmas. When, *e g*, the Christian asserts that he has experience of the indwelling Christ, he is obviously interpreting his really immediate experiences, which consist in consolations, joy, peace, uplifting of the will, etc He would not so interpret such mental happenings had not Christ been preached to him, and had he not received doctrine as to the Person of Christ which he did not make out of his individual experience. Nevertheless, it is a fact that the idea of God, both in dogmatic theology and in philosophy, was moulded by religious experience, guided both by morality and intellect, after the initial stage of the long course of religious development.

The Relation of Theology to Philosophy.—From the earliest times philosophy has had a theological side Since the dawn of Greek science and metaphysic, philosophy, Greek and other than Greek, has produced copious speculation concerning the existence and nature of God, as well as a vast volume of thought bearing more or less direct relevance to theological problems, such as the origin, destiny and meaning of the world and human life The greatest of philosophers have dealt with these problems and it has often been from the side of religion that great thinkers have received their chief impulse towards philosophy. Moreover theology and philosophy are largely identical in that theology is essentially metaphysics. No doubt the majority of those who profess theological beliefs hold their beliefs in complete absence of metaphysical reasoning; in that sense their belief—*i.e.*, believing—is non-metaphysical. But their beliefs—*i.e.*, their *credenda*—are all metaphysical dogmas or assertions about ultimate reality. They are religious beliefs in so far as they are metaphysical. For instance, that Jesus "suffered under Pontius Pilate" is, as a bare historical fact, of no religious import; but when it is intended to imply further that He suffered for us—*i.e.*, for our salvation—it is a metaphysical statement concerning the relation of God to human souls and, in virtue of that metaphysical content, is a religious doctrine.

Besides being concerned with the same metaphysical subject-matter, philosophy is involved in theology and can aid its work in various ways. Firstly, in respect of the systematization and unification of knowledge. Christian theology needs must connect

its more or less separate and independently elaborated doctrines into a coherent whole. Thus Origen, one of the first Fathers to present an ordered system of Christian dogma, tells us that while the Apostles delivered themselves clearly on certain points necessary for all to understand, they left the grounds of their utterances and the more precise determination and demonstration of many doctrines to the more zealous of their successors who should be "lovers of wisdom"; and he expresses his desire to form a connected series of truths or one body of doctrine. That is the goal of dogmatic theology which would relate, *e g*, the doctrine of the Atonement with that of the Incarnation or the doctrine of Sin with that of Creation, and obviously such connection involves resort to philosophy Again, the exposition of any single doctrine involves the use of interpretative ideas, such as can only be supplied by the science and philosophy current in a given age Several doctrines that purport to be deduced from scripture alone are less the result of strict exegesis than the result of speculation applied to such material as secular knowledge was believed to have established. To give one example: the doctrine of Original Sin is not contained in the Old Testament and the only unmistakable presentation of it that can be found in the New does not appear to have been the starting-point for the first framers of the ecclesiastical doctrine Tertullian set out from stoic psychology, Origen from the institution of infant-baptism and also from the myth of Plato concerning the fall of the soul from the celestial sphere into earthly life. But of greater importance than cases of this kind is the fact that the very terms and conceptions, requisite as a mould into which the relatively undefined traditional beliefs of the early Church must be cast in order to yield explicit and definite doctrine and, appropriated for that purpose, were supplied by Greek philosophy

The office of philosophy within the sphere of theology, with which we have thus far been concerned, may be described as that of interpreting to the reason the contents of religious experience. The philosophy of religion seeks to show that the fundamental ideas of religion, so far from being contrary to reason or from being ideas begotten of faith indifferent to knowledge, are capable of receiving a rational, or at least a reasonable, justification in terms of philosophical principles. Philosophy, or even theology, is no substitute for religion, and, of course, does not profess to be It professes, rather, to show the compatibility of faith with reason and knowledge and to interpret the contents of faith to the reason.

Another function of philosophy is the undertaking of a critical examination of the processes involved in what we call knowing and of the various conceptions that enter into the knowledge claimed either by common sense or the sciences, with a view to disclosing the nature, validity and limits of human knowledge. And this function has a necessary place also in the sphere of theology. There we require to understand the precise relations between what are respectively called knowledge and faith; and it is necessary to pursue the "critical regress" within the field of dogmatic theology because, as history shows, the legitimate desire for completeness of system and knowledge and for definiteness of dogmatic expression is apt to become the wish to know more than, perhaps, can be known and to know too definitely. In the middle ages, when theology was more ambitious than critical, fulness and precision were claimed in so inordinate a degree that, as a sympathetic historian has observed, an agnostic reaction was necessary in the interests of reverence. And it is always natural for theologians to betake themselves too exclusively to the drawing of inferences when more attention might profitably be devoted to the sifting of premisses. Thus it is that the word "dogmatic," which technically indicates one province of theology, has come sometimes to bear a less noble signification; and dogmatic theology has been distrusted as requiring assent to doctrines that are not self-evident and for which no proof can be supplied.

But while philosophy, as a critical method, is a corrective of dogmatism in the foregoing sense, philosophical theology is not necessarily hostile to dogma. Individual philosophers have doubtless tended to set up empty abstractions, as will presently be seen, in place of positive facts and concrete existents; but that is no necessity inherent in philosophy itself, as a pursuit.

Hegel observes in his *Philosophy of Religion* that in his day an anti-dogmatic spirit was abroad among dogmatic theologians, who at the same time charged philosophy with merely negative or destructive tendencies These, he said, have thrust dogmas into the background, pronouncing them unimportant and extraneous definitions or mere phenomena of past history. Christ's work of redemption had received a very prosaic and merely psychological significance and the doctrines of the Trinity, etc., were neglected as matters of indifference, even by pious theologians This spirit was by no means confined to Hegel's day. It might be called the temper of indefiniteness. It is met with in the supposed antitheses between kernel and husk—as if kernels ever grew without husks—and between the life and the creed—as if Christianity were not a life based on a creed, and Christian ethic did not owe its distinctiveness to its dependence on Christian doctrines In recoiling from dogmatism such as would be over-precise, it distrusts precision of expression as such.

The necessary and intimate connection of theology, even dogmatic theology, with philosophy now having been illustrated from several sides, the two main types of method that have been employed in philosophical theology may in turn be described: they are respectively called the *a priori* and the empirical

The a priori Method and Rational Theology.—Of the phrase *a priori* we can distinguish two meanings that are apt to be confounded It may have a psychological sense, when the phrase means "contributed by the mind itself," and so is generally equivalent to "innate" It may also bear a logical sense, as when *a priori* truth is described as truth characterized by universality such as, in contrast with mere generality, bespeaks intrinsic or unmediated necessity In the former case, contrast with the empirical and sense-given is pointed, in the latter case, contrast with the contingent—*i.e*, with what is, but conceivably might have been otherwise

It may be said, with accuracy sufficient for the present purpose, that the *a priori* method was introduced into philosophy and theology by Plato He took the ideal or pure science of mathematics, which deals with the non-actual, to be the paradigm of knowledge of the actual—science and philosophy Despising the sensory, and empirical investigation, he valued only the relations and the universal qualities manifested in facts, so that these came to be considered, not as entering into the constitution of actuality, but as existing wholly independently, and this rational or intelligible world, as contrasted with the sensorily perceived, was accounted the truly existent or the "real" Thus arose the *a priori* method, in the logical sense of that phrase, and the rationalistic theory of knowledge, which, without much qualification, may be said to have dominated philosophy for centuries So long as it did not and could not—till analytical psychology was born—be suspected that sense and understanding may have a common root and that between understanding and reason there is continuity rather than disparateness, the rationalist's belief in a faculty called reason, capable of functioning in independence of sensation and sensory data, was possible and natural. This faculty was regarded by the ancient philosophers as the sole source of real, *i.e*, higher, knowledge; as independent of body and "animal soul," and even as a participation in the Divine Reason, a "spark of Deity." Christian theologians, who found much in Plato's system that they could assimilate, also appropriated this ancient doctrine as to reason. Augustine applied it to explain the reception of supernatural truth and the divine illumination of the mind of man, and it coalesced with the Logos-doctrine of the Church. From Augustine and neoplatonism it was accepted by Descartes and so became entrenched in early modern philosophy. The existence of a *lumen naturale,* a faculty innate as instinct, but mediating necessary and eternal truths, was one of the tenets of rationalism and one that theologians were naturally inclined to adopt. Hence *a priori* theology, in the psychological as well as the logical sense of the phrase, flourished long Another feature of the rationalistic and *a priori* theory of knowledge is its tendency to identify knowledge and thought. Knowledge (of actuality) is pre-eminently

thought, but since the 18th century we have been compelled to recognize that it is also more. Further, the consistency of thought with itself was often confounded with validity—*i.e.*, with "holding of" actual things. But fiction can be consistent while not being truth about actual persons, and metageometries may be as consistent as Euclid without having any applicability to our world. Moreover, what were deemed to have been self-evident axioms, forming the basal principles of various sciences from mathematics to theology and purporting to be read off as necessary truths by pure reason, have in these latter days been accused of being either conventions, like the rules of a game, or disguised empirical inductions. These modern discoveries and the emergence of a genetic science of common or universal, as distinct from private or individual, experience have rendered tenet after tenet of the *a priori* school obsolete for many minds.

Turning now to the application of this method and type of philosophy to the sphere of theology, we may note that to it is due a large part of the content of the traditional conception of God and His attributes. From the patristic age to the modern period of philosophy philosophical theologians took over the concept of God as largely fashioned during the long development of religious thought, including the Hebrew thought in which Christianity has its roots And in Hebrew religion, the transcendent attribute of Jehovah is His holiness God is personal, not a cosmic force, interested in individuals, immanent in Nature and man But the Greek philosophers, who founded philosophical theology, had relatively little concern with such qualifications of Deity. Greek philosophy began as cosmology and ethics was an after-development. And Greek theology was rather an academic product than born of personal experience and life Hence, save for Plato's identification of God with the Good, it endowed God with what may roughly be called "the physical" attributes in a predominant degree. The Greek mind, not the Hebrew, is responsible for the attribute of infinity, perhaps for those of omnipotence and omniscience in their absolute and rigorous senses, and for the qualities of immutability and impassibility, the taking over of which by Fathers of the Church involved them in the difficult task of reconciling such attributes with the nature of a living Spirit. Some of the Greek theological ideas, *a priori* in character rather than derived from life and experience, proved to be a mould somewhat incongruous with the Hebrew-Christian content which philosophically-minded Christian doctors thrust into it It was at once too large and too small. If immutability means more than self-consistency, and impassibility more than freedom from human anger and corporeal passions, they cannot be predicates of a God of love and a Father of spirits. Like infinity, until that concept passes over into the idea of ethical perfection, they are derived from inert matter rather than active spirit and are quasimaterialistic or mathematical rather than spiritual and ethical conceptions "Infinity" has borne several distinct meanings, both in Greek and in later philosophy. Originally its sense seems to have been that of indeterminateness or being devoid of any particular characters, formless, indefinite and indefinable: in which case it is, of course, not predicable of any actual being. Then it came to mean the endless or limitless, what cannot be reached by successive acts of addition or division. Infinity, in this sense of the endless in time, space or number, is only relevant in mathematics; it can have no application to God, who is without parts or magnitude Lastly, "infinity" acquired the meaning of completeness, ethical perfection and immutability. Then, however, it became a redundant word; as properly used it can be dispensed with by theology.

Even more inapt to Christian or theistic theology than some of the Greek *a priori* concepts is the abstractive method of arriving at a conception of God, which passed, through Philo especially, from Greek thought to some of the Fathers of the Church. The rationalistic propensity to regard the most abstract conception as the ultimately real being, coupled with the formally intellectual tendency to oust from philosophy and theology not only the anthropomorphisms of vulgar thought but also the inalienable anthropic functions of human mentality, led to usage of "the negative way." That consists in repudiating all positive characterizations of God supplied by human analogies. It has aptly been described as a deification of the word "not." Everything, it is represented, that can be affirmed of the finite must be denied of the Infinite One. Thus God becomes conceived as an indeterminate absolute, ineffable and unknowable; the living Spirit is replaced by a pure idea. The Fathers favourable to this method, who even when abstract philosophers were also pastors and curators of Christian tradition, were saved from propounding these extravagances by a wholesome inconsistency. But Philo, gnostics, and neoplatonists, who took the negative way more seriously, found it necessary, in order to bridge the impassable gulf which they set between the Infinite One and the finite world, to invent powers, aeons and emanations.

The Empirical Method and Natural Theology.—The phrase "natural theology" has usually been a synonym for "rational theology"; *e.g.*, the natural theology of the English deists, who may aptly be described as rational theists, consisted of doctrines supposed to have been discerned by human reason, its first principles being self-evident, and its secondary doctrines being deduced from them, in accordance with the *a priori* principle, that so and so is because it must be. But it is convenient to give to "natural theology" a distinctive meaning. As a synonym for "rational theology" it is superfluous; while there is a theology derivable empirically from the study of Nature, man and human history, and consequently not "rational" and *a priori*, for which the title "natural" is the most appropriate. It will therefore be so used in the present context.

The possibility of a theology of this kind was recognized at least as early as the time of St. Paul, who wrote that "the invisible things of [God] from the creation of the world are clearly seen, being understood by *the things that are made*." But though theology is thus derivable, it must be added that it has not as yet been derived, at least not with anything like the completeness and system possessed by some of the rational theologies that have been forthcoming between the times of, say, Aristotle and Hegel Empiricism, in a nobler than its historical sense which degrades it to sensationism, yet awaits its master-mind comparable to a Plato or a Spinoza, hitherto, both in philosophy and theology, it has been represented but fragmentarily, and, if by able thinkers, scarcely by genius of the highest order. Some of the threads which await weaving into the texture of an empirically grounded philosophical theology by a future master-weaver are already within the common ken and may be briefly indicated.

It is admitted that theology rests on faith Faith, in the first instance, creates ideas, such as that of God, and believes in real or actual counterparts to them It claims to be knowledge, but is not knowledge or cannot be known to be knowledge, in the same sense that natural science is knowledge. Faith may issue in knowledge or it may not. The individual believer, whether a mystic or a non-mystic, may adopt, for the ordering of his own life, the attitude "I am certain." Therein he is invulnerable; but his faith will be a matter of personal biography and his certainty will be but subjective certitude or convincedness until reasons be forthcoming for taking the objects of his belief to be actual (as is the king of England) and not merely imaginal (as the mermaid) or purely ideal (as the line without breadth) Theology and philosophy are concerned with the knowability and the actuality of God and with the validity of statements about Him. Rational theology maintained that God's existence, etc., could be proved as coercively as a theorem in Euclid. Empirical theology denies that this is so, and empiricism asserts that knowledge, in that sense, is not forthcoming even as to the existence of other subjects or souls than one's own. Empiricism can also assert that what is called scientific knowledge and what are our most assured convictions as to the physical world rest ultimately on indemonstrable postulates or an act of faith, and observes that there is no more a rational cosmology than there is a rational theology. In both spheres verification is pragmatic and is very different from logical certification, which would only be forthcoming if science were composed of deductions from axioms, instead of inductions from facts. Thus, in the entire realm of actuality, as distinguished from that of the pure or ideal sciences, what, of courtesy, we

call knowledge is after all but probable belief. We can only be reasonable, not rational.

Such is the empirical account of the relation of faith to reason, theology to science and philosophy. It follows that no proof, in the most rigid sense, of the primary dogma of theism is possible. Such proof as may be had will consist in showing that theism is the most reasonable interpretation of the world and man, and in displaying the cumulative evidence for the assertion that the cosmos is due to the conspiration of innumerable causes and adaptations, by their united and reciprocal action, to issue in a general order of Nature, such as cannot reasonably be ascribed to fortuitousness but only to design by a supreme mind that must be intelligent and moral, the ground of the Good, the Beautiful and the True. Philosophical theology will thenceforward consist in the reinterpretation of the world and human history in terms of that metaphysical conclusion.

Theology Based on Other Grounds.—After rational theology received the classic criticism of Hume and Kant, attempts were made to establish theology on a new basis The old proofs having been shown to be either fallacious or insufficient, the theoretical knowledge-methods by which they had been mediated were renounced, as not the proper foundation of theology But the empirical procedure, seeking for grounds of reasonable belief wherewith intellectually to justify faith, did not commend itself to the generations which succeeded Kant In the 19th century the discovery of the deists that revealed religion presupposes natural religion was ignored, and Butler's suggestion, that what he vaguely called probability constituted our guide, was deemed inadequate. The latter line of thought was indeed pursued, without explicit awareness of the fact, by the numerous English writers who, from S T. Coleridge onwards, developed the doctrine that religious truth can only be judged and accepted by "the whole man," and not by man as merely intelligent. Recoil from discredited 18th century rationalism, however, did not direct itself to the empiricism represented by Locke, and perhaps more faithfully, in the theological sphere, by Butler. Confusing probability, as something pertaining to common or public beliefs and "knowledge," with acceptance as merely probable on the part of the individual believer, objectors generally submitted that ardent faith is not a weighing of probabilities, nor can faith be content to stake its vital convictions on what it merely deems probable

Of course the faithful man is certain, in the sense of being privately convinced; but what he is confident about may not have logical or scientific demonstrability from the point of view of objective or common knowledge. And it is the latter issue, not the mentality of this or that individual, with which theology is concerned. But inasmuch as this confusion of standpoints was prevalent, it is not surprising that efforts were forthcoming to find a new basis for theology such as should constitute it a science, yet vindicate subjective certitude. Schleiermacher appealed to immediate experience But it may perhaps be said that the immediacy of which he treated is but mediateness unrecognized. when he proceeded to draw out what was implicit in his fundamental immediate truths, he reveals the presupposing of a whole system of philosophy and science Another such attempt was that of Ritschl, who sought to make theology independent of the sciences of Nature and historical criticism, of metaphysics or theoretical (by which he seems to have meant rational) knowledge, grounding it on judgments of worth. That theology derives its arguments largely from considerations as to values is of course true. But these valuations must be appreciations of the actual, and so presuppose knowledge of the world and man, in order to yield any theistic argument The existence of a real object, such as God or heaven, cannot be inferred from the worth of an ideal object or from doctrines about such objects. An existential science, then, cannot be extracted from considerations as to worth alone. There is room, moreover, for nothing but private faith or blind hope in the realization and conservation of the valuable, until the universe has been found, by theoretical knowledge, at least not to be of such a nature as to involve extinction of the valuable. That the good *ought* to be conserved is irrelevant to whether it *will* be conserved, until we have established a reasonable belief in a good God. Thus it would again seem that theology can only claim to be reasonable belief and that it can only provide itself with reasonable belief by interpreting the actual world. Once severed from the kind of "knowledge" on which it is dependent, it is unable to find any criterion whereby to distinguish reasoned and reasonable belief from superstition, theology from rules for pious behaviour or for pious feeling towards objects that may be but fond imaginations.

Biblical and Dogmatic Theology.—Only a few words can be added here to what has been already said as to dogmatic and Biblical theology, subjects on which the special headings should be consulted. There is, of course, no one theology of the Old Testament. that collection of books, belonging to different times, is constituted a unity by its record of how Hebrew monotheism gradually developed during several centuries. It describes man's groping after God, which, from the theistic point of view, is but the converse side of God's progressive revelation of Himself to man, imparting knowledge of Himself or inspiring the pursuit of religious discovery, not by over-riding human faculties but by adaptation or condescension to them God, as a Christian Father expresses it, ever took man as he was, in order to make him what he was not. Thus was gradually reached the lofty and ethical conception of God and His relation to humanity which was presented by the great prophets. The Old Testament contains the history of God's preparation for the reception by humanity of the highest and fullest revelation of Himself in a human personality. The New Testament, again, contains the account of the impression produced by the life and teaching of Christ and the earliest extant interpretations of His Person. The relation of Christ to God came to be formulated in terms of the conception of incarnation; but though incarnation involves an event in "the fulness of time," the Incarnation has been by no means exclusively regarded by Christian doctors as a complete discontinuity or as but contingent on man's need of redemption. From antiquity there have been those who regard the Incarnation, on the one hand, as the last of many stages and, on the other, as part of the eternal counsel of God The doctrine of the Incarnation and that of the Trinity which is intimately bound up with it are the two dogmas that are most distinctive of the Christian type of theism; and they are the two which for the first five centuries figure most prominently in the development of the Church's doctrine In this connection it is interesting and important to observe that during this constructive period there was a considerable approach, within the Church, to that divergence as to philosophical method that has received notice in earlier sections of this article. The school of Alexandria was largely platonist in its theological conceptions; and, setting forth from the divinity of Christ as—in a sense—*a priori* datum or prior certainty, sought as best it could to account for Christ's human nature and to explain its union with the divine nature in one person The school of Antioch, on the other hand, was more empirical. It pursued the scientific or historical, rather than the allegorical, method of exegesis of Scripture and, in Christology, it set out from the observed facts about Christ as man, seeking how to conceive of His deity compatibly with them The Alexandrines cherished the metaphysical concepts of substance, etc , and spoke of the union of the two natures in Christ as "hypostatic"; the Antiochenes preferred to think in terms of the ethical and spoke of a "moral harmony" For better or for worse, the former school exerted the dominating influence in the final and oecumenical formulation of orthodoxy. It transmitted doctrines expressed in terms of philosophical conceptions which the modern mind sometimes evinces a desire to discard or supersede, on the ground that they do not take account of distinctions which, once emergent, cannot be ignored, and otherwise present difficulties which, unsuspected in the past, to-day are felt to be acute.

Returning to the particular dogmas of the Trinity and the Person of Christ, we may observe that in the case of the elaboration of the former of them the search was made for a conception of the Persons of the Triune God such as should avoid the implication that God is a divine society of several individuals and also the implication that the Persons are merely temporal rôles or

modes of God. In other words, the great doctors from Tertullian to Aquinas who have expounded Trinitarian doctrine were feeling for a mode of being intermediate between what can be denoted by a noun and what can be denoted by an adjective, such as an attribute or a relation. Since human experience knows of no such mode of being and the conception of it cannot be elucidated by any analogy, these teachers have recognized that, in the last resort, they were dealing with mystery or with what transcends the limits of the human mind to comprehend or to conceive And, shrinking more from tritheism than from modalism, they gave to the orthodox formulation of the doctrine of the Trinity a meaning which it is not easy to distinguish in essence from the rigidly monotheistic or monarchian conception of God as undifferentiated, save in respect of possessing a plurality of attributes or relations that are eternal and intrinsic and not merely temporary, as heresiarchs had asserted On the other hand the doctrine of the Person of Christ which received the consent of the universal Church implies that in Christ, as incarnate, there was but one subject—if this term of modern psychology accurately represents what was meant—viz, the Logos or pre-existent Son, and that our Lord's human nature was "impersonal" This would seem to involve a conception of the Trinity somewhat different from that contained in the dogma as just expounded, inasmuch as the Logos is now treated as an agent or subject and yet as distinct from God or the Father. Perhaps it is owing to a sense of discrepancy in this connection that recent thought has sometimes manifested a tendency to interpret the Incarnation of the Logos in terms of the notion of divine immanence in a human personality. From this point of view, "God was in Christ . . ." would better express the Incarnation-doctrine than "The Word became flesh." But the translation of these two fundamental Christian doctrines into terms of conceptions such as are serviceable in psychology and theology at the present day has not yet been accomplished.

Bibliography —Of the theology of ancient Greece a particular interpretation will be found in Edward Caird, *The Evolution of Theology in the Greek Philosophers* (2 vols. 1904). On the influence of Greek philosophy on early Christian thought, *see* C Bigg, *The Christian Platonists of Alexandria* (1886, new ed 1913). Of the theological thought of ancient and modern philosophers an account is given in J. Watson, *The Interpretation of Religious Experience* (vol. 1, 1912) The most important book on religious experience is the pioneer work of William James, *The Varieties of Religious Experience* (1902). For studies propaedeutic to philosophical theology and an empirical approach to theology, *see* F. R. Tennant, *Philosophical Theology* (1928). A concise account of the early development of dogmatic theology is contained in J. F. Bethune-Baker, *An Introduction to the early history of Christian Doctrine* (1903, 2nd ed. 1920) For further relevant literature *see* Theism, Faith, Dogma and articles on specific doctrines, etc. (F. R T.)

THEOPHANES, surnamed "the Confessor" (*c.* A D. 758–818), Greek ascetic, chronicler and saint, belonged to a noble and wealthy family and held several offices under Constantine V., Copronymus (741–775). He subsequently founded a monastery (τοῦ Μεγάλου Ἀγροῦ) near Sigriane. He took a strong position against the Iconoclastic policy of Leo V. and was imprisoned in Samothrace, where he died (818). He subsequently received the honours of canonization. He continued the Chronicle of George the Syncellus from the accession of Diocletian to the downfall of Michael I. Rhangabes (284–813). The work, although wanting in chronological accuracy, is of great value as supplying the accounts of lost authorities.

There is also extant a further continuation, in six books, of the *Chronicle* down to the year 961 by a number of mostly anonymous writers (called Οἱ μετὰ Θεοφάνην, Scriptores post Theophanem), who undertook the work by the instructions of Constantine Porphyrogenitus.

Editions of the *Chronicle:—Editio princeps*, J. Goar (1655); J. P. Migne, *Patrologia Graeca*, cviii; J. Classen in Bonn *Corpus Scriptorum Hist. Byzantinae* (1839–41); and C. de Boor (1883–85), with an exhaustive treatise on the ms. and an elaborate index; E. W. Brooks in *Byzantinische Zeitschrift*, 15, p. 578 *et seq.*

Editions of the *Continuation* in J. P. Migne, *Patr. Gr.*, cix., and writer in *Sitzungsberichte der philos.-philol. und der hist. Cl der k* by I. Bekker, Bonn *Corpus Scriptorum Hist. Byz.* (1838); on both works and Theophanes generally, *see* C. Krumbacher, *Geschichte der byzantinischen Literatur* (1897); *Ein Dithyrambus auf Theophanes Confessor* (a panegyric on Theophanes by a certain *protoasecretis*, or chief secretary, under Constantine Porphyrogenitus) and *Eine neue Vita des Theophanes Confessor* (anonymous), both edited by the same writer in *Sitzungsberichte der Philos.-philol. und der hist. Cl. der k. bayer. Akad der Wissenschaften* (1896, pp 583–625; and 1897, pp. 371–399); Gibbon's *Decline and Fall* (ed. Bury, 1896–1900), v. p. 530.

THÉOPHILE, the name by which Théophile de Viau (or Viaud), French poet (1591–1626), is more commonly called. He was born in 1591, at Clairac, near Agen, and was educated at the Protestant college of Saumur. In 1612 he met Balzac, with whom he made an expedition to the Netherlands, which ended in a serious quarrel. On his return he seems to have been for two years a regular playwright to the actors at the Hôtel de Bourgogne. In 1615 he attached himself to Henry, duke of Montmorency (1595–1632), under whose protection he produced the tragedy of *Pyrame et Thisbé,* acted probably about 1617. This piece, written in the extravagant Spanish-Italian manner, was ridiculed by Boileau (Preface to his *Œuvres*, 1701). Théophile was a Huguenot and a freethinker, and had made unsparing use of his sharp wit in epigrams on the Church and on the government. In 1619 he was banished from Paris, but was allowed to return in the next year. He then served in that year in the campaign against the Huguenots, but in the autumn was an exile in England. He was recalled in 1621, and abjured Protestantism in 1622 In 1622 he had contributed four pieces to the *Nouveau Parnasse Satirique,* a miscellany of verse by many hands. In the next year a new edition appeared, with the addition of some licentious verse, and the inscription *par le sieur Théophile* on the title-page. Contemporary opinion justified Théophile's denial of this ascription, but the Jesuit father, François Garasse, published a tract against him entitled *La Doctrine curieuse* (1623) Théophile was again prosecuted. This time he fled from Paris, to the court of Montmorency, and was condemned in his absence (Aug 19, 1623) to death. On his flight to the border he was arrested, and imprisoned in the Conciergerie in Paris. He defended himself in an *Apologie au roi* (1625), and was liberated in September, his sentence being commuted to banishment for life Under Montmorency's protection he hid in Paris for some time, and subsequently accompanied his friend and patron to the south. He died in Paris on Sept 25, 1626.

Forty-two pamphlets on the prosecution of Théophile, written between the dates 1622 and 1626, are preserved in the Bibliothèque Nationale in Paris. The standard modern edition of the works of Théophile is that of Alleaume in the *Bibliothèque Elzévirienne* (2 vols 1856). Besides *Pyrame et Thisbé*, his works include a paraphrase, half verse, half prose, of the *Phaedo.* There are numerous French and Latin letters, his *Apologie*, a promising fragment of comic prose narrative, and a large collection of occasional verses, odes, elegies, stanzas, etc. *See* K Schirmacher, *Théophile de Viau* (Leipzig and Paris, 1897)

THÉOPHILUS, East Roman emperor (829–842), the second of the "Phrygian" dynasty, a pronounced iconoclast In 832 he issued an edict strictly forbidding the worship of images. His whole reign was occupied in war against the caliphs of Baghdad. (*See* Caliphate, especially sect. C., § 8.) This war was caused by Theophilus, who afforded an asylum to a number of Persian refugees. The Roman arms were at first successful; in 837 Samosata and Zapetra (Zibatra, Sozopetra), the birthplace of Motasim, were taken and destroyed. Eager for revenge, Motasim assembled a vast army, one division of which defeated Theophilus, who commanded in person, at Dasymon, while the other advanced against Amorium, the cradle of the Phrygian dynasty. After a brave resistance the city fell into Motasim's hands through treachery. Thirty thousand of the inhabitants were slain, and the city razed to the ground. Theophilus never recovered from the blow, and he died at the beginning of 842.

See Gibbon, *Decline and Fall*, chaps. 48 and 52; F. G. Schlosser, *Geschichte der bilderstürmenden Kaiser* (1812); G. Finlay, *History of Greece*, ii. (1877), p 142; G. F. Hertzberg, *Geschichte der Byzantiner und des osmanischen Reiches*, bk. i. (Berlin, 1883); H. Gelzer, "Abriss der byzantinischen Kaisergeschichte" in C. Krumbacher's *Geschichte der byzantinischen Literatur* (2nd ed., 1897); and authorities under Roman Empire, Later. On the early campaigns against the Arabs *see* J. B. Bury, in *Journ. Hell. Stud.* xxix., 1909, pt. i.

THEOPHRASTUS, the successor of Aristotle in the Peripatetic school, a native of Eresus in Lesbos, was born *c.* 372 B.C. His original name was Tyrtamus, but he later became known by the nickname "Theophrastus," given to him, it is said, by Aristotle to indicate the grace of his conversation. After receiving his first introduction to philosophy in Lesbos from one Leucippus or Alcippus, he proceeded to Athens, and became a member of the Platonic circle. After Plato's death he attached himself to Aristotle, and in all probability accompanied him to Stageira. Aristotle in his will made him guardian of his children, bequeathed to him his library and the originals of his works, and designated him as his successor at the Lyceum on his own removal to Chalcis. Theophrastus presided over the Peripatetic school for 35 years, and died in 287 B.C.

The most important of the works of Theophrastus are two large botanical treatises, *On the History of Plants,* in nine books, originally ten, and *On the Causes of Plants,* in six books, originally eight, which constitute the most important contribution to botanical science during antiquity and the middle ages. We also possess in fragments a *History of Physics,* a treatise *On Stones,* and a work *On Sensation,* and certain metaphysical Ἀπορίαι, which probably once formed part of a systematic treatise. The writings of Theophrastus are accessible in the Teubner series.

The *Ethical Characters* (Ἠθικοὶ χαρακτῆρες) consist of brief, vigorous and trenchant delineations of moral types, which give a most valuable picture of the life of his time. They form the first recorded attempt at systematic "character" writing. The *Ethical Characters* was edited by Casaubon in 1592 and translated by La Bruyère (1688–89); the best modern translation (with introduction and notes) is that of Sir Richard Jebb (1870; rev. ed. J. E. Sandys, 1909).

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THEOPOMPUS (380 B.C.), Greek historian and rhetorician, was born at Chios about 380 B.C. In early youth he seems to have spent some time at Athens, along with his father, who had been exiled on account of his Laconian sympathies. Here he became a pupil of Isocrates, and rapidly made great progress in rhetoric. We are told that Isocrates used to say that Ephorus required the spur but Theopompus the bit (Cicero, *Brutus,* 204). At first he appears to have composed epideictic speeches, in which he attained to such proficiency that in 352–351 he gained the prize of oratory given by Artemisia (*q.v.*) in honour of her husband, although Isocrates was himself among the competitors. It is said to have been the advice of his teacher that finally determined his career as an historian—a career for which he was peculiarly qualified owing to his abundant patrimony and his wide knowledge of men and places. Through the influence of Alexander, he was restored to Chios about 333, and figured for some time as one of the leaders of the aristocratic party in his native town. After Alexander's death he was again expelled, and took refuge with Ptolemy in Egypt, where he appears to have met with a somewhat cold reception. The date of his death is unknown.

The works of Theopompus were chiefly historical, and are much quoted by later writers. They included an *Epitome of Herodotus's History* (the genuineness of which is doubted), the *Hellenics* (Ἑλληνικά, Ἑλληνικαὶ ἱστορίαι), the *History of Philip* (Φιλιππικά), and several panegyrics and hortatory addresses, the chief of which was the *Letter to Alexander.* The *Hellenics* treated of the history of Greece, in 12 books, from 411 (where Thucydides breaks off) to 394—the date of the battle of Cnidus (*cf.* Diod. Sic., xiii. 42, with xiv. 84). Of this work only a few fragments were known up till 1907. The papyrus fragment of a Greek historian of the 4th century B.C., discovered by B. P. Grenfell and A. S. Hunt, and published by them in *Oxyrhynchus Papyri,* vol. v. (1908), has been recognized by Ed. Meyer, U. von Wilamowitz-Moellendorff and G. Busolt as a portion of the *Hellenics.* This identification has been disputed, however, by F. Blass, J. B. Bury, E. M. Walker and others, most of whom attribute the fragment, which deals with the events of the year 395 B.C. and is of considerable extent, to Cratippus (*q.v.*). A far more elaborate work was the Φιλιππικά in 58 books. In this Theopompus narrated the history of Philip's reign (360–336), with digressions on the names and customs of the various races and countries of which he had occasion to speak, which were so numerous that Philip V. of Macedon reduced the bulk of the history from 58 to 16 books by cutting out those parts which had no connection with Macedonia. It was from this history that Trogus Pompeius (of whose *Historiae Philippicae* we possess the epitome by Justin) derived much of his material.

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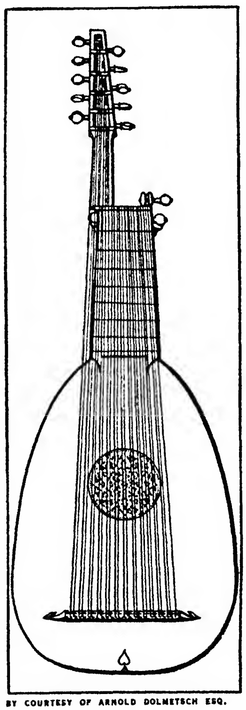
(E. M. WA.)

THEORBO, the large double-necked bass lute much used during the 16th and 17th centuries as general bass in the orchestra. The body of the theorbo was constructed on the same principles as that of the lute. The theorbo was made in two sizes, the ordinary instrument measuring about 3ft. 6in., and the Paduan, also known as archlute, about 5 feet. The chitarrone, or Roman theorbo, was the largest of all, a contrabass lute in fact, and frequently stood over 6ft. high. (*See* BARBITON; LUTE.)



BY COURTESY OF ARNOLD DOLMETSCH ESQ.
THE THEORBO

THEOREM, a term used in mathematics to represent a proposition which is to be demonstrated. In geometry, a proposition is commonly considered as a problem (a construction to be effected) or a theorem (a statement to be proved). For example, the statement: "If two lines intersect, each pair of vertical angles are equal" is a theorem. The so-called "Fundamental Theorem" of algebra asserts that every rational integral equation has at least one root. The Greeks also recognized a proposition lying between a theorem and a problem, the porism (*q.v.*). (*See* also FERMAT'S THEOREM; BINOMIAL THEOREM; REMAINDER THEOREM.)

THEORY, in logic and science, is a term used in various, though connected, meanings. Sometimes it is used as synonymous with hypothesis, that is, to denote any tentative explanation of phenomena. Sometimes it is restricted to explanations that have already passed beyond the stage of mere hypotheses by having received a considerable amount of verification. Sometimes, again, the term theory is simply contrasted with "practice" or "practical application," and will then include any kind of explanation, be it hypothetical or fully established. Lastly, the term is sometimes restricted to the most comprehensive explanation (hypothetical

or verified and established) as contrasted with the less comprehensive laws or explanations comprised under them and deducible from them. In this sense we speak of the *theory* of gravitation, but of Kepler's three *laws* of planetary motion, and of Boyle's *law*, but of the dynamic *theory* of gases. This last usage is perhaps the best. *See* A Wolf, *Essentials of Scientific Method* (1928).

THEOSOPHY, a term used to denote those forms of philosophic and religious thought which claim a special insight into the Divine nature and its constitutive moments or processes (from Gr. θεός, god and σοφία, wisdom). Sometimes this insight is claimed as the result of the operation of some higher faculty or some supernatural revelation to the individual; in other instances the theosophical theory is not based upon any special illumination, but is simply put forward as the deepest speculative wisdom of its author But in any case it is characteristic of theosophy that it starts with an explication of the Divine essence, and endeavours to deduce the phenomenal universe from the play of forces within the Divine nature itself

General Theory.—Theosophy is thus differentiated at once from all philosophic systems which attempt to rise from an analysis of phenomena to a knowledge, more or less adequate, of the existence and nature of God In all such systems, God is the *terminus ad quem,* a direct knowledge of whom is not claimed, but who is, as it were, the hypothesis adopted, with varying degrees of certainty in different thinkers, for the explanation of the facts before them. The theosophist, on the other hand, is most at his ease when moving within the circle of the Divine essence, into which he seems to claim absolute insight This, however, would be insufficient to distinguish theosophy from those systems of philosophy which are sometimes called "speculative" and "absolute," and which also in many cases proceed deductively from the idea of God In a wide sense the system of Hegel or the system of Spinoza may be cited as examples of what is meant. Both thinkers claim to exhibit the universe as the evolution of the Divine nature; so much is involved, indeed, in the construction of an absolute system. But in such systems the known universe—the world of experience—is nowhere transcended; God is really no more than the principle of unity immanent in the whole Hence, while the accusation of pantheism is frequently brought against these thinkers, the term theosophical is never used in their regard. A theosophical system may also be pantheistic, in tendency if not in intention; but the transcendent character of its Godhead definitely distinguishes it from the speculative philosophies which might otherwise seem to fall under the same definition An historical survey shows, indeed, that theosophy generally arises in connection with religious needs, and is the expression of religious convictions or aspirations. Accepting the testimony of religion that the present world lies in wickedness and imperfection, theosophy faces the problem of speculatively accounting for this state of things from the nature of the Godhead itself. It is thus in some sort a mystical philosophy of the existence of evil; or at least it assumes this form in some of its most typical representatives. The term Mysticism (*q v*) has properly a practical rather than a speculative reference; but it is currently applied so as to include the systems of thought on which practical mysticism was based Thus, to take only one prominent example, the profound speculations of Meister Eckhart (*q v*) are always treated under the head of Mysticism, but they might with equal right appear under the rubric Theosophy. In other words, while an emotional and practical mysticism may exist without attempting philosophically to explain itself, speculative mysticism is in current usage almost another name for theosophy.

In the above acceptation of the term, the neoplatonic doctrine of emanations from the supra-essential One, the fanciful emanation-doctrine of some of the gnostics (the aeons of the Valentinian system, for example), and the elaborate esoteric system of the Kabbalah, to which the two former in all probability largely contributed, are generally included under the head of theosophy. In the two latter instances there may be noted the allegorical interpretation of traditional doctrines and sacred writings which is a common characteristic of theosophical writers. Still more typical examples of theosophy are furnished by the mystical system of Meister Eckhart and the doctrine of Jacob Boehme (*q v*), who is known as "the theosophist" *par excellence* Eckhart's doctrine asserts behind God a predicateless Godhead, which, though unknowable not only to man but also to itself, is, as it were, the essence or potentiality of all things. From it proceed, and in it exist, the three persons of the Trinity, conceived as stadia of an eternal self-revealing process. The eternal generation of the Son is for Eckhart equivalent to the eternal creation of the world. But the sensuous and phenomenal, as such, so far as they seem to imply independence of God, are mere privation and nothingness; things exist only through the presence of God in them, and the goal of creation, like its outset, is the repose of the Godhead The soul of man, which as a microcosmos resumes the nature of things, strives by self-abnegation or self-annihilation to attain this unspeakable reunion (which Eckhart calls being "buried" in God). Regarding evil simply as privation, Eckhart does not make it the pivot of his thought as was afterwards done by Boehme; but his notion of the Godhead as a dark and formless essence is a favourite thesis of theosophy.

Boehme was indebted not only to mystical theology but also to the writings of Paracelsus This circumstance is not accidental, but points to an affinity in thought The nature-philosophers of the Renaissance, such as Nicolaus Cusanus, Paracelsus, Cardan and others, curiously blend scientific ideas with speculative notions derived from scholastic theology, from neoplatonism and even from the Kabbalah Hence it is customary to speak of their theories as a mixture of theosophy and physics, or theosophy and chemistry, as the case may be Boehme offers us a natural philosophy of the same sort As modern theosophy has nourished itself almost in every case upon the study of his works, his dominating conceptions supply us with the best illustration of the general trend of this mode of thought His speculation turns, as has been said, upon the necessity of reconciling the existence and the might of evil with the existence of an all-embracing and all-powerful God, without falling into Manichaeism on the one hand, or, on the other, into a naturalistic pantheism that denies the reality of the distinction between good and evil He faces the difficulty boldly, and the eternal conflict between the two may be said to furnish him with the ground-principle of his philosophy. It is in this connection that he insists on the necessity of the Nay to the Yea, of the negative to the positive. Eckhart's Godhead appears in Boehme as the abyss, the eternal nothing, the essenceless quiet (*Ungrund* and *Stille ohne Wesen* are two of Boehme's phrases). But, if this were all, the Divine Being would remain an abyss dark even to itself In God, however, as the condition of His manifestation, lies, according to Boehme, the "eternal nature" or the *mysterium magnum*, which is as anger to love, as darkness to light, and, in general, as the negative to the positive. This principle (which Boehme often calls the evil in God) illuminates both sides of the antithesis, and thus contains the possibility of their real existence By the "Qual" or torture, as it were, of this diremption, the universe has qualitative existence, and is knowable. Even the three persons of the Trinity, though existing *idealiter* beforehand, attain reality only through this principle of nature in God, which is hence spoken of as their *matrix*. It forms also the matter, as it were, out of which the world is created; without the dark and fiery principle, we are told, there would be no creature. Hence God is sometimes spoken of as the father, and the eternal nature as the mother, of things. Creation (which is conceived as an eternal process) begins with the creation of the angels. The subsequent fall of Lucifer is explained as his surrender of himself to the principle of nature, instead of dwelling in the heart of God He sought to make anger predominate over love; and he had his will, becoming prince of hell, the kingdom of God's anger, which still remains, however, an integral part of the Divine universe

Schelling's *Philosophical Inquiries into the Nature of Human Freedom* (1809) is almost entirely a reproduction of Boehme's ideas, and forms, along with Baader's writings, the best modern example of theosophical speculation. In his philosophy of identity Schelling (*q.v*) had already defined the Absolute as pure indiffer-

ence, or the identity of subject and object, but without advancing further into theogony. He now proceeded to distinguish three moments in God, the first of which is the pure indifference which, in a sense, precedes all existence—the primal basis or abyss, as he calls it, in agreement with Boehme. But, as there is nothing before or besides God, God must have the ground or cause of His existence in Himself. This is the second moment, called nature in God, distinguishable from God, but inseparable from Him. It is that in God which is not God Himself, it is the yearning of the eternal One to give birth to itself. This yearning is a dumb unintelligent longing, which moves like a heaving sea in obedience to some dark and indefinite law, and is powerless to fashion anything in permanence But in correspondence to the first stirring of the Divine existence there awakes in God Himself an inner reflective perception, by means of which—since no object is possible for it but God—God beholds Himself in His own image In this, God is for the first time as it were realized, although as yet only within Himself This perception combines, as understanding, with the primal yearning, which becomes thereby free creative will, and works formatively in the originally lawless nature or ground In this wise is created the world as we know it. In every natural existence there are, therefore, two principles to be distinguished—first, the dark principle, through which the being in question is separated from God, and exists, as it were, in the mere ground; and, secondly, the Divine principle of understanding The first is the particular will of the creature, the second is the universal will In irrational creatures the particular will or greed of the individual is controlled by external forces, and thus used as an instrument of the universal. But in man the two principles are consciously present together, not, however, in inseparable union, as they are in God, but with the possibility of separation This possibility of separation is the possibility of good and evil. In Boehme's spirit, Schelling defended his idea of God as the only way of vindicating for God the consciousness which naturalism denies, and which ordinary theism emptily asserts Among thinkers on the same lines, but more or less independent, Molitor is perhaps the most important Swedenborg (*q v*) is usually reckoned among the theosophists.

THE THEOSOPHICAL SOCIETY

The term "theosophy" has in recent years obtained a wide currency in certain circles as denominating the beliefs and teachings of the Theosophical Society. This society was founded in the United States in 1875 by Madame H. P. Blavatsky (*q.v*), in connection with Col. H. S Olcott and others. Col Olcott remained president of the original society till his death in 1907, when he was succeeded by Mrs Annie Besant But soon after the death of Madame Blavatsky (1891) a split took place which led to the formation of a separate organization in America under the leadership of William P Judge. The main objects of this society, as originally propounded, were:

(1) To establish a nucleus of the universal brotherhood of humanity;

(2) to promote the study of comparative religion and philosophy; and

(3) to make a systematic investigation into the mystic potencies of life and matter, or what is usually termed "occultism."

Mahatmas.—According to Madame Blavatsky's original statements this wisdom has been transmitted through the ages as a secret doctrine or esoteric teaching by a brotherhood of adepts or Mahatmas scattered through the world but in close relation with one another. With a certain group of these in Tibet she claimed to be in communication. In such adepts the spiritual nature is supposed to have been so developed that the body has become the ductile instrument of the intelligence and they have thus gained a control over natural forces which enables them to bring about results that appear to be miraculous.

Religious Aspect.—The most characteristic feature of this modern "theosophical" teaching is the belief in reincarnation, and here again the close connection with Indian thought is observable. The succession of earthly lives through which the spirit advances to its goal is interpreted in strict accordance with the Brahmanic and Buddhistic doctrine of Karma. First introduced in the Upanishads as the great secret which solves the problem of human destiny, Karma is in a sense the logical origin of all Indian thought. It expresses the inexorable law of moral causation—whatsoever a man soweth that shall he also reap—and this law is represented as fulfilling itself in the life-history of each individual agent. The consequences of a man's actions in his present life are reaped by the agent on earth in a fresh incarnation. Hence the saying, "A man is born into the world he has made." The theory of Karma is thus primarily an explanation of a man's lot in the present life as determined by his own actions in a series of previous lives If it is true that whatsoever a man soweth that shall he also reap, it must be equally true that whatsoever a man reaps that he must also have sown. The doctrine is thus in its essence a vindication of cosmic justice in face of the perplexities caused by the apparent disregard of moral considerations in the distribution of happiness and misery in the present life, and it is in this sense that it is accepted and applied by theosophists. (A. S. P -P.)

THÉOT, CATHERINE (d. 1794), French visionary, was born at Barenton (Manche). In Robespierre her followers saw the redeemer of mankind and preparations for his initiation were put in train. Catherine, with others, was arrested and imprisoned. The accused were ultimately acquitted, Catherine herself having died in prison on Sept 1, 1794

THEOTOCOPULI, DOMENICO (*c* 1542–1614), known as El Greco, Spanish painter. He was born in Candia, Crete. His Greek name, Domenicos Theotocopoulos, was changed in Italy and Spain into Domenico and Dominico Theotocopuli, and he thus signed his name in Greek characters. We first hear of him in a letter written by the miniaturist, Julio Clovio, to the cardinal Alessandro Farnese, dated Rome, Nov. 16, 1570. "There has arrived in Rome a young man from Candia, a pupil of Titian, who, I think, is a painter of rare talent. . . . He has painted a portrait of himself which is admired by all the painters in Rome I should like him to be under the patronage of your reverend lordship without any other contribution towards his living than a room in the Farnese Palace" Unfortunately, the portrait here mentioned is lost. Works of this early period are. the portrait of Clovio (Naples museum), "The Healing of the Blind," of which there are two versions (Museums of Parma and Dresden) and "Christ driving the Traders from the Temple," of which there are versions in the collection of Sir Herbert Cook, Richmond, in the Minneapolis museum and in the Frick collection, New York, the last of a somewhat later period Though a pupil of Titian, he was influenced by Tintoretto and the Bassanos, and while in Rome he studied Michelangelo. In the picture at Minneapolis, Titian and Michelangelo are introduced with Clovio in the lower right hand corner.

We next hear of Theotocopuli in Toledo, at work in the church of Santo Domingo el Antiguo, rebuilt in 1575 on the outskirts of the city. Here he designed the architecture and sculpture of a composite altar in Venetian style and painted the pictures for it The centrepiece (now in the Chicago Art institute) representing "The Assumption of the Virgin," is a free adaptation to Spanish surroundings of Titian's masterpiece, in the Frari at Venice, and is painted with daring and intensity, in a rich, deep colour scheme. Flanking it, and still in their original position, are the imposing figures of St. John the Baptist and St. John the Evangelist. On the side altars are "The Adoration of the Shepherds" and "The Resurrection," while "The Trinity" with its Michelangelesque "The dead Christ in the Arms of God the Father" is now in the Prado. Toledo had never seen such art before; and in 1577, the year when "The Assumption" was completed, he was asked by the chapter of Toledo cathedral to paint the chief picture for their new sacristy. He chose as his subject "The Stripping of Christ before the Crucifixion" (El Espolio). Christ's impressive figure in the centre stands out among a crowd of executioners whose brutality contrasts with the Gentle Marys in the lower part of the picture The whole surface of the canvas is compactly filled. As in Michelangelo's blocks of marble, there are no open views, no empty spaces The cold tone of the painting contrasts with the glowing Venetian

colour of his earlier work, and is distinctly Spanish. The picture was completed in 1579. The chapter, finding its price too high, had it valued by artists, who decided in Theotocopuli's favour. Whereupon the chapter demanded the removal from the picture of "certain improprieties" such as the presence of the Marys below the Christ. The artist, being threatened with imprisonment, at length gave in; but somehow the picture was left as it was. It constitutes the masterpiece of his early period in Spain. He had lavished all his art on it in the hope that the doors of the Escorial might open to him, and he seemed to succeed, for Philip II. asked him to provide an altarpiece for his church in the spring of 1580 In "St. Maurice and his Legion," El Greco realized a new form of expression, for which he had been searching since his arrival in Spain. Withdrawn as he was from the example of the great Italian masters, he was thrown on himself. His Byzantine origin made itself felt in the swinging rhythm of his design, the fervent religiosity of 16th century Spain in the extreme expression of feeling.

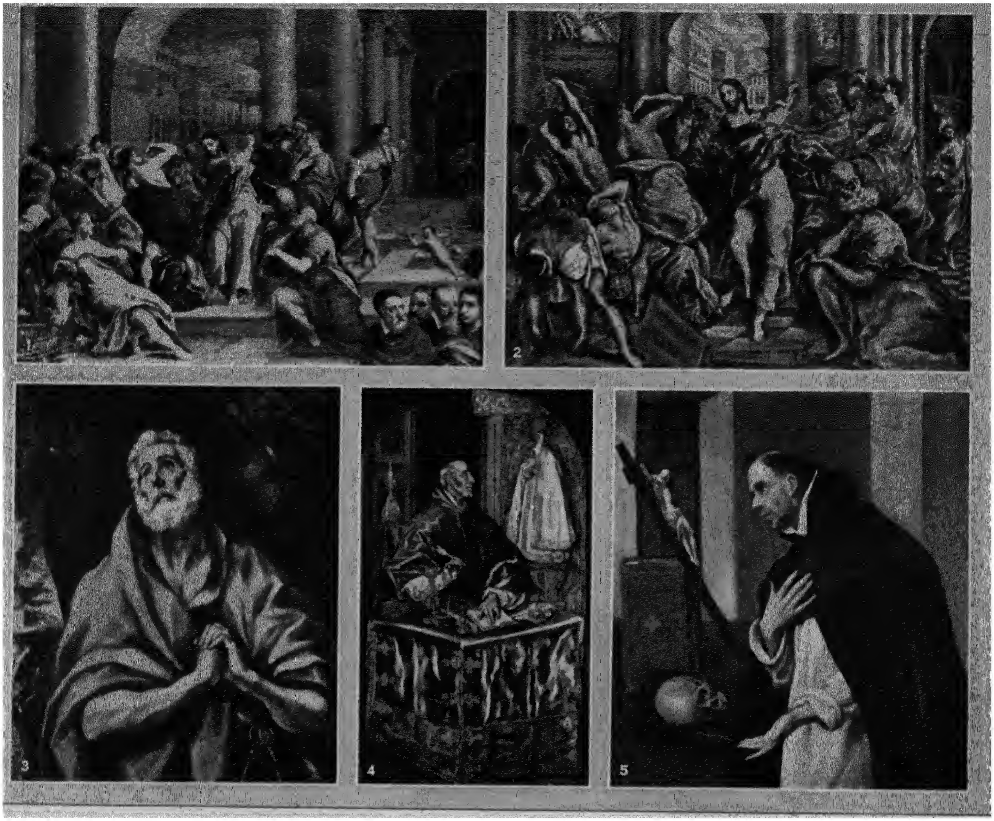
However, when the completed work was submitted to the king he failed to understand the strange new treatment, and though it remained at the Escorial, it was not placed over the appointed altar. His next important work was the famous "Burial of Count Orgaz" (El Enterrio), for the church of St. Tomé at Toledo. It treats of a miracle Don Gonzalo Ruiz, governor of Orgaz, had, during his lifetime, professed devotion to St. Augustin and St. Stephen, who descended from heaven when his body was about to be buried in the church of St Tomé, which he had rebuilt, and laid him to rest to the wonder of the attending clergy and mourners, who are shown in a long row of vivid Spanish heads, placed like a frieze horizontally across the picture The upper portion of the painting depicts the reception of the court in heaven The supernatural world is joined to the realistic scene below by the harmonious lines of a geometric design recalling the tracery of a Gothic window. Again the price of the picture was the cause of a lawsuit El Greco henceforth seemed wholly occupied by his imaginative vision All elements of secondary value are discarded, and everything is subordinated to the realization of a rhythmical unity. In 1590 he completed, for the church of Dona Maria de Aragon at Madrid, an altarpiece with subjects from the life of Christ. Three pictures in the Prado representing "The Crucifixion," "The Resurrection" and "The Baptism," came from this church. An "Annunciation" at Villanueve y Cetru, formerly in the Prado, probably also belonged to this group Here colour and form are used as a means of emphasizing dramatic expression, with a result that, to many, is exaggeration and distortion The figures are elongated, the limbs twisted, and strange streaks of light flash across. The artist does not represent nature as it is, but uses it for his own ends. Here is restless religious strife, tumult, agony and mystic absorption. His contemporaries thought he had gone mad; others explained that he was suffering from astigmatism.

In 1597 followed the works for the chapel of San José at Toledo, of which "The Coronation of the Virgin" and "The St. Joseph" are still in their original place over the high altar, and "The St. Martin" and "The Virgin with Saints" are in the Widener collection at Philadelphia. Fewer figures are introduced, the colouring is silvery, the style severer and simplified. The same sober tendency is displayed in the paintings for the hospital of the Caridad at Illeseas, where "The San Idelfonso" combines poetry with realism in the interpretation of a Spanish legend. Other works of this period are: "The Dream of Philip II" and the "St. Francis," "St. Peter" and "St. Eugene" in the Escorial, and the splendid portrait of the Inquisitor, Neno Guevara (Havemeyer collection, New York), which seems to anticipate Velazquez's "Innocent X."

The most representative work of the closing stage, characterized by an intensification of his imaginative qualities, is "The Assumption," in the church of San Vicente at Toledo, completed in 1613, a few months before his death. It is a powerful and original composition showing the Virgin rising through the air among clouds of angels. Other important works of the late period are "The St. Bernard" (1603) and "The Plan of Toledo," in the Greco museum at Toledo; "The Pentecost," in the Prado; "The Laocoön" in Munich, and his last work, "The Baptism" at the Hospital of Tavera. El Greco anticipates imaginative landscape painting of later periods in the romantic representation of "Toledo in a Storm" (Havemeyer collection) where the old city, with its Alcázar and its cathedral is seen towering over the ravine of the Tajo against a thundery sky. Another late work is the fine portrait of Fray Hortensio Felix Paravicino at Boston. The Prado possesses a number of portraits painted at various times. Though few of his sitters are known to us by name, they are evidently all eminent men, of proud and distinguished race, types unchanged in Toledo to-day. These austere heads, with pointed beards resting on white ruffs, emerge from a sombre background and are modelled in cool tones. The eyes are full of inward life and reserve, the hands white and sensitive. As a painter of women, El Greco produced two masterpieces; "The Lady with the Flower," in the collection of Sir J. Stirling Maxwell, and "The Lady with the Mantilla" in the Johnson collection, Philadelphia. The portrait of an old man in the Metropolitan Museum, New York, passes as a self-portrait of the artist. Palomino states that Velazquez greatly admired El Greco's portraits, and there can be no doubt that he learned much from his predecessor.

El Greco had but few pupils, among them Maino and Tristan; they were unable to live up to his standard. Giuseppe Martinez explains: "None cared to follow his capricious and extravagant style, which was only suitable to himself." His son, Jorge Manuel, painter, sculptor and architect, born in 1578, worked with him, carrying out the paintings, which he left unfinished. The mother's name is given as Dona Jeronima de las Cuevas, but it is not stated that she was El Greco's wife. El Greco died at an advanced age, and was interred like a noble in the church of Santo Domingo el Antiguo on April 7, 1614, all Toledo mourning his death. When dangerously ill, he made his son universal heir, and gave him power to make his will. He left 115 finished paintings, 15 sketches, 4 grisailles and 150 drawings. Many of the pictures were replicas; the drawings no longer exist. There is but one authentic drawing by him, in the Biblioteca Nacional (Madrid). From his will we may draw inferences about his mode of life. He occupied 24 rooms of a palace of the Marques de Villena, once situated in the Paseo del Transito, on the edge of the cliff overlooking the Jajo, near the present Greco museum. He owned a good library of Greek books, including Homer, Aristotle, Plutarch; also editions of Tasso, Petrarch and Ariosto, and numerous volumes on architecture. Pacheco, who visited the painter in 1611, says that he was a great philosopher given to witty sayings, a sculptor and architect as well as a painter. He speaks of a cupboard, in which were models in clay which he made use of in his pictures, and says he saw the originals of all that he had painted in his life, painted in oils on smaller canvases (*Arte de La Pintura*). The great orator, F. Ortensio, Paravicino, and the celebrated poet, Luis de Gongona, wrote sonnets in his memory. A quotation from the writings of St. Theresa, the mystic of Spain, who was his contemporary, will help to explain the trend of El Greco's art. "I see a white and a red of a quality as one finds nowhere in nature, for they shine more brightly than the colours we perceive; and I see pictures, as no painter has yet painted, whose models one finds nowhere in nature; and yet they are nature itself, and life itself, and the most perfect beauty imaginable." Forgotten for centuries, Greco's art has only recently come into its own. It makes a strong appeal to the younger artists of the day. Manet was already a great admirer, the followers of Cézanne lay special claims on him as a forerunner, and Expressionists search for the principles, determined emphasis and distortion of form in his works.

See M. B. Cossio, *El Greco* (1908); *Lo que se sabe de la vida del Greco* (1914); *El entierro de conde de Orgaz* (1914); *Borja de San Roman, El Greco en Toledo* (1910); A. L. Mayer, *El Greco* (Munich, 1911); *Domenico Theotocopuli, El Greco,* Kritische Verzeichnis des Gesamtwerkes (Munich, 1926); J. F. Willumsen, *Le Jeunesse du Peintre El Greco* (1927); M. Barrè's, *Le Greco* (1911); H. Kehner, *El Greco* (Munich, 1020); A. F. Calvert and C. G. Hartley, *El Greco* (1909); E. du Cue Trapier, *El Greco* (Hispanic Society, New York, 1925). (I. A. R.)



PAINTINGS OF DOMENICO THEOTOCOPULI (EL GRECO) 1542–1614

1. "Christ Driving the Money Changers from the Temple," one of El Greco's early paintings now owned by the Minneapolis Institute of Art
2. Another painting of "Christ and the Money Changers," showing interesting contrast in style; now in the possession of Aaron Naumburg
3. "St. Peter," painted near the end of the 16th century, owned by Phillips Memorial Gallery, Washington
4. "Saint Ildefonso" combines poetry with realism, painted for the hospital of the Caridad of Illescas. A sober tendency is displayed in this painting now belonging to Andrew W. Mellon
5. "St. Dominic," one of the well known paintings of El Greco, now owned by John Nicholas Brown

THERA, the southernmost island of the Sporades, now called Santorin (*q.v.*), but known as Thera until after the Fourth Crusade, when it became part of the duchy of the Archipelago.

THERALITE, in petrology, a group of plutonic rocks built up of basic plagioclase (labradorite), nepheline, and a titaniferous augite. The name is derived from θηρᾶν, to pursue, as its discovery was looked forward to as completing the series of basic rocks containing nepheline as an essential constituent.

Olivine, an alkali-amphibole, biotite and orthoclase may be present as subordinate constituents. With the exception of nepheline and orthoclase, the minerals of theralites are usually in well shaped crystals. Nepheline itself may be largely represented by secondary zeolites. Theralites are of comparatively rare occurrence. They are known from the Bohemian alkali province, as at Duppau, in association with shonkinite, at the Katzenbuckel (South-east Tirol), together with pulaskite and foyaite in the Serra de Monchique (Portugal), at Umptek (on the White sea), and among the Carboniferous intrusions of Ayrshire (Scotland).

Closely related to the theralites are the teschenites (from Teschen, Moravia). In place of nepheline these rocks contain primary analcime, but types containing both nepheline and analcime are known. In central Scotland, around Edinburgh and Glasgow, teschenites are abundant, forming thick sills intrusive into the Carboniferous rocks. Teschenites are sometimes ophitic, and show transitions to olivine-dolerites on the one hand and to picrites on the other. The rock known as lugarite (from Lugar, Ayrshire) is a related type containing small amounts of plagioclase but abundant analcime; nepheline is present in subordinate amount.

Other rocks related to the theralites are the essexites and shonkinites. The former are characterized by dominant plagioclase, subordinate orthoclase, and green augite, hornblende, biotite and olivine. Nepheline also occurs by no means uncommonly. By increase in the proportion of nepheline the essexites pass into theralites. Essexites occur, together with nepheline syenite, in Essex county, Mass., at Mount Royal near Montreal, in southern Norway (Oslo district), at Rongstock, Bohemia, and among the carboniferous teschenites near Edinburgh and in the Campsie hills, Stirlingshire. The shonkinites are melanocratic rocks of much rarer occurrence. Augite and orthoclase are the prime constituents, but plagioclase, barkevikite, olivine, biotite and variable amounts of nepheline are present. At Shonkin Sag, in the Highwood mountains of Montana, shonkinite forms the greater part of a stratified laccolith passing at the border into a peculiar basic rock described as a leucite-basalt porphyry.

Shonkinites are also known from Ontario, British Columbia, and the East Indies (Celebes, Timor). (C. E. T.)

THERAMENES (d. 403 B.C.), Athenian statesman, was the adopted son of Hagnon, a prominent conservative who in 430 impeached Pericles, and after the Sicilian expedition became one of the ten *probuli* (πρόβουλοι, commissioners) appointed to devise economies in the administration. Theramenes formulated a new party-cry, "the constitution of our fathers." It was no doubt largely due to his advocacy that the *probuli,* strengthened by further members, were commissioned to draft new measures on behalf of the public safety and to examine Cleisthenes' "ancestral code." (*See* BOULE and GREECE: *History.*)

Late in 405 Theramenes went as plenipotentiary to Lysander (*q.v.*) to obtain peace terms (*see* PELOPONNESIAN WAR); after long negotiations he proceeded to Sparta and arranged a settlement which the Athenians ratified (April 404). In spite of this peace the disorder in Athens did not abate. At the instance of Critias, Theramenes was arraigned for treason and, although he successfully repelled the denunciation, he was led away by violence and forced to take poison.

See Plutarch, *Cicero,* chap. 59; Cicero, *de Oratore,* iii. 16, 59; Wilamowitz-Möllendorff, *Aristoteles und Athen* (Berlin and Leipzig, 1893), ii. p. 113 *sqq.;* E. Meyer, *Forschungen zur alten Geschichte* (Halle, 1899), ii. pp. 406 *sqq.;* B. Perrin in *American Historical Review,* ix. (1904), pp. 649–69.

THERAPEUTAE, an ancient sect of ascetics believed to have lived in the vicinity of Alexandria and near Lake Mareotis. They are mentioned in Philo's *De Vita Contemplativa,* and are characterized as being unusually severe in their discipline and mode of life. Abjuring money rather than matter, the Therapeutae lived a secluded life, each member keeping to his own dwelling rather than mingling together in common fellowship.

Chief among the institutions of this sect was a festival held every seven weeks and at the culmination of which, bands of women and men danced and sang throughout the night. On every Sabbath they gathered for worship jointly. Their entire lives were devoted strictly to meditation and prayer. They despised all forms of avarice.

As the result of Philo being the only authority regarding the life and existence of the Therapeutae, there are a number of controversial questions concerning the sect. Some authorities regard the Therapeutae as a Christian order due to the similarity between their asceticism and that of Christian monasticism, but the consensus of opinion among modern scholars is that they were a radical offshoot of pre-Christian Judaism. The supposition that the Therapeutae were a branch of the Essenes is contested by Harnack. While these two ascetic sects resembled each other in many instances and especially in discipline, the Therapeutae regulations were more severe.

To the modern reader the importance of the Therapeutae, as of the Essenes, lies in the evidence they afford of the existence of the monastic system long before the Christian era. We have no clue to the origin of the Therapeutae, but it is plain that they were already ancient when Philo described them. Eusebius was so much struck by the likeness of the Therapeutae to the Christian monks of his own day as to claim that they were Christians converted by the preaching of St. Mark. He goes so far as to say that "the writings of ancient men, who were the founders of the sect" referred to by Philo, may very well have been the Gospels and Epistles (which were not yet written). Eusebius having gone wrong on this point, others of the Fathers followed suit, so that Philo is reckoned by Jerome among the ecclesiastical writers of the Christians.

THERAPEUTICS, the name given to that branch of medicine which deals with the means employed to prevent or cure disease if possible, or to control and lessen its evil results when a cure is impossible.

Treatment may be symptomatic or radical, empirical or rational. Obviously the ideal is a radical treatment based on reasoned knowledge of the disease and of the means employed to combat it. Such a form of therapeutics is represented by the antitoxin treatment of diphtheria But in the case of many diseases and drugs knowledge is still so imperfect that symptomatic and empirical treatment is all that can be employed at the present time. Of this form of therapeutics the use of colchicum in gout is an example. In the case of drugs the purpose to which each is usually put is contained in the article under that special heading (*e.g.,* DIGITALIS, OPIUM, QUININE, etc.); here other and more recent therapeutic methods are considered.

Prevention.—Prevention, the ideal aim of medicine, has greatly advanced in its practical application. In Great Britain this has been fostered by the establishment of a Ministry of Health in 1919 which has greatly expanded the scope of work carried on by the Local Government Board, and also by the activities of the Medical Research Council founded in 1913 as part of the National Insurance Scheme. Preventive medicine includes, in addition to improvement of environmental conditions, prophylactic treatment in the very early stages of disease, such as can be provided in antenatal, school, dental and venereal clinics and so comes within the heading of therapeutics.

A notable example of prophylactic treatment is the prevention of goitre (*see* GOITRE); this is an endemic or local disease, probably depending, as Lieut.-Colonel R. McCarrison in India showed, on contamination of the water supply with micro-organisms; it is extremely prevalent in Switzerland and in North America both in men and lower animals in the neighbourhood of the Great Lakes, and has been found to be associated with a diminished content of iodine, which has a well-marked antiseptic action, in the thyroid gland. By the periodical administration of iodine to children in districts where the condition is prevalent it has been most suc-

cessfully prevented.

Deficiency Diseases.—Another aspect of the same question is presented by the group of "the deficiency diseases" or the avitaminoses, which depend on the absence from the food of the vitamins or "accessory food factors." As constituents of food these vitamins (*q.v.*), of which there are several, are remarkable for the contrast between the extremely minute amounts present and the striking changes resulting from their absence. (*See* BERI-BERI, SCURVY, RICKETS, PELLAGRA.)

Tropical Diseases.—The prevention of tropical disease, originated in Great Britain under Sir Ronald Ross's direction with the destruction of the mosquito, the carrier of the malarial parasite (*see* TROPICAL MEDICINE), has been much expanded by the Rockefeller Foundation, which has instituted many campaigns against diseases, such as malaria, yellow fever and especially a world-wide attack on ankylostomiasis (*see* HOOKWORM; MALARIA; YELLOW FEVER). Yellow fever, which formerly took such a terrible toll of life, has now been almost entirely eradicated from South America by destruction of mosquitoes, the carriers of the infection.

Inoculation.—The World War proved the enormous value of prophylactic or protective inoculations against certain diseases on the same lines as Edward Jenner's vaccination against smallpox (*q v.*). Just before the South African campaign Sir Almroth Wright started the method of protection against typhoid fever (*see* IMMUNITY) by injection with a vaccine composed of killed cultures of the *Bacillus typhosus;* this inoculation sets up changes in the body which render the individual immune for a time, probably about four years, to this form of infection, in the same way as an attack of the disease After the South African campaign cases were observed resembling typhoid fever but due to different though allied bacilli, and two additional forms, paratyphoid A and paratyphoid B, of fever became recognized, the three diseases being collectively described as enteric fever (*q.v*). In order to protect against infection of these three forms of fever, it is necessary to inoculate the individual with the three vaccines, and soon after the outbreak of the World War paratyphoid fever attacked the troops in Flanders and did not spare those inoculated against typhoid fever only; the three vaccines, known collectively as T A B, were then given, and the wonderful freedom of the army from enteric fever, which in past wars has killed as many as bullets, was a triumph for preventive medicine. In like manner men who were wounded and so likely to be infected with *Bacillus tetani* (*see* TETANUS), were at once injected with antitetanic serum and so protected from tetanus or lockjaw

Dysentery (*q v*) is another war disease, and there were many cases among the troops at Gallipoli and elsewhere in the East There is more than one kind of dysentery One of them, amoebic dysentery, is prone to be followed by liver abscess, the amoeba passing to the liver Before the War it was found that emetine, an alkaloid of ipecacuanha which had been long known as an empirical remedy for dysentery, was extremely efficient in curing this form of dysentery and also the hepatitis or inflammation of the liver which precedes the formation of an abscess

Psychotherapy.—As a result of the large numbers of officers and men who suffered from war strain and its effects, often called shell-shock, during and after the War, the psychotherapy of these nervous disorders has greatly developed (*see* PSYCHOTHERAPY).

Endocrine Therapy.—When any of the endocrine glands, the thyroid, adrenals, pituitary, which pour an internal secretion into the blood and keep the body in health, are diseased or fail to do their work properly, signs of disorder or disease result. The secretion may be suppressed or diminished, excessive or altered in character (*see* ENDOCRINOLOGY). When the secretion is diminished an attempt to provide it can be made, and in the case of thyroid, which when inadequate produces myxoedema, or in early life cretinism, brilliant results have long been obtained by this substitution therapy of giving the thyroid gland or an extract of it by the mouth In 1914 E C Kendall of the Mayo Clinic, Rochester, Minnesota, obtained in a pure form the active principle—thyroxin —which is extremely effective. The parathyroid glands, small bodies close to the thyroid gland in the neck, manufacture an internal secretion which passes into the blood and exerts an action apparently opposed to that of the thyroid. Whereas the thyroid is concerned with the control of iodine in the body, the parathyroids deal in a similar manner with calcium salts. Deficiency in the action of the parathyroids appears to lead to a diminished quantity of calcium salts in the body and to an irritable state of the nervous system, and is thought to be responsible in children for the contracture of the hands and feet known as tetany, though on this question there is considerable discussion. Recently the extract of the parathyroid glands has been given in a number of diseases of a chronic infective nature, especially in sprue (*see* SPRUE), a tropical disease characterized by diarrhoea, want of digestion of food so that the patient wastes as if from starvation.

Organotherapy.—An outstanding advance in organotherapy is the insulin treatment of diabetes mellitus (*see* DIABETES). In this disease the patient, who is unable to utilize sugar and starches, passes sugar in the urine, wastes and may eventually die in coma. The pancreas, or sweetbread, is a gland concerned with the digestion of food, including starches, in the alimentary canal, and at the same time that it provides this external secretion pours an internal secretion into the blood which enables the body to make use of sugar. This internal secretion is manufactured by structures in the pancreas known as the islands of Langerhans, and the extract from them is called insulin. After many trials the technical difficulties in obtaining a satisfactory insulin (*see* INSULIN) were surmounted in 1922 by F. C Banting and C. H. Best of Toronto, and a remedy was thus made available, which though it does not cure diabetes, any more than the thyroid extract cures myxoedema, yet for some hours makes the previous diabetic practically a normal person as regards the utilization of starch and sugar. The hypodermic administration of insulin must be repeated at least once daily, but this treatment keeps the disease in abeyance and has thus prolonged and saved innumerable lives. In diabetes insipidus, a comparatively rare disease, in which large quantities of urine free from sugar are passed, relief for some hours is similarly obtained by hypodermic injection of extract of the posterior lobe of the pituitary gland The success of thyroid and insulin treatment has stimulated research and trial in the case of other glands and numerous commercial preparations have been placed on the market; but the claims sometimes made for various forms of organotherapy have yet to be confirmed The most recent is the treatment of pernicious anaemia by feeding with liver This method was introduced by Minot of the Rockefeller Institute and the success he claims for it has been confirmed in England

Chemiotherapy.—Chemiotherapy, or the use of a drug which has a selective affinity for a germ and leads to its destruction without damaging the tissues of the body, was the conception of Paul Ehrlich of Frankfort-on-Main who in 1910 discovered the specific remedy "606" or salvarsan which rapidly leads to the destruction of the *Spirochaeta pallida* (*see* VENEREAL DISEASES), the protozoan responsible for syphilis It now appears that the action is not independent of the activities of the patients' bodies and that the germ is not poisoned and killed off solely by the drug, which indeed may damage the tissues of the patient very severely and even cause death, so that the ideal of chemiotherapy has not been realised. Remedies of this class are, like quinine in malaria, specific, lead to a complete cure, and are therefore of the greatest importance in opening a new vista in medicine. Since its introduction salvarsan and its modification neo-salvarsan "914" and allied organic preparations of arsenic have been increasingly used in the numerous results of syphilis with great success; but this treatment has its limitations, for when the parasite of syphilis gets inside the central nervous system and causes locomotor ataxia and general paralysis of the insane the drug cannot follow the spirochaete and the disease is little if at all influenced Recently it has been found that inoculation with the malarial organism and an attack of the disease benefits patients with general paralysis, but how far this is a permanent cure remains to be proved (*see* MALARIA). Trypanosomes, animal (or protozoan) parasites closely akin to spirochaetes are responsible for diseases, such as trypanosomiasis and African sleeping sickness (to be distinguished from quite a different disease epidemic encephalitis [*see* ENCEPHALITIS LETHARGICA] popularly called sleepy sickness) which are also curable by

the organic arsenical compounds atoxyl and arsacetin. Tartar-emetic, a salt of antimony, acts like arsenic on trypanosomes and in addition effects a cure in bilharziasis (*see* BILHARZIASIS) (a disease due to flukes), filarial disease and kala-azar, three tropical infections (*see* KALA-AZAR; PHARMACOLOGY).

Serum Therapy.—Just as in enteric fever, so in cerebro-spinal ("spotted") fever and pneumonia (*see* CEREBRO-SPINAL FEVER) bacteriology has shown the existence of several strains or types of the causal micro-organism; these though morphologically indistinguishable are so biologically different that each is most efficiently treated by an antitoxic serum, obtained from an animal injected with, and so immunised to, that particular type. Before the recognition of these types antitoxic serums were employed, but they might or might not correspond to the exact strain of the micro-organism present in an individual case In 1913 Douchez and Gillespie, working at the Rockefeller Institute, New York, isolated four types of pneumococci, the micro-organism causing acute pneumonia; but it is only the antitoxic serum corresponding to pneumococcus type I that is curative.

During the World War, especially in 1915, epidemic cerebro-spinal meningitis or cerebro-spinal ("spotted") fever became prevalent among the fighting forces, especially in young recruits It is due to the *Meningococcus intracellularis* (*see* SPINAL MENINGITIS; SERUM THERAPY), and in order effectively to neutralise its effects Simon Flexner of the Rockefeller Institute prepared an antitoxic serum from animals immunised from 40 different strains (multivalent). This serum is injected by lumbar puncture into the (subdural) space around the spinal cord, so that it can come into direct contact with the meningococci which chiefly select the central nervous system The prevalence of the disease stimulated research and strains of meningococci were isolated; Mervyn Gordon, working for the Medical Research Committee (now Council), isolated four types of meningococci and prepared four corresponding mono-type sera; when a case was bacteriologically proved to be due to infection with one of these strains, the corresponding serum was given, while waiting for the bacteriological decision as to the responsible type, a mixture of type I. and type II serum was given, as 80 to 85% of the cases were due to these strains

Tuberculosis.—The search for a specific remedy for tuberculosis, such as a new form of tuberculin, an antitoxic serum or a metallic preparation analogous to salvarsan or tartrate of antimony in protozoan diseases, has continued, but no finality has been reached (*see* TUBERCULOSIS). Spahlinger's treatment by vaccines and serums has received intermittent attention, mainly in the lay press, Dreyer in 1923, by removing the fatty material from tubercle bacilli, obtained a vaccine, called diaphyte, which has been tried on human beings, and from experiments on animals was at first thought to have an increased effect, as compared with other vaccines; later reports have not been favourable, but both experimentally and clinically it may still be premature to decide about its ultimate value Recently sanocrysine (a gold compound) has been introduced by Möllgaard of Copenhagen and is still on trial; it is a powerful remedy which kills the tubercle bacilli and, by liberating their poisons, may produce severe constitutional reactions; Knud Faber, from his clinical experience, points out that to avoid these dangerous results, the doses should be small.

In pulmonary tuberculosis a great factor in obtaining arrest and cure of the disease is rest, and in order to immobilize the lung the production of artificial pneumothorax (*q v.*) is now widely practised. Air is introduced into the pleural cavity on the side of the affected lung which then collapses and comes to rest, all the work of respiration being carried on by the other lung. This procedure has given very good results in selected cases. Treatment in sanatoria is of great value in arresting the progress of pulmonary disease and in teaching the patient the laws of health that he must follow, but it is now becoming recognized that there is urgent need for a more prolonged protection from the strain of ordinary life in the environment of cities, and that tuberculous colonies in the country are required for this purpose, such as Papworth near Cambridge and Preston Hall near Maidstone.

The treatment of leprosy (*see* LEPROSY) by intravenous and intramuscular injections of soluble products of chaulmoogra, hydnocarpus, soya bean and cod-liver oils, as advocated by Sir Leonard Rogers, has been shown by reports from leper asylums in various parts of the world to have had beneficial effects and to have reduced the death-rate in a remarkable manner. Although there are very few lepers in Great Britain, there are 300,000 in the British Empire, and at a conservative estimate 1,700,000 in the world, so that any efficient remedy is obviously important.

Protein Therapy.—By a turn of the wheel the strictly scientific employment of vaccines composed of the micro-organisms thought to be responsible for the morbid conditions has led by an empirical process to non-specific protein therapy. It was found, sometimes accidentally, not only that the administration of a vaccine specific for one form of infection benefits a morbid condition due to another infection, but that intravenous injection of foreign protein, such as peptone and milk may when they set up a reaction, namely fever, shivering and illness ("protein shock therapy"), produce a beneficial effect, just as one disease sometimes cures another. This protein shock therapy has been employed particularly in asthma and in chronic rheumatoid arthritis.

After an attack of many infective diseases there develops an immunity so that a second attack is rare; the reverse of immunity is an exaggerated susceptibility or hypersensitiveness (*see* ANAPHYLAXIS); this is what is meant by idiosyncrasies and the proverb "What is one man's meat is another man's poison." This is seen in various diseases, such as recurrent colds and asthma. A method of cure is to desensitize the subject of one of these toxic idiopathies by the administration, usually by hypodermic injection, of the substance, a bacterial or other protein, to which the individual is hypersensitive Thus a patient subject to hay fever is injected with the pollen of the plant which excites an attack; or a patient with bronchitis and asthmatic seizures is injected with an emulsion of dead bacilli (vaccine) obtained from the expectoration

In many cases of disease and ill-health the cause is a "septic focus" or a local collection of micro-organisms, for example, in the teeth (*see* DENTISTRY), tonsils, appendix, gall bladder and intestines, which poison the body and may produce chronic painful conditions, such as chronic arthritis, sciatica, lumbago, fibrositis The removal of such foci is therefore the important and indeed the first step in treatment; after that vaccines made from the predominant micro-organism present in the focus, and spa treatment may complete the cure.

Anaemia.—The form of anaemia (*q v.*) called pernicious or Addisonian after its describer Thomas Addison of Guy's Hospital (*see* ANAEMIA) is apparently the result of chronic infection of the stomach and alimentary canal, which in its turn may be due to a septic focus, but the observations of Arthur F Hurst, also of Guy's Hospital, indicate that an important factor is absence of the hydrochloric acid in the gastric juice. It has, therefore, been treated by supplying the absent hydrochloric acid by its medicinal administration by the mouth, with a success which is due to investigation of the chemistry of the stomach. The manner in which liver feeding acts in pernicious anaemia (*vide supra*) is unknown

In pernicious anaemia, as in anaemia due to haemorrhage, transfusion of blood (*see* BLOOD TRANSFUSION) has been carried out, after the blood of the donor has been compared with that of the patient to see that they are compatible and after measures have been taken to avoid transmitting diseases, such as influenza, malaria and syphilis from the donor. Transfusion of blood is a very old method of treatment and was performed as long ago as 1667, but it is only recently that the tests for the compatibility of the blood based on the existence of four blood groups in man have rendered the procedure less dangerous Transfusion of blood with these precautions was employed on a large scale in the War for haemorrhages and severe shock, as from gunshot and shell wounds, and has also been used in conditions popularly called blood poisoning. A recent development of blood transfusion is to immunize by means of vaccines, made from the micro-organism infecting the patient, the blood of the donor, and then to transfuse his blood into the patient.

Radiotherapy.—X-rays, though mainly employed for diagnosis, have from their power of destroying the tissue cells, many

therapeutic uses. Thus enlarged glands and the spleen in various diseases of the blood, and especially in lymphadenoma, are much reduced by X-ray exposure. The recent Erlangen treatment of internal cancer by intensive X-rays has the grave disadvantage of making some patients extremely ill (*see* RADIOTHERAPY) Radium bromide, the rays of which are much the same, has been much used in the treatment of inoperable carcinoma and in quite superficial growths of the skin, especially rodent ulcer on the face, which, though classed as malignant, is much less virulent. In cancer of the neck of the womb radium has proved of unquestionable value; from a combination of operation and radium good results have been obtained in cancer of the breast; in malignant growths of the tongue, mouth and throat its successful use is probably dependent upon technique

The important advance in the diagnosis of disorders of the heart and the mechanism of its beat have been followed by a more accurate knowledge of how to give digitalis and by the employment of quinidine in the disorders known as auricular fibrillation and paroxysmal tachycardia. Numerous researches have been undertaken with the view of devising reliable tests for the functional activity of the liver, and it is clear that sugar is the food which most readily protects and repairs the damaged liver cells

Heliotherapy.—Recent years have shown an increasing tendency to utilize to the full the *vis medicatrix naturae* in open air treatment, improved ventilation, heliotherapy which has indeed been imitated by the use of ultra-violet rays (*see* HELIOTHERAPY), baths and waters, and exercises. The prophylactic measures based on experience and empirical use have been elaborated by the teaching of scientific research and as a result physiotherapy or physical therapeutics, which includes massage and the various forms of electrical treatment, has considerably advanced in knowledge and application Medical hydrology has been studied and taught on these rather than on purely empirical lines, and it may be noted that spas did excellent work during and after the War for invalided soldiers Hand in hand with open air treatment and heliotherapy has come less surgical activity in the way of operating in tuberculous disease of bones and joints (H R)

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THERESA, ST. (1515–1582), or Teresa de Cepeda, Spanish nun, was born at Avila, in Old Castile, on March 28, 1515, and was educated in an Augustinian convent in the town At the age of eighteen she entered the Carmelite convent of the Incarnation In 1554, when she was nearly forty, her conversion took place, and the second part of her life began The death of her father roused her to serious reflection, and one day, as she entered the oratory, she was struck by the image of the wounded Christ, placed there for an approaching festival. She fell in tears at the feet of the figure, and felt every worldly emotion die within her. The shock threw her into a trance, and these trances, accompanied by visions, recurred frequently in the subsequent part of her life The visions grew more and more vivid The cross of her rosary was snatched from her hand one day, and when returned it was made of jewels more brilliant than diamonds, visible, however, to her alone. She had often an acute pain in her side, and fancied that an angel came to her with a lance tipped with fire, which he struck into her heart. Aug 27 is kept sacred in Spain to this mystery.

Foundation of the Descalzos.—Meanwhile, the spread of the Reformation exercised the minds of pious Catholics. Teresa sought the cause of the catastrophe in the relaxation of discipline within the religious orders. She determined to found a house in which all the original rules of the Carmelite order would be observed. In spite of great opposition from the authorities of the order, and in particular from the prioress and sisters of the Incarnation, she persevered with her scheme, and secured papal approval. On Aug. 24, 1562, mass was said in the little chapel of the house prepared for her at Avila and the new order constituted. It was to be an order of Descalzos or Barefoots, in opposition to the relaxed parent body, the Calzados. The sisters were to wear sandals of rope; they were to sleep on straw, to eat no meat, to be strictly confined to the cloister, and to live on alms without regular endowment. Teresa encountered great opposition, but after six months a fresh bull arrived from Pius V., and the provincial of her order now gave her leave to remove and take charge of her sisterhood The number of thirteen, to which on grounds of discipline she had limited the foundation, was soon filled up, and Teresa spent here her five happiest years.

Her visions continued, and, by command of her ecclesiastical superiors, she wrote her autobiography containing an account of these experiences but she based no claim to holiness upon them.

The general of the order visited her at Avila, and gave her powers to found other houses of Descalzos, for men as well as women. The last fifteen years of her life were spent mainly in hard journeys with this end and in the continually growing labour of organization. Convents were founded at Medina, Malaga, Valladolid, Toledo, Segovia and Salamanca, and two at Alva under the patronage of the famous duke. Then she had three years of rest, as prioress of her old convent of the Incarnation She next went to Seville to found a house, thus overstepping for the first time the boundaries of the Castiles, to which her authorization limited her. The latent hostility of the old order was aroused; the general ordered the immediate suppression of the house at Seville, and procured a bull from Gregory XIII prohibiting the further extension of the reformed houses (1575) But the movement against her came from Italy, and was resented by Philip and the Spanish authorities as undue interference; and after a fierce struggle, during which Teresa was two years under arrest at Toledo, the Carmelites were divided into two bodies in 1580, and the Descalzos obtained the right to elect their own provincial-generals (*See* CARMELITES) The few remaining years of Teresa's life were spent in the old way, organizing the order she had founded, and travelling about to open new convents Sixteen convents and 14 monasteries were founded by her efforts; she wrote a history of her foundations, which forms a supplement to her autobiography Her last journey of inspection was cut short at Alva, where she died on Sept 29, 1582

Canonization.—A violet odour and a fragrant oil were said to distil from her tomb; and when it was opened nine months afterwards the flesh was found uncorrupted Her relics were found to work miracles She was buried at Avila, but her remains were eventually restored to Alva Teresa was canonized by Gregory XV. in 1622. The honour was doubtless largely due to her asceticism and mystic visions She called herself Teresa de Jesus, to signify the closeness of her relation to the heavenly Bridegroom, who directed all her actions. Though she deprecated excess of ascetic severity in others, she scourged herself habitually, and wore a peculiarly painful hair-cloth. But her life shows her to have been, besides, a woman of strong practicality and good sense, full of natural shrewdness, and with unusual powers of organization. "You deceived me in saying she was a woman," writes one of her confessors; "she is a bearded man." She was brave in the face of difficulties and dangers, pure in her motives, and her utterances, some of which have been quoted, have the true ethical ring about them. Her mss. were collected by Philip II. and placed in a rich case in the Escorial, the key of which the king carried about with him. Besides her autobiography and the history of her foundations, her works (all written in Spanish) contain a great number of letters and various treatises of mystical religion, the chief of which are *The Way of Perfection* and *The Castle of the Soul*. Both describe the progress of the soul towards perfect union with God.

Her works, edited by two Dominicans, were published in 1587, and have since appeared in various editions. They were translated into Italian, French (4 vols., 1840–46) and Latin, and an English translation of the *Life* and works (except the letters) by A. Woodhead appeared in 1669. Other translations are: J. Dalton, *Life* (1851), *The Way of Perfection* and *Letters* (1902); D. Lewis, *Life* (1870), *Foundations* (1871); A. R. Waller reprinted Woodhead's translation of *The Way of Perfection* (1901); B. Zimmerman, *Minor Works* (1913); *The Way of Perfection* (1916); *The Interior Castle* (3rd ed. 1921). A translation of the *Letters* with introduction by Cardinal Gasquet appeared 1919–24 (4 vols.).

THEREZINA, a city of Brazil, capital of the State of Piauhy, on the right bank of the Parnahyba river, about 220 m. from its mouth. The population for the commune or municipio, (1920) was 57,500. It is prettily situated on an open plain and is laid out regularly with broad straight streets with seven large squares. The town is characteristically Portuguese in appearance, its buildings being one or two stories in height, plastered and frequently coloured outside, with large rooms, thick walls, and tile roofs to ensure coolness. Its manufacturing industries include cotton-mills, sugar refineries, a foundry, and soap-works. A steamboat service, with small boats, maintains regular communication with Parnahyba, near the mouth of the river, besides which there are a number of independent freight-carrying boats. A railway connects Senado Furtado, across the river Parnahyba, with the port of São Luiz on the coast of Maranhão. Therezina was founded in 1852, its site being originally called Chapada de Corisco, and was named after the Empress Thereza Christina.

THERM. A name originally employed in elementary textbooks for any thermal unit, but now generally restricted to the statutory unit of heat adopted for the sale of lighting gas in terms of its calorific value. For this purpose the therm has been defined as being equal to 100,000 British Thermal Units (B.T.U.) the unit of heat most commonly employed for measuring the calorific value of gas or other fuels throughout the British empire and the United States of America (*See* GAS LIGHTING.)

THERMAE, in classic architecture, originally warm baths, but then used of any large bathing establishment. (*See* BATHS.)

THERMIDOR, the name given during the French Revolution to the eleventh month of the year in the Republican calendar. The name Revolution of Thermidor is often given to the events of 9 Thermidor year II (July 27 1794), which resulted in the fall of Robespierre and the collapse of the Terror The name Thermidorian (*Thermidorien*) was given to the authors of this revolution and to the supporters of the reactionary movement of which it was the signal.

THERMIONICS. Thermionics is the branch of science which deals with the influence of heat on matter in generating atomic or sub-atomic electrically charged particles (ions or electrons) and with the electrical properties of the assemblages so produced Effects of this general character have been familiar to physicists for about two hundred years but the subject attracted little attention until about the beginning of the present century when J J. Thomson discovered that the carriers of these discharges at very low gas pressures were electrons and O W Richardson discovered the fundamental law connecting the phenomena with temperature In recent years interest in the subject has extended to a still wider field owing to the great importance of its electrotechnical applications, particularly to the art of electrical communication (*See* art. THERMIONIC VALVE.) In the treatment which follows, attention will be confined mainly to the emission of electrons by solids owing to the practical and theoretical interest of this aspect of the subject.

If a solid body, for example a wire, is heated in a vacuous enclosure it is found in general to emit both positively and negatively electrified particles; as may be ascertained by having a neighbouring insulated electrode in the enclosure and connecting it outside through a battery of suitable polarity and a galvanometer or other detector of electric current If the wire is of a refractory material such as tungsten or platinum and the heating is continued the positive emission, which is caused by electropositive contaminants such as potassium, dies away, so that ultimately in a highly evacuated enclosure the emission consists solely of electrons, that is to say sub-atomic negatively charged particles. In this way it comes about that a heated body admits of the escape of negative electricity from its surface, but not of positive. Thus an evacuated enclosure containing a hot and a cold conductor only allows the passage of electricity in one direction, the negative electricity passing from the hot to the cold body, and so functions as an electrical valve. This emission varies very rapidly with the temperature in a manner which will now be investigated. The electron currents from the surfaces of bodies obtained in this way at high temperatures may be very considerable.

This emission of electrons from hot bodies is a special kind of evaporation It differs from the evaporation of a solid chiefly in the fact that the particles in the gaseous phase are electrically charged. Thus a hot body in an evacuated enclosure will be surrounded by an electron gas which will be capable of exerting a pressure and in fact will have the same dynamical properties as other gases having the same temperature and molecular concentration. The reason why the electrons do not all prefer to leave the solid for the enclosure is that they have to do a certain amount of work in passing through its surface This electron atmosphere will be capable of being in equilibrium with all the bodies present in the enclosure at any fixed temperature and in this condition each body will emit in a given time as many electrons as it receives.

If we suppose a single hot body to be contained in such an enclosure maintained at the absolute temperature T°K and if the enclosure is provided with a movable piston we can obtain useful work from the pressure p exerted by the electron atmosphere on the piston. If there are n electrons in unit volume, if v is the volume of the enclosure and ϕ is the change of energy when one electron passes from the hot body to the surrounding space, the increment dS in the entropy of the system due to an infinitesimal displacement of the piston is

$$dS = \frac{1}{T}\{d(nv\phi)+pdv\} \qquad (1)$$

The second law of thermo-dynamics requires that dS should be a complete differential in v and T from which we deduce

$$T\frac{\partial p}{\partial T} = p + n\phi \qquad (2)$$

In very small concentrations such as we are now dealing with the pressure of the electron atmosphere must be governed by the gas law

$$p = nkT \qquad (3)$$

where k is Boltzmann's constant By integrating (2) after substituting from (3) we get

$$n = A_0 e \int^T \frac{\phi}{kT^2}\,dT \qquad (4)$$

where A_0 is independent of the temperature. If we neglect small quantities comparable with the specific heat of electricity (Thomson coefficient) it can be shown that

$$\phi = \phi_0 + \tfrac{3}{2}kT \qquad (5)$$

where ϕ_0 is the value of ϕ at O°K Hence

$$n = A_1 T^{3/2}\,\epsilon^{-\phi_0/kT} \qquad (6)$$

The constant A_1 is, subject to some reservations which it would take too long to discuss in this article, a universal constant, the only material constant entering into the formula being ϕ_0 Equation (6) gives the concentration of the electrons in the equilibrium atmosphere. This is not readily accessible to experiment but it is related in a very simple way to the maximum emission current i_0 which is easily measured The relation is

$$i_0 = ne\sqrt{\frac{kT}{2\pi m}} \qquad (7)$$

where e is the charge and m the mass of the electron. By combining (6) and (7)

$$i_0 = AT^2\epsilon^{-\phi_0/kT} \qquad (8)$$

Subject to the reservations referred to above and to the further assumption that different substances reflect electrons to the same extent, the constant A should have the same value for all substances. Its absolute value can be determined by introducing the quantum theory. It is

$$A = \frac{2\pi k^2 me}{h^3}\alpha \qquad (9)$$

where h is Planck's constant and α is the proportion of an incident beam of electron gas reflected at the surface

The most usual device for testing the implications of equation (8) is to use an electrically heated wire placed on the axis of a surrounding cylinder, both these elements being suitably mounted in an evacuated container of glass or quartz. If a steady potential difference is maintained between the hot wire and the cylinder by means of an external battery, the current across the gap can be measured by a galvanometer placed in series with the battery. If the wire is held at a high positive potential no current will flow, but with a small positive potential it is found that a small current flows in a direction contrary to the applied potential difference. The reason for this is that the large potential differences are high enough to stop all the emitted electrons from reaching the opposite electrode The electrons, however, are not emitted with zero velocity in general but some of them have sufficient initial kinetic energy to carry them to the opposite electrode against a small opposing electric field. If the wire is charged negatively, then the number of electrons which are carried across the gap increases as the accelerating field is increased This increase does not go on without limit, but a stage is soon reached when the electron current becomes independent of any further increase in the applied potential differences. The reason for this is that the field is now so strong that it carries to the cold electrode all the electrons which are emitted from the hot wire. This limiting value of the current is known as the saturation current and when reduced to unit area it is the quantity to which the symbol i_0 in equation (8) applies. The chief reason why this current rises to the saturation value gradually and that any accelerating potential, however small, is insufficient to guide the electrons across the gap is the effect of the self repulsion of the electrons This effect is more marked the higher the temperature, that is to say the greater the maximum current to be dealt with.

The validity of an equation of the form

$$i_0 = AT^{\alpha}\epsilon^{-b/T} \qquad (8\ 1)$$

with A, α and b constants and α comparable with unity is well established experimentally In the case of tungsten it has been shown to be valid over a range of variation by 10^{12} in the current i_0 and a corresponding range in the temperature An earlier theoretical formula put $\alpha = \frac{1}{2}$ and from an empirical point of view there is little to choose between $\alpha = \frac{1}{2}$ and $\alpha = 2$ on account of the insensitivity of the factor T^{α} compared with the exponential term, but the formula with $\alpha = 2$ is definitely required by theoretical considerations This brings us back to equation (8), viz : $i_0 = AT^2\epsilon^{-\phi_0/kT}$, in which form A/α should have the absolute value expressed by (9). There is no doubt that for a considerable number of metals A is comparable with

$$\frac{2\pi k^2 me}{h^2}\ (=60\ 2\ \text{amps cm}^{-1})$$

Whether such deviations as appear are due to the neglect of electron reflection ($\alpha \neq 1$) or to other refinements which have been disregarded is at present under experimental investigation There is, however, no reason to doubt that the major part of A is given by equation (9).

The remaining constant ϕ_0 in equation (8), which is the only constant in the equation involving the specific properties of the material concerned, is directly related to other important physical properties of the substance If we consider an enclosure containing two different substances in contact and imagine an electron taken along a closed path passing through the area of contact and also outside both substances the law of conservation of energy requires that

$$\phi_1 - \phi_2 = eV - eP \qquad (10)$$

where ϕ_1 and ϕ_2 are the values of ϕ (the quantity in equations (4) and (5) above) for each substance, V is the contact potential difference between them, P is the Peltier electromotive force at the junction and e the electronic charge. In general P is small compared with V in (10), so that if we neglect the thermoelectric terms as small compared with the others it follows from (5) that the contact potential difference (Volta effect) between two substances is equal to the difference in the values of ϕ_0 appropriate to them. Another relation satisfied by the contact potential V is

$$V = \frac{kT}{e}\log\frac{i_2}{i_1} \qquad (11)$$

i_2 and i_1 being the saturation current densities from the two substances at temperature T The quantity ϕ_0 is also equal to $h\nu_0$ where ν_0 is least frequency of light which is able to eject electrons from the material under consideration. For all metals ϕ_0 is of the order of magnitude 4 in equivalent volts the values ranging from about 2 for the most electropositive to about 6 for the most electronegative metals

When a current of electrons is drawn away from the surface of a hot body, each electron has to do an amount of work ϕ in escaping This involves a cooling effect of equivalent amount at the surface of the wire There is also an equal heating effect at the surface when a stream of electrons flows into a body. These effects are precisely analogous to the cooling and heating effects caused by the more familiar evaporation and condensation of vapours Their magnitudes have been measured and are in agreement with the values of ϕ got from the variation of the emission with temperature

It has been mentioned that with small retarding fields there is an electron current from hot bodies, so that the current flows in a direction opposite to that of the applied electromotive force. This is due to the fact that the electrons are emitted with definite initial velocities. By measuring the currents which will flow against various retarding potentials the number which have a velocity exceeding any assigned value can be ascertained In this way it has been found that the emitted electrons have the same distribution of velocity as would have the molecules of a gas of the same molecular weight at the same temperature in accordance with Maxwell's Law To be precise, out of any number N emitted, the number with velocity components between u and $u+du$ perpendicular to the surface is

$$N u du = N\frac{m}{kT}\epsilon^{-(mu^2/kT)}du \qquad (12)$$

and the number with velocity components between v and $v+dv$ parallel to the surface is

$$N v dv = N\left(\frac{m}{2\pi kT}\right)^{\frac{1}{2}}\epsilon^{-(mv^2/kT)}dv \qquad (13)$$

For practical purposes a thermionic source of electrons should be very refractory and preferably have a low value of ϕ. The refractoriness is required to ensure durability and to withstand the somewhat drastic preliminary heating treatment which is required to establish the necessary degree of vacuum. The best material on the score of refractoriness is tungsten, but it has a rather high ϕ (about 4 5 volts) This can be reduced by mixing a small quantity of thoria with the tungsten during manufacture which by an appropriate technical treatment produces a layer of thorium over the tungsten surface. Similar effects are got by coating suitable metals with mixtures of the oxides of the alkaline earths or with the products of the decomposition of barium azide. In these cases also it is believed that the effects are due to a layer of the alkaline earth metal which develops on the surface of the supporting metal. It has also been found that tungsten, and especially oxidized tungsten, can be coated with layers of alkali metals such as potassium and caesium which are stable below a certain limiting temperature. These bodies admit of quantitative study and it is found that the effective work function ϕ has a minimum value when the layer of alkali metal is approximately one atom thick. There is perhaps still some uncertainty as to the values of the work function for the pure alkali metals, but it is probable that they are higher than this minimum value. This conclusion is supported by the existence of an exactly parallel displacement of the photo-electric threshold with the composition of the surfaces in which the minimum value is less than that for the pure alkali metal.

There is evidence in some cases of the emission of electrons from a body in which more than one work function is involved

It is, however, not established that such an effect may occur at a single surface of a crystal of a pure element.

The emission of electrons from metals is in general very sensitive to the action of gaseous contaminants. These effects, which are complicated and only partially understood, are mainly indirect and caused by the modification of the surface arising from the interaction with the gaseous atmosphere. For any given atmosphere there is usually a fairly stable emission condition characterized by fairly definite values of A and b in equation (8·1). These values may, however, differ enormously from the standard values for the pure metal, but they are characterized by the remarkable fact that, no matter by what agencies the changes are caused, the new values always satisfy approximately a relation of the form $b = \text{const} \times \log A + \text{constant} \ldots\ldots (14)$ A similar relation has been observed in connection with the emission of positive ions by hot metals in gases No observable effects on the electronic emission from hot bodies are caused by the inert gases and vapours such as helium, argon or mercury.

It is required by thermodynamics that the total photoelectric emission of electrons from any substance in equilibrium at temperature T arising from the equilibrium (black body) radiation imprisoned within it should satisfy an equation of the same form as equation (8) and with an identical exponential factor This makes it possible to regard the thermionic electron emission from a substance as an integrated photoelectric effect of its temperature radiation It appears, however, that the absolute value of the emission calculated from optical and photoelectric data is less than one millionth part of the thermionic emission observed at convenient temperatures Consequently this idea has not made much progress but it is not certain that it is wrong

When wires of fresh metal are heated it is found that there is a temporary emission of positive ions which usually comes off at a lower temperature than the negative electron emission Direct measurement has shown that these ions are positively charged atoms of the alkali metals This emission generally decays roughly as an exponential function of the time at constant temperature, but the decay may sometimes be preceded by an initial rise Similar effects from involatile salts, such as aluminium phosphate, are due mainly to alkaline contaminants Recently very powerful and steady sources of positive ions have been got by coating metals with an admixture of an alkali salt, and an involatile body such as iron oxide.

If a wire has been heated in a vacuum long enough for the initial positive emission to disappear and gas is admitted at a low pressure there is, in general, an emission of positive ions which is a function of the pressure of the gas It is believed that the ions in this discharge are charged atoms or molecules of the gas but this is an inference from indirect evidence and there are no direct measurements of the specific mass of the carriers. These discharges frequently exhibit slow changes with time in response to changes in the external conditions such as pressure or temperature, and there is other evidence that the formation and decomposition of surface films of adhering gas play an important part in their generation. For example, the emission in a mixture of nitrogen and oxygen such as air, is very much less than the emission in an equal amount of oxygen with the nitrogen absent. Thus the nitrogen exerts a definite inhibition on the oxygen emission. At low temperatures the emission in oxygen varies nearly as the square root of the pressure of the gas, but at high temperatures it is more nearly proportional to the pressure.

Most salts emit positive ions when heated With salts of the alkali metals or the alkaline earth metals the ions are charged atoms of the metallic constituent. These are usually singly charged but may be multiply charged if the metallic element is polyvalent. With salts in which the metallic constituent is not very electropositive the positive emission usually observed is caused by alkaline contaminants. Some salts, such as calcium iodide, emit electrons and heavy negative ions in proportions which vary with the temperature but the two emissions may, at suitable temperatures, be comparable with each other.

In all cases when the remaining conditions can be held constant the emission of positive ions from hot bodies follows the same general temperature law as that for electrons, the saturation current being given by $i = AT^{\alpha}\epsilon^{-b/T}$, A, α and b being constants and α comparable with unity

See O W. Richardson, "The Emission of Electricity from Hot Bodies" (2nd Edn., 1916). (O. W. R.)

THERMIONIC VALVE (Thermionic Tube, Audion or Radiotron) The term *thermionic valve* is applied to any form of electric discharge tube in which one or more of the electrodes is heated so as emit electricity by the process of thermionic emission More commonly the term indicates a highly-exhausted tube in which the electric current consists of negative electrons evaporated from an electrically heated wire filament and collected by a metal sheet electrode, known as the plate or anode, which surrounds the filament The maximum current which can pass through such a tube is equal to the electron current emitted by the filament or cathode. If the current passing through the tube is not as large as this emitted current, as is usually the case when the tube is in operation, the difference is made up by the return of electrons to the filament. The current reaching the anode, called the anode current, may be caused to vary by varying the potential of the anode with respect to the filament, as in a two-electrode valve or diode; or the anode potential may be fixed and the anode current controlled electrically by means of a perforated electrode or grid situated between the filament and anode, as in a three-electrode valve or triode Tubes with more than three electrodes are used, but their behaviour, in general, is very similar to that of a triode

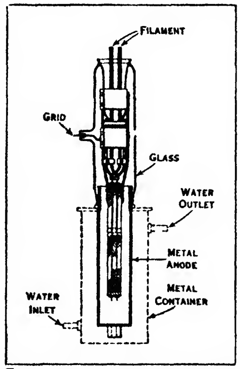

FIG 1—(A) MARCONI WATER-COOLED TRANSMITTER VALVE

Construction.—The filament is usually a wire which may be made of (a) pure tungsten, (b) thoriated tungsten, or (c) chemically-coated metal such as platinum The wire is stretched between two metal supports which act as conductors for supplying the heating current to the filament and also are connected by leads through the glass containing envelope to the external filament terminals The filament, when of pure tungsten, is maintained at a temperature of about 2400° Kelvin (2127° C). As, at this temperature, the wire is white hot, such a filament is called a *bright emitter*. Pure tungsten filaments require a greater rate of supply of heat energy to produce the same thermionic emission than do thoriated tungsten or chemically-coated filaments, and thus are not so useful for valves used in receiving sets High power valves for wireless transmitting stations, however, are operated at high anode voltages and pure tungsten filaments are chiefly used in them because of their greater ruggedness and ability to withstand accidental voltage overloads.

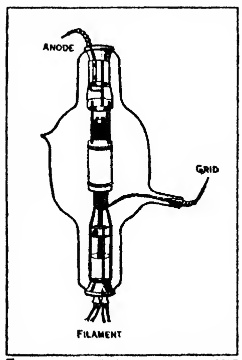

FIG. 1—(B) TRANSMITTING VALVE WITH GLASS ENVELOPE

The admixture of less than 1% of thoria (ThO_2) to a tungsten filament is found to increase very appreciably the electron evaporation at any given temperature. According to I Langmuir the thoria is turned to metallic thorium when the wire is heated and a thorium layer one molecule thick forms on the tungsten surface. It is this layer which reduces the amount of work necessary to transfer an electron across the surface and

which thus increases the electron emission A thoriated tungsten filament is usually run at 2,000° K. and since, at that temperature it is not very bright, it is called a *dull-emitter* At that temperature the electricity it emits is many times that emitted by a tungsten filament run at 2,400° K. with the same energy supply.

A typical example of a filament with a chemical coating is the oxide-coated platinum filament This is also a dull-emitter and is run at a temperature as low as 1,200° K. or even less It is usually a platinum ribbon coated with a mixture of barium and strontium oxides and carbonates The pronounced thermionic emission appears to be due to the presence of a film of metallic barium on the filament surface Another way of obtaining such a barium film is to use a filament with a copper coating on which is put barium azide (Ba_2N_6). When such a filament is heated the nitrogen is driven off leaving the barium which alloys with the copper and thus remains on the surface of the filament.

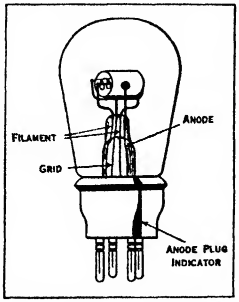

FIG 1 —(C) RECEIVING VALVE

The relation between the electron emission per sq cm. (J) of filament surface and the temperature (T) may be expressed by O W. Richardson's formula

$$J = AT^2 e^{-\frac{b_0}{T}},$$

where A and b_0 are constants for any particular substance. The values of these constants for three of the types of filament mentioned above are given in the table below In the formula J is expressed in amperes per sq cm. and T in degrees Kelvin

Filament	A (amp/cm² deg²)	b_0 (degrees Kelvin)
Tungsten	60·2	52,000
Thoriated tungsten .	3·0	30,500
Oxide-coated platinum .	$1{\cdot}07\times10^{-3}$	12,100

The ratio of the total emission from a filament to the rate of supply of energy to heat is a constant for a given temperature. For the operating temperatures used in present-day valves this ratio is about 0·003 amp per watt for tungsten, 0·050 amp per watt for thoriated tungsten and 0·130 amp per watt for oxide-coated platinum.

The other electrodes of a thermionic valve are made of nickel or molybdenum or other conductors having high melting points The anode is usually cylindrical, surrounding the grid and filament, but may consist of two parallel flat plates situated on opposite sides of the filament. The grid is usually a spiral of wire or a mesh wound on a cylinder with the filament as axis The electrode system is fixed at the centre of the containing glass, silica or metal envelope and is supported by a glass (or silica) "pinch" through which pass the connecting wires between the electrodes and the outside terminals. In a two-electrode valve there are three outside terminals, one for the plate and two for the positive and negative ends of the filament heating battery In the case of the three-electrode valve there are the same three terminals, together with an extra one for the grid.

The majority of valves are those of the high-vacuum type, so that in the process of manufacture various methods are used to rid the electrodes and glass envelope of occluded gas both before and during the process of pumping the air from the envelope. Such methods are also employed even with a tube which is subsequently made "soft" by the admission of helium.

Internal Action of a Thermionic Valve.—The performance of a thermionic valve in an electrical circuit is usually interpreted in terms of its static characteristic curves which represent the relations between the currents flowing to the collecting electrodes and the potentials of these electrodes with respect to the filament. Since the data for such curves are obtained using steady electrode potentials certain discrepancies are often found between the behaviour predicted from these curves and the actual performance of a tube when functioning with rapidly alternating electrode potentials and currents. In such cases the discrepancy can usually be traced to the effects of the electrode capacities or to the small but finite time required for the electrode currents to respond to the electrode voltage changes

(a) *The Two-Electrode Valve.*—in the case of the diode or two-electrode valve the most important characteristic is that showing the relation between the anode potential (v_a) and the anode current (i_a), the filament current being maintained constant at the normal operating value A typical diode characteristic is shown in fig. 2 and may be interpreted in terms of the internal action of the tube When the anode is at a positive potential it attracts the negative electrons and so an anode current flows. On the other hand when the anode is negatively charged it repels the electrons back into the filament as fast as they are emitted and no anode current flows From the characteristic it will be seen that as the positive potential of the anode is increased the anode current also increases until a certain maximum value is reached. A further increase of anode potential brings about no further increase of anode current and the latter is then said to have reached saturation value (i_s). The saturation current is reached when all the electrons emitted by the filament are attracted and caught by the anode The necessity for a fairly large anode potential to produce saturation current is caused by the mutual electrical repulsion between the electrons which are situated at any moment in the space between the filament and the anode This body of electrons is termed the space charge The electrons which are on their way to the anode repel those just starting from the filament, thus neutralizing to a large extent the pull which the positively charged anode exerts on the latter

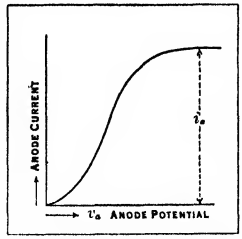

FIG 2 —CHARACTERISTIC CURVE OF TWO-ELECTRODE TUBE

The effect of the electron space charge in opposing the establishment of saturation conditions has been examined quantitatively by C D. Child and by I Langmuir The essential basis of their calculation is the assumption that the disposition and magnitude of the space charge is so adjusted that an electron at the filament surface is repelled by the electrons in front of it with a force equal and opposite to that due to the positive charge on the anode For such conditions the space charge must obviously be equal and opposite to the charge on the anode. In the case of a plane emitting surface with a parallel plane anode such assumptions lead to the Child-Langmuir formula:

$$i_a = \frac{\sqrt{2}}{9\pi}\sqrt{\frac{e}{m}}\,\frac{v_a^{3/2}}{x^2}, \qquad (1)$$

where i_a and v_a are the anode current and anode potential, e and m the charge and mass of an electron and x is the distance between the electrodes. In practical units (amp. per. cm², volts, cm) this becomes

$$i_a = 2{\cdot}33\times10^{-6}\,\frac{v_a^{3/2}}{x^2}. \qquad (2)$$

For the more usual case in which filament and anode are coaxial cylinders the formula corresponding to (1) is

$$i_a = \frac{2\sqrt{2}}{9}\sqrt{\frac{e}{m}}\,\frac{v_a^{3/2}}{r\beta^2} \qquad (3)$$

where v_a, e and m have the same significance as before, i_a is the current per unit length of cylinder, r is the radius of the anode cylinder and β is a complicated function of the ratio $\frac{r}{r_0}$ (*i.e.*, $\frac{\text{anode radius}}{\text{filament radius}}$). In practical units (am. per cm., volts, cm.) this

becomes

$$i_a = 1{\cdot}46 \times 10^{-6} \frac{v_a^{\frac{3}{2}}}{r\beta^2} \qquad (4)$$

Tables of values of β^2 for different values of $\frac{r}{r_0}$ have been given by I. Langmuir and K. B. Blodgett from which it is found that when $\frac{r}{r_0}$ is greater than 10, a condition usually met in practice, the value of β is little different from unity.

Although the Child-Langmuir formulae are sufficiently accurate for most practical purposes, the assumption of an unlimited supply of electrons from the filament makes the formulae satisfactory only for cases in which the anode current is appreciably below saturation value. Moreover the electrons, on emerging from the filament are all assumed to possess uniform velocities, either zero or finite, whereas it is known that such electrons possess velocities with a Maxwellian distribution. The effects of both finite filament emission and of the Maxwellian distribution of electron velocities have been taken into account in more elaborate treatments of the problem by P. S Epstein and T C. Fry

Two examples of the use of the two-electrode valve are its applications as a detector of wireless signals and as a rectifier of alternating current for power purposes. Both of these applications depend on the fact that when an alternating voltage is applied between anode and filament a current flows through the valve only during the half cycle when the anode is positive. The practical use of the two-electrode valve as a detector of wireless signals was first made by J A. Fleming in 1904[1], though the fact that a tube containing rarefied gas with one hot and one cold electrode showed unilateral conductivity had been previously demonstrated by Elster and Geitel in 1889 A simple wireless circuit with diode rectifier is represented in fig 3 As a result of the high frequency oscillatory potentials produced between the points A and B by the action of wireless waves on the aerial, unidirectional currents pass through and actuate the telephone or galvanometer.

For the rectification of alternating current from a power circuit, the arrangement shown in fig 4 is commonly employed

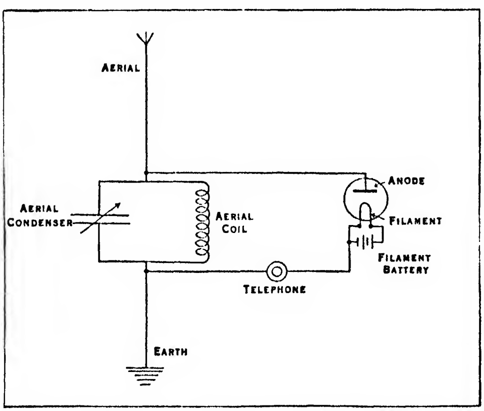

FIG 3 —SHOWING USE OF FLEMING VALVE AS WIRELESS DETECTOR

With such an arrangement the alternating supply is first transformed to a convenient voltage and then applied to two diodes, the filaments of which are connected together With this arrangement both halves of the alternating voltage cycle are used, the diodes passing current alternately. This circuit is used in many high-tension eliminators for use with broadcast receivers.

(b) *The Three-Electrode Valve.*—The introduction of a third electrode between the filament and anode was first made by Lee de Forest[2] in 1907. De Forest had previously, like Fleming, used a two-electrode tube for detecting wireless signals and had named such an instrument an audion The same name was, however, retained for the three-electrode tube of de Forest in which a zigzag wire or grid was introduced between the filament and anode. Recently the name audion has been applied to a three-electrode tube.

Because of its closer proximity to the filament, the grid of a triode permits of a more effective control of tube current than

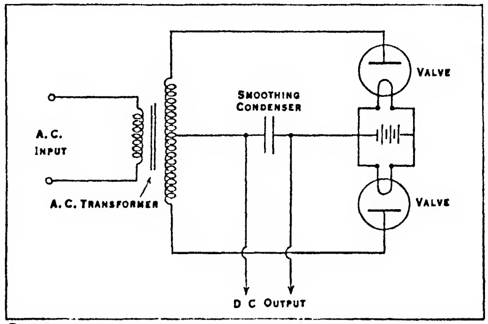

FIG. 4 —ILLUSTRATING USE OF VALVE AS RECTIFIER OF ALTERNATING CURRENT

does the anode This control is effected by way of space-charge neutralization and this is determined quantitatively in terms of the positive charges on the grid and anode For example, if the grid and anode are maintained at the same positive potential with respect to the filament the charge on the grid is greater than that on the anode Actually it is m times as large where m is the amplification factor of the tube For normal operating conditions the grid and anode potentials are not the same, but the effect is similar, for if we increase the grid potential by say one volt the increased charge it acquires is m times as large as that acquired by the anode when its potential is similarly increased.

The electron current leaving the filament which, when the emission is adequate, is controlled by the electric field produced there by the grid and anode charges, passes out towards the grid and anode. In doing so the electrons acquire high speeds and shoot through the holes in the grid and are collected by the anode. Practically only the electrons which leave the filament opposite a grid wire are caught by the grid when positively charged When the grid is at a negative potential it does not collect electrons at all. It is because the grid is efficient in attracting electrons, but inefficient in catching them that the current variations produced by changes of grid potential are registered mainly in the anode current and not in the grid current If a triode were not evacuated but were filled with a gas at atmospheric pressure the electrons, moving comparatively slowly, would follow the lines of electric force and the thermionic current would be divided between the grid and anode in the ratio of their respective electric charges. For the case mentioned above in which grid and anode potentials were identical, the grid current would be m times the anode current.

If the filament, grid and anode are represented as conductors 1, 2, 3 respectively the charge on the filament Q_f may be written

$$Q_f = C_{12}v_g + C_{13}v_a, \qquad (5)$$

where the C's represent capacity coefficients and v_g and v_a the grid and anode potentials with respect to the filament which is assumed to be at zero potential Since the electric field E_f at the filament is directly proportional to Q_f we have

$$\frac{\partial E_f}{\partial v_g} \Big/ \frac{\partial E_f}{\partial v_a} = \frac{C_{12}}{C_{13}} = m \text{ (the amplification factor).} \qquad (6)$$

The value of m depends only on the geometrical configuration of the electrodes and, for a case in which the filament, grid and anode are parallel planes and the grid consists of equidistant

[1]British Patent No. 24850, Nov. 16, 1904, U S.A. Patent No. 803684, April 19, 1905.

[2]U.S.A. Patent No. 841387, Jan. 15, 1907

parallel wires of radius c it may be shown that

$$m = \frac{2\pi h}{d}\,\frac{1}{\log\dfrac{1}{2\sin\left(\dfrac{\pi c}{d}\right)}} \qquad (7)$$

where d is the distance between adjacent grid wires and h is the distance between the grid and the anode

For a cylindrical tube with a spiral wire grid wound on a cylinder of radius r_g it has been shown that

$$m = \frac{2\pi n r_g \log(r_a/r_g)}{\log(1/2\pi n c)} \qquad (8)$$

where n is the number of grid turns per cm length, r_a is the radius of the anode cylinder and c again is the radius of the grid wire

From (5) and (6) we may write

$$Q_f = C_{12}\left(v_g + \frac{v_a}{m}\right) \qquad (9)$$

so that, so far as the effect on the space charge is concerned, we may imagine the anode absent and the grid as being maintained at an effective potential $\left(v_g + \dfrac{v_a}{m}\right)$. In this way we are able to apply the Child-Langmuir diode formulae to the case of the triode We may regard the grid with its composite potential $\left(v_g + \dfrac{v_a}{m}\right)$ as acting approximately as the anode in the case of the diode so that for a triode the practical formulae (2) and (4) become respectively

$$i_a = \frac{2\cdot 33\times 10^{-6}\,(v_g + v_a/m)^{\frac{3}{2}}}{r_g^2} \qquad (10)$$

and

$$i_a = \frac{14\cdot 6\times 10^{-6}\,(v_g + v_a/m)^{\frac{3}{2}}}{r_g\beta^2} \qquad (11)$$

where r_g, in both cases, is the distance between the emitting plate or filament and the grid surface Such formulae, as before,

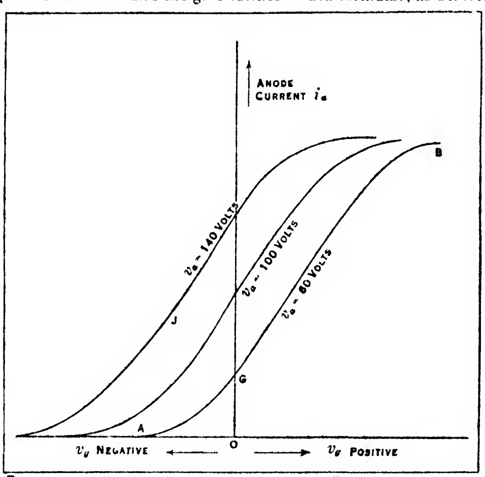

FIG 5 —SHOWING ANODE CURRENT—GRID POTENTIAL CHARACTERISTICS OF THREE-ELECTRODE VALVE

apply only to non-saturation conditions and to cases in which the current flowing to the grid (i_g) is small When i_g is appreciable (i_a+i_g) replaces i_a on the left-hand side of both equations.

From (10) or (11) we have

$$\frac{\partial i_a}{\partial v_g}\Big/\frac{\partial i_a}{\partial v_a} = -\frac{\partial v_a}{\partial v_g} = m \qquad (12)$$

and this practical expression for the value of amplification factor m is usually accepted also for conditions approaching saturation in which (10) and (11) are no longer strictly valid.

The quantity $\dfrac{\partial i_a}{\partial v_g}$ is called the differential mutual conductance of the tube and $\dfrac{\partial i_a}{\partial v_a}$ the differential anode conductance.

As with the diode the performance of a triode is usually interpreted in terms of the static characteristics For a triode the most important ones represent the relations between the anode current and grid potential for constant values of anode potential.

A set of such characteristics is shown in fig. 5 In considering it let us suppose that the anode potential is fixed at 60 volts and

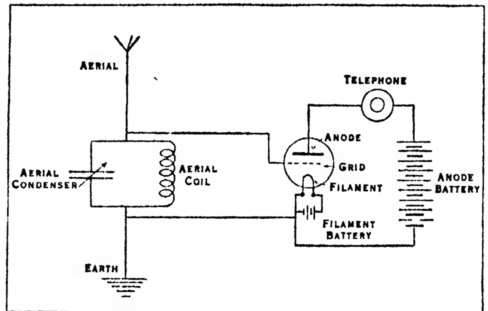

FIG 6 —ILLUSTRATING THE USE OF VALVE AS ANODE-BEND RECTIFIER

that the grid potential is zero The current flowing to the anode will then be represented by OG If the grid potential is made increasingly positive the anode current is increased until the saturation value is reached at B On the other hand when the grid potential is made increasingly negative with respect to the filament, more and more electrons are sent back into the filament and ultimately the anode current is reduced to zero, as at A For these particular conditions the negative charge on the grid is equal and opposite to that on the anode, the numerical ratio of anode and grid potentials being equal to the amplification factor m

For conditions represented by G it is evident that if the grid potential is varied symmetrically, the resulting anode current changes will be asymmetrical For such conditions the tube may therefore be used as a rectifier of wireless signals, the process

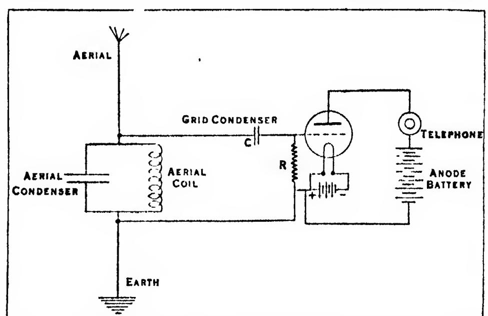

FIG. 7.—ILLUSTRATING USE OF VALVE AS CUMULATIVE GRID RECTIFIER

being termed *anode rectification*. When used in this way a typical circuit would be that shown in fig 6 which may be compared with the use of the diode as illustrated in fig 3.

The other method of using a three-electrode valve as a rectifier of wireless oscillations is illustrated in fig. 7. High frequency oscillations produced by signals received on the aerial system are transferred to the grid via the condenser C Due to the fact that the grid collects electrons during the positive half-cycles of potential, but does not do so during the negative half-cycles, the mean potential of the grid becomes negative in the course of a

signal and a diminution of anode current, the telephone responds to this as a result When the signal ceases the negative grid charge leaks away via the resistance R

If, for a tube with characteristics shown in fig 5, the anode potential is maintained at 100 volts, the relation between grid potential and anode current is, for a fair range of grid potential, sensibly linear For such a value of anode potential the tube

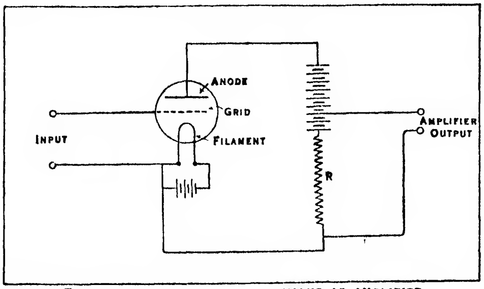

FIG 8 —ILLUSTRATING USE OF VALVE AS AMPLIFIER

could be used as an amplifier Since, however, the grid when positive attracts a certain proportion of the electric current and yet when negative does not do so, a certain asymmetry would prevent the anode current changes from reproducing faithfully the grid potential variations To obtain distortionless amplification it is usual to use a higher anode potential (*e g*, 140 volts) and shift the point representing the conditions of operation into the region of negative grid potential (*e g*, to J) by using negative grid bias

For operating conditions such as are indicated by the point J in fig 5 the characteristics are approximately linear and for sufficiently small variations may be represented by the equation

$$i_a = k_0 + k_1 v_g + k_2 v_a, \tag{13}$$

where k_0, k_1 and k_2 are constant k_1 is the differential mutual conductance while k_2 is the differential anode conductance From (12) the amplification factor is evidently $\frac{k_1}{k_2}$; also the differential internal resistance R_i is equal to $\frac{1}{k_2}$.

If a resistance R is connected in the anode circuit of a triode a change of grid voltage brings about a change in voltage across

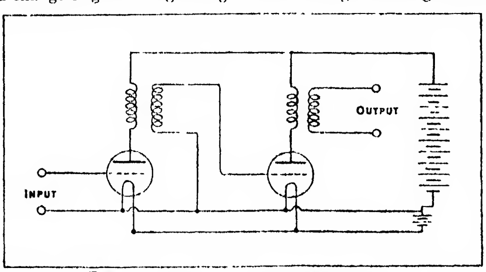

FIG 9 —VALVES WITH TRANSFORMER LINKAGE

the resistance. The ratio of the latter to the former is called the voltage magnification of the valve and circuit, and may be shown to be equal to $\frac{k_1 R}{1+k_2 R}$. As the value of R is increased the voltage magnification approaches the amplification factor of the tube m. Receiving valves have m values ranging from 2 to 120 and transmitting valves from 8 to 200.

A circuit illustrating the use of a valve for producing voltage magnification is shown in fig. 8 where a portion of the anode battery is included between the output terminals to neutralize the fall of potential across the resistance R.

The Use of Amplifying Valves in Cascade.—Thermionic valves are frequently used in cascade to secure still higher amplification The type of linkage used between one valve stage and the next depends on the particular type of electrical signal to be amplified In the majority of cases this signal is either a high-frequency alternating potential, such as a radio-frequency wireless signal, or a low frequency alternating potential such as a wireless signal after rectification Thus in a broadcast receiver

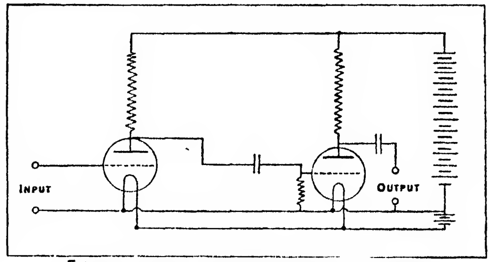

FIG 10 —VALVES WITH RESISTANCE-CAPACITY LINKAGE

we have high-frequency amplifying stages before the detector stage and low-frequency amplifying stages after the detector stage

Two methods of linkage for amplifying valves are shown in figs 9 and 10. In the first case a transformer is used to connect the anode circuit of the first valve with the grid circuit of the second In the second case the changes of potential that occur across the resistance in the anode circuit of the first valve are communicated to the grid of the second valve by means of the condenser C This method of linkage is known as resistance-capacity coupling

Both of these methods may be used for either high or low frequency amplification, but the type of transformer used in the one case and the values of resistance and capacity used in the other depend upon the frequency of the impulses to be amplified. In transformer coupling air core coils are normally used for radio-frequency amplification and iron core transformers for low or audio-frequency amplification In the case of resistance-capacity coupling the values of resistance and capacity used depend on the particular type of valve used, but in this connection it should be remembered that the linkage capacity is always considerably higher for low-frequency amplification than it is for high-frequency amplification.

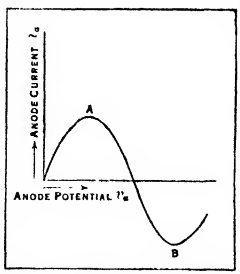

FIG 11 —SHOWING CHARACTERISTIC CURVE OF DYNATRON

The Secondary Electron Tube or Dynatron.—When electrons of sufficient energy strike a metal surface secondary electrons are emitted by the surface As the speed of the impinging electrons is increased, the number of secondary electrons emitted for each electron impact is increased and may reach values higher than unity As the majority of secondary electrons possess very small velocities, the chief factor deciding whether the electrons leave or return to the surface from which they are emitted is the direction of the electric field at that surface. Secondary emission takes place at the surfaces of both anode and grid in a three-electrode valve when these electrodes are bombarded by electrons, but the effect, however, is most strikingly marked in the case of the anode because of the much greater value of the current which reaches that electrode.

Consider a case in which the grid potential is maintained at some high potential, say 300 volts and the anode potential is

gradually increased from zero At first the anode current increases at the expense of the grid current, but, as the proportion of secondary electrons emitted by the anode increases, the collection of these secondary electrons by the grid more than counterbalances this effect and eventually the anode current falls with increasing anode potential

A typical characteristic curve is shown in fig 11 where it will be seen that between *A* and *B* the anode current falls with increasing anode potential, the differential internal resistance of the tube being negative The system, therefore, instead of dissipating energy, may be used as a source of energy and so used for maintaining or amplifying a current in a circuit (*c g*, an oscillatory circuit in a transmitter as in fig 12) which dissipates energy When used in this way the tube is called a dynatron, a name given to it by A W Hull, who first called attention to the marked effects of secondary emission for high electrode potentials

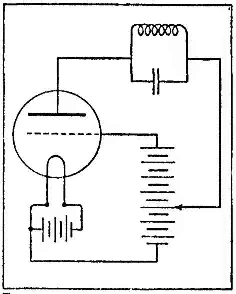

FIG 12 —SHOWING USE OF DYNATRON AS OSCILLATION GENERATOR

The Four-electrode Valve or Tetrode.—Tubes with two grids, and thus four-electrodes in all, are of two types. In both types the grids are situated between the filament and anode. In the first type the grid nearer the filament (known as the inner or space-charge grid) is maintained at a constant positive potential with respect to the filament, while the outer grid performs the normal functions of the grid in a three-electrode tube. The positive charge on the inner grid, even when the potential of the latter is low, is sufficient to neutralize the effect of space charge near the filament Thus practically the whole of the emission current leaves the filament and passes through the interstices of the inner grid For such conditions we can regard the inner grid surface as the cathode or "filament," the outer grid and anode performing their normal functions The chief advantage of this type of tube is that only low anode potentials need be used

In the second type of tetrode (the shielded grid type) the inner grid plays the part of the normal one, and the outer grid, which is usually in the form of a wire net or mesh, is maintained at a constant potential, usually a little lower than the anode potential. The function of the outer grid is to shield the inner grid electrostatically from the anode, and so prevent undesired reaction between the grid and anode circuits when the tube is used in a high-frequency amplifier.

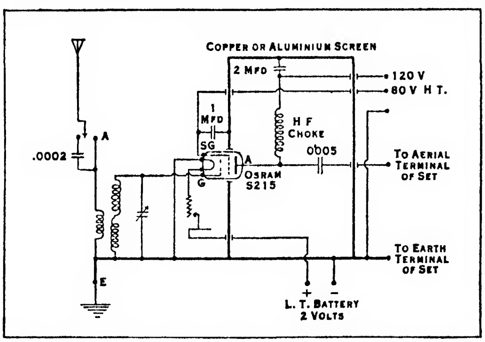

FIG 13 —SHOWING CIRCUIT FOR USE WITH SCREENED-GRID VALVE (OSRAM)

The shielding grid has, however, the further effect of shielding the filament from the anode so that variations of anode potential cause, under normal working conditions, inappreciable variations of the current leaving the filament. The result is that this type of tube has a large amplification factor and a large internal resistance. The shielding grid is usually maintained at a lower potential than that of the anode—a shielding grid potential of 80 volts, together with an anode potential of 120 volts, being commonly used. To increase the shielding effect between the anode circuit and the other electrodes it is usual to complete the shield with a metal screen as shown in fig 13 where a screened grid high-frequency stage is added to an ordinary receiver

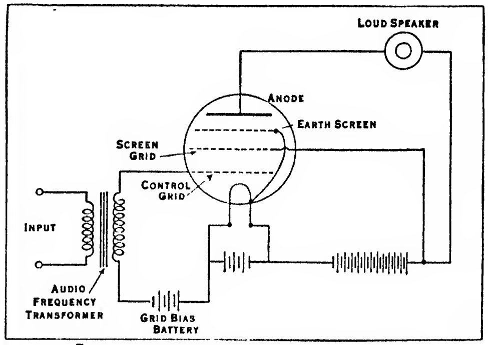

FIG 14 —ILLUSTRATING CONNECTIONS OF PENTODE

The Five-electrode Valve or Pentode.—The pentode is a screened grid valve like the screened tetrode, but includes an extra grid between the screening grid and the anode Since this extra grid is connected (*see* fig 14) internally to the filament of the valve, it is called the earth grid The function of this extra grid is to prevent the collection by the shielding grid of the low velocity secondary electrons emitted by the anode under primary electron bombardment Such collection otherwise takes place whenever the anode potential falls below that of the screening grid. The result is a tube with a high amplification factor together with a high internal resistance.

For good-quality loud speaker reproduction a mean anode current of about 15 milliamps (m a) is required, and it must be possible to vary the current substantially 12 m a. above and below this value. For this to take place, as a result of small grid potential variations, the mutual conductance of the valve should be high. This condition is fulfilled in the case of the pentode which is therefore specially suitable for the output or loud speaker valve in a wireless receiver

Soft Valves.—In certain types of valves, gas, at low pressure, is introduced into the envelope and plays an essential part in the working of the tube Gases used in this connection are helium, argon, nitrogen and mercury vapour The potentials applied to the electrodes are sufficiently high to cause the electrons to ionize the gas molecules by collision and produce positive ions. The presence of the positive ions affects the action of the tube in two ways. In the first place the ions are of opposite electrical sign to the electron space-charge, so that the effect of the latter in discouraging the escape of electrons from the region near the filament is much reduced. The presence of gas, therefore, facilitates the flow of current through the tube at lower anode potentials. The positive ions, in fact, play the same part as the positively charged inner grid in a tetrode of the first type described above. In the second place the presence of positive ions causes current to flow to the grid when the latter is charged negatively with respect to the filament. Since, however, with in-

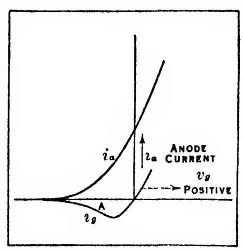

FIG. 15 —ILLUSTRATING ANODE AND GRID CURRENT CHARACTERISTICS OF SOFT VALVE

creasing negative potentials the anode current, and thus the rate at which the positive ions are produced, is decreased, the positive ion current to the grid is similarly reduced. This is illustrated by typical grid and anode current characteristics for a soft tube in fig. 15. For conditions represented by point *A* the grid filament space acts like a negative resistance, in that, with decreasing applied potential, increasing current flows, so that if an oscillatory circuit is connected across it, phenomena similar to those experienced in connection with the use of with a dynatron may be reproduced.

Indirectly-heated-cathode Valves.—In order to dispense with the use of accumulators for filament heating, valves with thick filaments, heated from the A C. supply mains, may be used. Such a practice, although successful for the amplifying stages of a receiver, is quite unsuitable for the detector stage, for which special valves have to be used if the A.C. heating is to be retained throughout These special valves have, as cathode, a nickel cylinder coated with barium or strontium oxide which is heated by the thermal radiation from a hot tungsten spiral filament inside the cylinder to a temperature sufficiently high to cause thermionic emission. Such valves are usually designated as indirectly-heated-cathode tubes. Apart from the highly specialized structure of cathode the electrodes conform very closely to normal design.

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THERMIT. Thermit is a mixture of aluminium powder and iron oxide. On ignition the reaction, $8Al+3Fe_3O_4=9Fe+4Al_2O_3$ gives a temperature estimated to be between 2,300° and 2,700° Centigrade The reaction, stated in weights, means that 217 parts of aluminium plus 732 parts magnetite (iron oxide) equals 540 parts steel plus 409 parts slag, or approximately, three parts of aluminium plus ten parts of magnetite will produce, on combustion, seven parts of steel. The steel thus produced represents about one-half of the original thermit by weight and about one-third by volume.

Thermit was discovered by Dr. Hans Goldschmidt, of Essen, Germany, in 1895, while trying to reduce chromium and manganese Dr. Goldschmidt's principal discovery related to a simple and safe method of ignition, as the action of aluminium when mixed with various oxides, sulphides and chlorides was well known. Fine aluminium will not burn below the temperature of molten cast-iron, and previous experimenters had resorted to heating their mixtures in a crucible. This made the initial temperature so high at the moment of ignition that there was an explosion. Dr. Goldschmidt obtained ignition of a cold mixture by means of a barium-peroxide fuse, which was set off by a storm match. Later, magnesium powder or ribbon was used, being set off in the same way. A red-hot iron rod may also be used to set off the magnesium, which in turn ignites the thermit. Dr. Goldschmidt's original American patent No. 615700 was granted March 16, 1897, and related principally to the use of aluminium as a reducing agent for the production of carbon-free metals such as cobalt, chromium, magnesium, tungsten, etc , by what is known as the aluminothermic process. Thermit is used considerably in the foundry for purifying iron and steel in the ladle. For this purpose the thermit is placed in a can on the end of a rod and plunged to the bottom of the molten metal. The intense heat generated tends to liberate many impurities which are carried away in the slag. The principal and better-known use for thermit, however, is in the various forms of welding

Thermit Welding.—Two methods are used, known as the plastic and the fusion. The first is used for welding pipe and the latter for solid or large sections. In the plastic method, in which the thermit is used merely for heating purposes, the ends of two pieces of pipe are machined square and clamped in a cast-iron mould with the ends butted together. This mould is in two parts, so arranged that the pipe ends may be forced together when heated. The thermit is placed in an open-top crucible lined with magnesia-tar, and ignited. After the reaction takes place, the slag, which is of course lighter in weight, rises to the top of the molten metal, and is first poured into the mould. This slag forms a protective coating on the pipe and on the inside of the mould, and keeps the thermit from melting or burning through. The thermit flows into the mould and forces out the bulk of the slag, but leaves a coating as mentioned When the pipe ends become plastic they are forced together, completing the weld. After cooling, the mould is easily knocked off, since the slag coating prevents adhesion. To weld a pipe takes from $\frac{3}{4}$ to $1\frac{1}{2}$ minutes (For a detailed description of thermit fusion welding, *see* the article WELDING.) Some of the principal uses to which thermit is put are in repairing broken rudder frames, propeller shafts, locomotive frames, steel rolling-mill pinions, and other heavy sections, but it cannot be economically used for welding thin sheet metal sections. Welds have been made where from 3,000 to 4.000 lb of thermit were used For commercial purposes there are now produced three varieties of thermit, known as plain thermit, railroad thermit and cast-iron thermit. The plain thermit is simply a mixture of aluminium and iron oxide, as already given Railroad thermit is plain thermit with the addition of $\frac{5}{8}$% nickel, 1% manganese and 15% mild steel punchings. Cast-iron thermit is plain thermit with the addition of 3% ferrosilicon and 20% mild steel punchings. The various names of these mixtures indicate very closely their principal uses. (E. V)

THERMOCHEMISTRY is the name given to that branch of theoretical chemistry which seeks to trace the connection between the heat evolved or absorbed during a chemical reaction and the nature and course of the reaction. Chemical reactions which are accompanied by a great evolution of heat are familiar; the combustion of coal or gas, the reduction of iron ores by coke in the blast furnace, and the slaking of lime are common examples All explosives are unstable compounds or mixtures of compounds, the gaseous reaction products of which are raised to a very high temperature by the great heat evolved by the explosion; the propulsive force is due to the great pressure exerted by the gaseous products, owing to the high temperature and to the small volume they occupy before expansion Such reactions are familiar because their effects are so obvious They take place so rapidly that the heat evolved cannot be dissipated without raising the products of the reaction to a high temperature. It is the effects of the high temperature that are noticed, rather than the fact that large amounts of heat are evolved. In the rusting of iron we have an example of a chemical reaction which is also accompanied by the evolution of much heat; but this fact escapes ordinary notice since the rusting usually takes place so slowly that the heat has time to dissipate without perceptibly raising the temperature of the metal. If, however, finely divided iron filings are dropped into pure oxygen, the reaction takes place so suddenly that there is no time for the heat to get away before the particles get white hot.

Confronted with so many every-day examples of chemical reactions accompanied by evolution of heat, it is natural to assume a close connection between the energy changes and the material changes. For a long time, however, the interest of chemists was mainly occupied by material changes only. Following the general recognition of the law of conservation of matter and the gradual acceptance of Dalton's atomic theory in the early part of the 19th century, there was a great development of knowledge of the properties and composition of different chemical substances and of their action on each other The real development of modern thermochemistry may be said to start from the recognition of the law of conservation of energy in the middle of the century. Somewhat earlier Thomas Andrews and Hess had systematically studied the thermal effects of chemical reactions taking place in solution, and Hess, as a result of his work, had formulated a law which is one of the consequences of the conservation of energy, namely, that the thermal effect of a chemical reaction is the same however it takes place.

Law of Conservation of Energy.—According to the law of

conservation of energy, energy, though it can exist in many forms, is indestructible. No method is known by which it is possible to create energy out of nothing No system is known from which it is possible to obtain useful work without an exactly corresponding diminution in the total energy of the system. If the system is restored to its original condition by the addition of heat, then the heat absorbed is found always to be exactly proportional to the amount of work performed by the system. A few specific examples will illustrate the application of the law to chemical processes

(*a*) Heat is necessary to convert water at its boiling point into steam at the same temperature. A small part of this heat goes to perform work through expansion against atmospheric pressure, the major part is transferred into internal energy of steam molecules. The internal energy of unit mass of water vapour is therefore considerably greater than that of unit mass of liquid water at the same temperature When steam is condensed again to water, exactly the same amount of heat is evolved as was absorbed when it was formed

(*b*) A chemical reaction, such as the combustion of petrol, can be made to take place without performance of useful work, *e g.*, by allowing it to take place in a closed vessel The heat evolved by the combustion of unit weight to carbon dioxide and water vapour under these conditions can be accurately measured When petrol is burnt in an internal combustion engine, the power output (and therefore the useful work performed by combustion of unit weight), the loss of heat to the cylinder walls and the residual heat in the exhaust gases can all be measured. The sum of the heat loss to the cylinder walls, and the residual heat in the exhaust gas is always less than the total heat of combustion by an amount which is the equivalent of the work done

(*c*) A solution of copper sulphate will react with zinc, dissolving it and depositing copper The heat evolved by the solution of an "equivalent" of zinc can be measured In the Daniell cell, which consists of a zinc electrode dipping into zinc sulphate solution in a porous pot, surrounded by another container where a copper electrode dips into copper sulphate solution, this chemical reaction takes place in such a way that it can yield an electric current We can obtain work from such a cell, *e g.*, by using it to drive a small electromotor. The work can be measured accurately If E is the electromotive force (volts) and C the current (ampères), then work done is EC units per second While the current is passing we can measure the heat changes in the cell itself These are found to be small, but not zero If we express in heat units the electrical work done by the solution of unit mass, and add (or subtract) the simultaneous evolution (or absorption) of heat in the cell, we obtain a result which is the same as that obtained when the simple reaction was allowed to take place without the production of electrical energy. Alternatively, we could join the two electrodes with a wire and measure the heat produced in the wire by the passage of the electric current and the heat produced in the cell itself at the same time. The sum of these two would be the same as the heat produced by dissolving the same weight of zinc in a similar solution of copper sulphate, but by arranging the experiment in this way, most of the heat appears outside the solution instead of inside it

It will be observed that the applications of the principle of conservation of energy depend on the assumption that a unit of one kind of energy always bears a constant relation to a unit of any other kind of energy This is a necessary deduction from the law. If a mass of m grams is held h centimetres above the earth's surface, its *potential energy* is measured by the product mgh, where g is the constant of gravity and mg the force (in dynes) with which the earth attracts it If it is allowed to fall freely, and we neglect the resistance of the air, it will have a velocity of v centimetres per second just before hitting the earth Its potential energy has then been entirely converted into ***kinetic energy*** which is measured by the product $\frac{1}{2}mv^2$. As no energy is lost, $\frac{1}{2}mv^2 = mgh$ and $v = \sqrt{2gh}$. When it hits the earth its kinetic energy is entirely converted into heat, and the amount of heat produced is exactly proportional to $\frac{1}{2}mv^2$, or to mgh The potential energy is so called because, if the restraining force is removed, the mass acquires kinetic energy if left to itself. The energy is originally latent and only becomes apparent when the restraining force is removed; we can speak similarly of ***latent*** chemical energy.

Every element and every chemical compound has a definite content of energy which varies with the temperature. We know it varies with the temperature, because if we want to raise the temperature of anything we have to put heat into it We do not know, however, what is the total energy content of any chemical substance, nor how it is divided up within the molecules; what we can determine is the *change in total energy* content which takes place during chemical reactions, and we can express the law of conservation of energy, in its application to chemistry, in the form

$$U = A - Q,$$

where U is the diminution in total energy content accompanying a chemical reaction, A is the work done during or by means of the reaction, and Q is the actual measured absorption of heat during the reaction In applying this equation it is necessary to express all quantities in the same units A, the work done by a chemical reaction, is usually either mechanical work, as in the internal combustion engine, or electrical work, as in the accumulator. The unit of mechanical work in the C.G.S system is the ***erg***, the unit of heat is the *calorie*, which is the amount of heat necessary to raise the temperature of 1 gram of water from 15° to 16° C The expenditure of $4\,18 \times 10^7$ ergs, or 4 18 *joules* will produce 1 calorie of heat.

Determination of Total Energy Changes.—The realization that the total energy content of a chemical substance was a property of the substance as important as any other property, and that the changes in energy accompanying chemical reactions were closely connected with the nature of the reaction, led to a very large number of experimental determinations of heats of reaction by J Thomsen and M Berthelot Heats of reaction are determined in principle by causing the reaction to take place rapidly under such conditions that its heat is transferred to a large and well stirred volume of water, which is thereby raised a few degrees in temperature As the specific heat of water is by definition unity at 15° C, the heat evolved can be calculated if the mass of water and its rise in temperature are accurately known Allowance must be made for the actual heating of the containing vessels and the reacting substances, and also for the loss of heat during the time the reaction takes place This loss of heat is kept down by keeping the rise in temperature small, which necessitates the use of very sensitive thermometers. Accurate calorimetry depends essentially on making proper allowances for this loss of heat, or alternatively on methods employed to counterbalance it. In general the data given in chemical literature cannot be relied upon to within $\frac{1}{2}$%, and in many cases the error of determination is much greater An experimental error of this order may be serious in certain cases, as we shall see later.

It is necessary to distinguish between heats evolved when reactions take place at constant pressure and at constant volume Only the latter accurately correspond in all instances to the change in total energy due to the reaction If the reaction is allowed to take place at constant (atmospheric) pressure and there is a change in volume due to the reaction, then work is done, and the measured heat of reaction will not be the same as the change in total energy. In the case of reactions taking place between solids or liquids the difference is usually negligible; in cases of gases the necessary correction can be easily applied For instance, in the combustion of methane to carbon dioxide and liquid water, $CH_4 + 2O_2 = CO_2 + 2H_2O$, three volumes of mixture react to form one volume of carbon dioxide and a negligible volume of liquid water. This diminution of volume means that at constant pressure work is performed by the atmosphere This work reappears as additional heat in the calorimeter. If we take the volume of one mol. of gas (22·4 litres) as the unit volume, the work done, $2P \times V$, according to the gas laws $= 2\,RT$, where R, the gas constant, is approximately 2 when the work is expressed in heat units, and T is the absolute temperature. Thus the heat of combustion of methane, measured at 18° C (or 291° absolute), should be approximately 1,200 calories higher when the combustion takes place at constant pressure, *e.g.*, when the gas is burnt in a jet, than when the mixture is burnt in a completely closed vessel. If, however, the

combustion takes place above 100° C so that no water vapour condenses, there is no change of volume, and no difference between the heats evolved at constant volume and constant pressure.

Indirect Determination.—Many heats of reaction are difficult if not impossible to measure directly. This is true of most reactions in organic chemistry which either do not take place rapidly enough to allow of accurate measurement, or yield other products besides those under investigation. But if the heats of combustion of organic compounds are known, the heat of any conceivable reaction between such compounds can be estimated by means of the first law. Take, for example, the technically important formation of methyl alcohol from carbon monoxide and hydrogen which proceeds according to the equation, $CO+2H_2=CH_3OH$ The heat of combustion of 1 mol. of carbon monoxide to carbon dioxide at constant pressure is 68,300 calories. The heat of combustion of 2 mols of hydrogen to *liquid* water at constant pressure is $2\times68,400$ calories $=136,800$ calories. The heat of combustion of 1 mol. of methyl alcohol in the form of vapour to carbon dioxide and liquid water is 182,000 calories Now the total change in energy must be the same whether the carbon monoxide and hydrogen are burnt directly to carbon dioxide and water, or whether they are first transformed into methyl alcohol and then burnt. Hence the heat evolved when carbon monoxide and hydrogen unite at constant pressure to give methyl alcohol in the form of vapour is.

$$68,300+136,800-182,000=23,100 \text{ calories}$$

This example will serve to show the importance of accuracy in calorimeter measurements. For suppose Thomsen, whose figures have been taken, underestimated the heats of combustion of carbon monoxide and hydrogen by 1%, and overestimated that of methyl alcohol by 1%, the corrected figure for the heat of reaction to methyl alcohol would then be $69,000+138,200-180,200=27,000$ calories, which is nearly 20% higher than the estimate made on the basis of Thomsen's recorded results

Variations Due to Physical Conditions.—Since the intrinsic (total) energy of a substance varies with the conditions under which the substance exists, it is necessary in recording the mechanical data to specify the conditions of the initial and final systems Besides change of volume, the following conditions have to be considered: (1) Dilution of solutions. (2) Physical state. (3) Temperature.

(*1*) *Dilution of Solutions*—Generally speaking, there is a considerable thermal effect when a substance is dissolved in water, and this effect varies in magnitude according to the amount of water employed It is only, however, when we deal with comparatively concentrated solutions that the heat-effect of diluting the solutions is at all great, the heat-change on diluting an already dilute solution being for most practical purposes negligible. In dealing, therefore, with dilute solutions, it is only necessary to state that the solutions are dilute, the exact degree of dilution being unimportant It occasionally happens that a change in dilution affects the chemical action that occurs. Thus, if concentrated instead of dilute sulphuric acid acts upon zinc, the action takes place to a great extent not according to the equation $Zn+H_2SO_4=ZnSO_4+H_2$, but according to the equation $Zn+2H_2SO_4=ZnSO_4+SO_2+2H_2O$, sulphur dioxide and water being produced instead of hydrogen Here we have a different final system with a different amount of intrinsic energy, so that the thermal effect of the action is altogether different.

(*2*) *Physical State.*—The physical state of the reacting substances must be considered, since comparatively large amounts of heat are absorbed on fusion and vaporization. Thus the heat of fusion of ice (for 18 grams of H_2O) is 1,440 cal., and the heat of vaporization of water at 100° for the same quantity is 9,670 cal. When a substance, *e g*, carbon, phosphorus, sulphur, exists in allotropic forms, the particular variety employed should always be stated, as the conversion of one modification into another is frequently attended by a considerable thermal effect. Thus the conversion of white into red phosphorus evolves about one-sixth of the heat of combustion of the latter in oxygen, and so the knowledge of which variety of phosphorus has been employed is of essential importance in the thermochemistry of that element. (*See* ALLOTROPY.)

(3) *Influence of Temperature.*—The influence of temperature on the thermal effects of a chemical reaction is sometimes considerable. If we know the change in total energy associated with any reaction at one temperature, the first law enables us to calculate it for any other temperature. If, for example, the total energy content at temperature T_1 is U_{H_2} for 1 mol. of hydrogen, U_{O_2} for 1 mol of oxygen, and U_{H_2O} for 1 mol of water vapour, the change in total energy due to the combination of hydrogen and oxygen to form 2 mols of water vapour is, say,

$$2U_{H_2}+U_{O_2}-2U_{H_2O}=U_{T_1}.$$

If we raise the temperature of 1 mol. of hydrogen (etc) from T_1 to T_2, its total energy is increased by $(C_v)_{H_2}(T_2-T_1)$, where $(C_v)_{H_2}$ is the mean capacity for heat of 1 mol of hydrogen at constant volume between the temperatures T_2 and T_1 This is simply a definition of what we mean by *molecular specific heats* Hence the total energy change at the higher temperature T_2 is·

$$2\{U_{H_2}+(C_v)_{H_2}(T_2-T_1)\}+U_{O_2}+(C_v)_{O_2}(T_2-T_1)$$
$$-2\{U_{H_2O}+(C_v)_{H_2O}(T_2-T_1)\}=U_{T_2}$$
$$\therefore\quad U_{T_2}-U_{T_1}=(T_2-T_1)\{2(C_v)_{H_2}+(C_v)_{O_2}-2(C_v)_{H_2O}\}$$

We can express this most simply by saying that the rate of change of U with the temperature (dU/dT) is equal to the sum of the heat capacities of the reacting compounds minus the sum of the heat capacities of the products of the reaction

Thermochemical Measurements.—Some general results of thermochemical measurements applied to heats of combustion, neutralization and solution may now be considered.

(*a*) *Heats of Combustion*—Experiment has shown that the heat of combustion of organic substances of various kinds varies regularly with the molecular weight. The difference between the heats of combustion of two neighbouring members in a series of homologous compounds is practically constant, and the value of the constant shows very little variation as we pass from one series to another Thus the heat of combustion of methane, CH_4, to carbon dioxide and liquid water at constant pressure is 212,000 calories; of ethane, C_2H_6, is 370.500 calories, a difference of 158,500 calories, of propane, C_3H_8, is 529.200 calories, which is 158,700 above that of ethane, and the heat of combustion of all paraffin hydrocarbons (C_nH_{2n+2}) can be expressed by the formula $212,000+158,500\ (n-1)$ or $158,500\ n+53,500$ calories, where n is the number of carbon atoms in the molecule, and the mass to which the heat of combustion refers is the molecular weight in grams of the compound

Similarly the heat of combustion of alcohols $C_nH_{2n+1}OH$, can be expressed by the formula.

$$183.000+158.800\ (n-1)$$

or

$$158,000n+34.200 \text{ calories.}$$

As a rule the addition of a CH_2 group to any organic molecule will increase the molecular heat of combustion by about 158.800 calories, but the rule is not exact, and the actual figure varies somewhat from series to series. In particular the heat of combustion of two isomeric substances, *i e.*, substances with the same number of carbon, hydrogen, oxygen, etc., atoms in the molecule, but differently arranged, are very nearly but not exactly the same. It follows that there are similar regularities in the *heats of formation* of organic compounds, for the heat of formation is the difference between the heat of combustion of a compound and the total heats of combustion of the carbon, hydrogen, etc., it contains.

(*b*) *Heats of Neutralization.*—The heats of neutralization of acids and bases in aqueous solution are additively composed of two terms, one being constant for a given base, the other constant for a given acid. In addition to this the further regularity has been observed that, when the powerful monobasic acids are neutralized by the powerful monacid bases in dilute solution, the heat of neutralization is in all cases the same. The following table gives the heats of neutralization of the commoner strong monobasic acids with soda:

	Formula	Cal
Hydrochloric acid	HCl	137,400
Hydrobromic acid	HBr	137,500
Hydriodic acid	HI	136,800
Nitric acid	HNO_3	136,800
Chloric acid	$HClO_3$	137,600
Bromic acid	$HBrO_3$	137,800

Within the error of experiment these numbers are identical.

It was at one time thought that the greater the heat of neutralization of an acid with a given base, the greater was the strength of the acid It is now known, however, that when weak acids or bases are used, the heat of neutralization may be either greater or less than the normal value for powerful acids and bases, so that there is no proportionality, or even parallelism, between the strengths of acids and their heats of neutralization (*see* CHEMICAL ACTION)

(*c*) *Heats of Solution* —When substances readily combine with water to form hydrates, the heat of solution in water is usually positive; when, on the other hand, they do not readily form hydrates, or when they are already hydrated, the heat of solution is usually negative The following examples show the effect of hydration on heat of solution in a large quantity of water:

I *Sodium Carbonate*

	Heat of solution	Heat of hydration
	cal.	cal.
Na_2CO_3	+ 5,640	
Na_2CO_3,H_2O	+ 2,250	+ 3,390
$Na_2CO_3,2H_2O$	+ 20	+ 5,620
$Na_2CO_3,10H_2O$	−16,160	+21,800

II *Sodium Sulphate*

	Heat of solution	Heat of hydration
	cal.	cal
Na_2SO_4	+ 460	
Na_2SO_4,H_2O	− 1,900	+ 2,360
$Na_2SO_4,10H_2O$	−18,760	+19,200

First and Second Laws of Thermodynamics.—It should be clearly realized that the *law of conservation of energy,* like the law of conservation of mass, is a statement of experimental observations and in chemistry admits of no exception. All recorded observations support the law within the unavoidable errors of experiment, all deductions from the law have been amply verified. Apparent limitations of the law have been brought to light by recent physical research, and in particular through Einstein's famous theory of relativity (*q v*), but in ordinary chemistry we do not deal with atomic or ultra-atomic changes, but with molecular rearrangements, and the laws of conservation of energy and mass, as originally conceived, still hold good

Reversible Chemical Reactions —As the result of the large number of experiments made by them, Thomsen and, later, Berthelot expressed the opinion that heat of reaction must be regarded as a measure of chemical affinity, and that every chemical change tended to take a course which evolved the maximum amount of heat Berthelot in particular regarded this as a general guiding principle in chemistry, and impressed its importance so much on others that it continued to be upheld long after Berthelot himself had recognized its error. It is not easy now to realize why this "principle" commanded such universal acceptance; simple physical transformations which took place spontaneously either with absorption or evolution of heat, according to the circumstances, must have been familiar For instance, water will freeze spontaneously and in doing so will liberate thermal energy if the temperature is below 0°. Above 0° ice melts spontaneously and in doing so absorbs heat from its surroundings. Further, even at the time Berthelot put forward his theory, there was a growing recognition of the fact that many *chemical reactions are reversible, i.e*, that they take place either in one direction (with evolution of heat) or in the opposite direction (with absorption of heat), according to the conditions of temperature and pressure and the relative masses of the reacting substances. So long ago as 1801, the great French chemist Berthollet had introduced the idea of "chemical equilibrium," and in the same year that Berthelot put forward his erroneous theory (1867) Guldberg and Waage published their famous book on chemical affinity, which dealt with reversible chemical reactions and in which they put forward the *law of chemical mass action*

Chemical Equilibrium.—This law, in so far as chemical equilibrium is concerned, may be formulated as follows. Suppose chemical substances, A_1, A_2, etc., react to form B_1, B_2, etc. The reaction tends to proceed until a condition of equilibrium is set up, governed by the equation

$$\frac{[A_1]\times[A_2]\times \text{etc.}}{[B_1]\times[B_2]\times \text{etc}} = K.$$

where $[A_1]$, etc., represents the concentration of the compound A_1, etc., in the equilibrium mixture On the other hand, if the compounds B_1 and B_2 are originally brought together, then the reaction will proceed in the reverse direction with production of A_1 and A_2 until the same condition of equilibrium is set up The value of the *equilibrium constant* K is itself independent of concentration—for example, in the case of gaseous reactions it is independent of pressure—but it varies with the temperature Clearly such constants are of great significance in the study of chemical affinities. If K is very small, then the affinity of A_1 for A_2, etc, may be said to be very great, and the affinity of B_1 for B_2, etc., small, although not zero

The important thing to notice is that every single instance of a reversible chemical reaction really disproves the Berthelot principle. Nevertheless, the principle has this much to be said for it, that most chemical reactions which take place spontaneously at low temperatures do so with evolution of heat, and that it is only when the effects of high temperatures are studied that we become really familiar with important reactions that take place spontaneously with absorption of heat. There is one such reaction that is made use of daily on an enormous scale for the production of heat, namely, the reaction between steam and coke at a bright red heat to yield "water gas," a mixture of approximately equal volumes of hydrogen and carbon monoxide. As the reaction proceeds the coke cools, and at regular intervals it is necessary to shut off the supply of steam, and to pass air over the coke in order to raise it again by combustion to a temperature sufficiently high to allow the reaction with steam to continue rapidly It is true that the cooling of the coke during the passage of steam is not entirely due to the chemical reaction, for it is partly accounted for by the cooling effect of the steam itself, which is introduced to the retort at a lower temperature than the coke. But even if the steam were initially at the same temperature as the coke, it would be found that the mass gradually cooled. The spontaneous formation of nitric oxide by the passage of air through an electric arc, a process by which nitric acid is manufactured on a large scale, is also accompanied by absorption of heat. Pure nitric oxide, on the other hand, decomposes into its elements, nitrogen and oxygen, at a somewhat lower temperature with evolution of heat Hydrogen and oxygen will combine explosively and completely at low temperatures; but steam is found to decompose spontaneously though not completely into hydrogen and oxygen if it is heated to a temperature above 2,000° C, and heat is absorbed during the decomposition. Clearly, therefore, the heat evolved during a chemical reaction cannot give a direct measure of the affinity of the reacting substances.

The first big practical advance that was made in our knowledge of the relations between thermal changes and chemical affinity was due to van't Hoff's demonstration that the law of mass action was a necessary consequence of the second law of thermodynamics and of the quantitative connection between the value of the "equilibrium constant" and the change in total energy due to the reaction. The second law of thermodynamics, like the first, is a statement of experience, perhaps one might say a collection of inter-related statements of experience. The first law states that it is impossible to create energy; the second law states that it is im-

possible to convert the heat energy of our surroundings continuously into useful work. The second law deals with a question which the first law does not answer, namely, under what conditions can heat energy be converted into useful work (that is to say, mechanical energy). If heat energy passes spontaneously from one body to another, the first body is said to be at a higher temperature. It is a matter of universal experience that the reverse change, *i.e.*, the passage of heat from one body to another of higher temperature never takes place spontaneously. It is also a matter of experience that any spontaneous process can be made to yield a definite amount of useful work. For instance, the cooling of a furnace is a spontaneous process By the use of steam and suitably designed engines, it is possible to obtain useful work from this process.

Carnot's Definition.—The question how much useful work can be obtained by the spontaneous passage of heat from one temperature to another is of fundamental importance not only in mechanical engineering but in the science of chemistry. Carnot, a French engineer, actually solved this problem in 1824 before the law of conservation of energy was universally accepted. He showed that the maximum amount of work which can possibly be obtained from the "spontaneous" transference of a quantity of heat Q from a reservoir at temperature T_1 to another of the lower temperature T_2 was $Q(T_1-T_2)/T_1$. It will be noted that Carnot's result involves a quantitative definition of "absolute" temperature. The so-called "thermodynamic scale of temperatures" which is implicit in his result, is based on the behaviour of a perfect gas, the energy content of which is independent of its volume and dependent only on the temperature The absolute temperature of a perfect gas is defined by the fundamental gas law $T=PV/R$, where P is the gas pressure, V its volume, and R a constant. The value of R depends on the units in which the pressure and volume are expressed. Many gases approach very nearly the properties of the imaginary "perfect" gas, particularly at low densities.

The next point of interest is that Carnot in deriving his result imagined a perfectly frictionless engine, with a perfect gas as a working fluid, taking heat from the high temperature reservoir (as steam takes heat from a furnace), converting part of the heat into work, and rejecting the rest to the low-temperature reservoir The argument is that such an engine will always yield the maximum amount of work, because if it is reversed, the expenditure of work, only infinitesimally greater in amount than the engine yields on the direct operation, will suffice to restore the heat from the low temperature to the high temperature reservoir. For suppose it was possible to make another reversible and frictionless engine which was capable of converting a greater proportion of the transferred heat into work. Then it would be possible to use part of the work yielded by this change to reverse the first engine, and to restore the whole system to its original condition, leaving a definite amount of work over which has been created out of nothing. This is contrary to the first law Hence we say that the work that can be done by a perfectly efficient reversible engine or process is independent of the nature of the process.

The Gibbs-Helmholtz Equation.—This conclusion leads to a mathematical expression of the first and second laws of thermodynamics in a form which can be applied to all chemical as well as other phenomena. For if, instead of having a perfect engine to transfer heat from the reservoir at $T+dT$ to another at T, we allow a chemical process to take place in the first reservoir, yielding a maximum amount of work A and absorbing heat from the reservoir equal to Q, and we then reverse this chemical process in the second reservoir by the expenditure of $A-dA$ of work, we have gained an amount of work$=dA$, and if the process is conducted reversibly this work must be equal to that gained by any other perfect process; in other words, $dA=Q{\cdot}dT/T$. But Q, the heat absorbed, is equal (by the law of conservation of energy) to the maximum work A, less the diminution in total energy U, *i.e.*,

$$dA=(A-U)dT/T,$$
$$\text{or } A-U=T{\cdot}dA/dT.$$

This is the relation which was deduced independently by Helmholtz and Willard Gibbs. The quantity A is the maximum amount of work that can be obtained from a (reversible) chemical process taking place spontaneously and at constant volume at the temperature T; $A+dA$ is the work that would be obtained by allowing it to take place at the same volume at the higher temperature $T+dT$; and U is the diminution of total energy which corresponds to the heat evolved when the reaction takes place without the performance of any work, *e g*, in a closed vessel. A is often known as the *decrease in free energy*, to distinguish it from U, the *decrease in total energy*.

The most direct use of this equation is found in its application to the electric cell or battery. For the electric cell is a contrivance for converting chemical energy into useful work If the cell is reversible, the work will be the maximum obtainable from the chemical reaction which is the source of the electric current What we mean by a reversible cell is that, if a potential infinitesimally greater than that yielded by the cell is applied to the electrodes, the current will travel in the reverse direction in the cell and the chemical reaction will be reversed. The lead accumulator is nearly reversible in this sense; so is the Daniell cell The electromotive force of the Daniell cell is found to be 1·1 volts. For every gram-equivalent of copper deposited and zinc dissolved in the cell, an amount of work is done$=EF$, where F is the quantity of electricity (96,540 coulombs) associated with one gram-equivalent These units can be expressed in calories; calculation shows that if E is the potential, the work done by the reaction is 23,050E calories Hence the work done by the Daniell cell is 25,260 calories per gram-equivalent of copper deposited. The heat of the reaction, when it takes place without performance of work, is found to be 25,060 calories. Hence in this case $A=U$ nearly. We should find therefore that dA/dT, or dE/dT, which is the change of electromotive force with the temperature, is very small. Measurement shows that it is only 0·000034 volt per degree

Lord Kelvin put forward the view in 1851 that the electromotive force of a cell could always be calculated from the heat of the chemical reaction, that is to say from the decrease in total energy This "law" involves the assumption that no chemical reaction can be made to yield electrical energy unless it is accompanied by a decrease in total energy It holds approximately for the Daniell cell, and for others such as the standard Weston cell. The Helmholtz equation shows that it can only be true when the electromotive force does not change with the temperature. We are familiar now with cells which yield an electric current even if the chemical reaction is associated with an absorption of heat; we know of cells the voltage of which increases with temperature, and others in which it decreases None of these cells obeys Kelvin's law, but the behaviour of all of them can be shown to be in exact accordance with the Helmholtz equation The study of electric cells provides the most interesting and exact confirmation of the fundamental laws of thermodynamics.

The Van't Hoff Equation.—Apart from the combustion of coal and oil, most chemical reactions interest us more from the point of view of the nature of their products than from that of the work obtainable from them. As all chemical reactions are in principle reversible, and as many of the more important from a practical point of view can be made to proceed in one or the other direction according to conditions of temperature and pressure, it is not only of theoretical interest but of great technical importance to get an accurate picture of the relations between chemical equilibrium and thermal changes Van't Hoff succeeded in doing this by calculating the maximum work that could be obtained from a chemical reaction taking place between gases, by the use of an imaginary "ideal" process By the application of the second law two important results emerged:

(1) *The law of mass action*, first deduced from consideration of molecular theory, was shown to be a necessary consequence of the thermodynamical laws, that is to say, if a state of equilibrium exists between gases according to the chemical equation

$$n_1\mathrm{A}+n_2\mathrm{B}+\text{ etc.}=n'_1\mathrm{A}'+n'_2\mathrm{B}'+\text{ etc.}+U\text{ calories,}$$

then
$$\frac{[\mathrm{A}]^{n_1}\times[\mathrm{B}]^{n_2}\times\cdots}{[\mathrm{A}']^{n'_1}\times[\mathrm{B}']^{n'_2}\times\cdots}=K.$$

(2) *The equilibrium constant* K was shown to be connected with the temperature and the decrease in total energy through the equation

$$d \log_e K/dT = U/RT^2$$

In practical applications it is usually more convenient to express the quantities of gases present in an equilibrium mixture in terms of their partial pressures instead of their concentrations. If there are N molecules of gas present altogether in a mixture which contains n_1 molecules of one kind, n_2 of another, and so on, the partial pressures are n_1P/N, n_2P/N, etc. where P is the total pressure It is simple to show that

$$\frac{P_A^{n_1} \times P_B^{n_2} \times}{P_{A'}^{n'_1} \times P_{B'}^{n'_2} \times} = K_p$$

where P_A^n represents the partial pressure of A, and the new constant $K_p = K(RT)\Sigma_n$, Σ_n being the difference between the number of the reacting molecules and the total number formed by the reaction. $d \log_e K_p/dT = Q_p/RT^2$. It can also be easily shown that where Q_p is now not necessarily the diminution in total energy, but corresponds to the heat evolved when the reaction takes place at constant pressure, without the performance of any work other than that due to the change of volume, if any, associated with the reaction This equation is similar to that found to hold good for the change of vapour pressures of liquids (and solids) with the temperature, *viz*, $d \log_e p/dT = \lambda/RT^2$, where λ is the latent heat of evaporation of one gram-molecule of the liquid or solid

Some Thermochemical Reactions.—The application of these equations to chemistry inaugurated a new era, and led not only to a rapid extension of our knowledge of chemical reaction, but also to the recognition of the connection between many apparently diverse phenomena. Some illustrations of the use of the equations will now be given

Hydrogen and oxygen combine to form steam with evolution of heat according to the equation

$$2H_2 + O_2 = 2H_2O + 116{,}000 \text{ calories.}$$

If we start with 2 mols of hydrogen and 1 mol of oxygen, then according to the law of mass action an equilibrium will be reached when $2(1-x)$ mols of water vapour are formed, and $2x$ mols of H_2 and x mols. of O_2 are left uncombined Supposing the volume occupied is v, then the law states that at equilibrium

$$\frac{(\text{Concn of } H_2)^2 \times (\text{Concn of } O_2)}{(\text{Concn of water vapour})^2} = K$$

or

$$\frac{\left(\frac{2x}{v}\right)^2 \times \frac{x}{v}}{\left\{\frac{2(1-x)}{v}\right\}^2} = K \text{ or } \frac{x^3}{(1-x)^2} \times \frac{1}{v} = K$$

Now at ordinary temperatures, the amount of hydrogen and oxygen left uncombined is very small and escapes direct measurement. As x is small, K is also small. But van't Hoff's equation shows that, as U is large and positive, log K, and therefore K, increases with the temperature. Hence x increases with the temperature. In other words, water vapour will dissociate when the temperature is raised.

This result may be generalized All compounds which are formed with evolution of heat tend to decompose when the temperature is raised. The same applies to molecules such as H_2, O_2, N_2, Cl_2, I_2, etc, which are formed from their atoms with evolution of heat Conversely, compounds which are formed with absorption of heat become more stable at high temperatures Nitric oxide cannot be made from nitrogen and oxygen at low temperatures, but is formed when air is blown through an electric arc Hydrogen peroxide may be detected in an oxy-hydrogen flame. Calcium carbide is formed in an electric furnace at a very high temperature If v in the equation given above is made smaller, then x must also diminish, because K is constant High pressure tends, therefore, to assist combination or to prevent dissociation. This is the case whenever the reaction is accompanied by a decrease in the number of molecules The synthesis of ammonia is an important technical example. Here one molecule of nitrogen combines with three molecules of hydrogen to form two of ammonia, $N_2 + 3H_2 = 2NH_3$. The mass action equation is

$$27x^4/4(1-x)^2v^2 = K,$$

where x is the fraction of nitrogen left over If the value of v is diminished, x must also be diminished, and the amount of ammonia formed increases. As is well known, the commercial success of the process depends on very high pressure being used If no change in the number of molecules is caused by a reaction, v cancels out, and therefore an alteration in the pressure has no effect on the equilibrium If the number of molecules is increased, v appears in the numerator instead of the denominator, and an increase of pressure will then have the opposite effect.

The effects of pressure and temperatures on equilibrium can be generalized in the statement that the equilibrium will always adjust itself in such a way as to oppose a change in physical conditions If the pressure is increased, the equilibrium will shift in the direction of smaller volume When heat is added that reaction will take place which results in an absorption of heat, thus tending to stop a rise of temperature The same applies to physical processes Water expands when it freezes; if we compress ice at the freezing point it will do its best to diminish its volume by melting Liquids always absorb heat when they evaporate, if heat is added to water which is boiling at atmospheric pressure, its temperature is not increased All that happens is that it boils faster

If a reaction between gases is studied experimentally at any one temperature and pressure, so that the equilibrium conditions are known, then the effect of a variation in pressure at that temperature can be accurately calculated provided the mixture obeys the "perfect gas" laws If the heat of reaction is also known at that temperature, then the equilibrium for any other temperature not too far removed can be calculated from van't Hoff's equation. For integration of the equation gives

$$\log_e K = -U/RT + \text{constant},$$

if U does not change much with the temperature Hence if K_1 and K_2 are the equilibrium constants at temperatures T_1 and T_2

$$\log_e K_1/K_2 = U(1/T_2 - 1/T_1)/R$$

Gases and Solids.—Chemical reactions in which gases and solids take part present features of special interest To take a simple example, carbon dioxide combines with lime to form calcium carbonate with evolution of heat:

$$\underset{\text{solid}}{CaO} + \underset{\text{gas}}{CO_2} = \underset{\text{solid}}{CaCO_3} + 42{,}500 \text{ calories}$$

Now the pressure of saturated vapour above any solid or liquid is independent of the amount of solid or liquid present, unless the amount is very minute If a closed space contains carbon dioxide gas, in the presence of solid calcium oxide and carbonate, there will be an equilibrium in the gaseous phase governed by the relation

$$\frac{(\text{Concn. of CaO vapour}) \times (\text{Concn of } CO_2)}{(\text{Concn. of } CaCO_3 \text{ vapour})} = K.$$

As the concentrations of the vapours of the two solids are constant (though extremely small) at any given temperature, it follows that the concentration of carbon dioxide must also be constant. In other words its pressure is constant. Above a mixture of calcium oxide and carbonate we have, therefore, our apparent "vapour" pressure of carbon dioxide, which varies with the temperature

The heat of the reaction is analogous to the heat of evaporation of any solid or liquid, and if P is the "vapour" pressure, which is called the ***dissociation pressure*** in this and similar cases,

$$d \log_e P/dT = Q/RT^2,$$

where Q is the heat of reaction, *i.e.*, the heat absorbed on dissociation of 1 gram-molecule, and includes the work done against atmospheric pressure by the evolution of 1 gram-molecule of

carbon dioxide. The dissociation pressure, like the vapour pressure of liquids, increases with the temperature. At a high temperature, about 900° C, the dissociation pressure is equal to ordinary atmospheric pressure. If the carbonate is heated above this temperature it is converted into lime and carbon dioxide is rapidly evolved.

If other carbonates are examined it is found that the temperature at which they are converted into their oxides varies directly with their heat of dissociation as the following table shows

Substance	Heat of dissociation	Temperature
	cals	°C.
Silver carbonate	20,100	225
Lead carbonate	22,600	302
Manganese carbonate	23,500	ca 330
Calcium carbonate	42,500	900
Strontium carbonate	55,800	1,150

On similar reasoning, it may be shown generally that in all reactions in which gases and solids take part, the equilibrium conditions only take account of the gases. For instance, when carbon dioxide is passed over red-hot coke it is converted into carbon monoxide with absorption of heat, $C+CO_2=2CO-38,500$ calories The equilibrium condition is

$$P_{co}/P_{co_2}=K \text{ or } d\log_e K_p/dT=38,500\ RT^2$$

from which it can be deduced (a) that the ratio CO/CO_2 in the gas mixture at equilibrium is constant if the temperature and pressure are constant; (b) that if the temperature is kept constant, and the pressure is increased, the proportion of carbon monoxide in the mixture goes down; (c) that if the temperature is increased, the proportion of carbon monoxide goes up

In the blast furnace, air is blown through a white-hot mixture of oxides of iron and coke, and the carbon monoxide formed by the combustion of coke reduces the oxides to metallic iron The exit gases must contain a large proportion of carbon monoxide to carbon dioxide, corresponding to the equilibrium conditions which obtain near the cooler top of the furnace It was at one time thought that by building furnaces higher, the period of contact between the gases and the ore would result in a greater measure of reduction, a diminished proportion of carbon monoxide in the exit gases, and consequently a smaller consumption of coke per ton of ore reduced Attempts to achieve these results, by building furnaces as high as 100 ft, failed As Le Chatelier pointed out, if there had been a better acquaintance with the laws of chemical equilibrium, these experiments would have been unnecessary. It was an expensive, although no doubt an instructive, method of proving the correctness of one of the deductions from the second law

Heat and Velocity of Reaction.—These examples will suffice to indicate how the quantitative application of simple fundamental thermodynamic principles has been successful in reducing to order an enormous range of observations on chemical reactions apparently very diverse in character It has also given the chemical engineer the power to calculate the conditions for achieving the maximum technical success in the conduct of any chemical manufacture on the large scale. Unfortunately, though the application of thermodynamics has been so successful in the study of chemical equilibrium, it has as yet taught us nothing about the rate at which equilibrium is attained, or, in other words, about the rate of chemical reaction. There seems to be no direct connection between the rate of a reaction and either the heat evolved (change in total energy), or the maximum work of the reaction (change in free energy). Hydrogen has a great affinity for oxygen, and much heat is evolved when they combine, yet a mixture of them can be kept for an indefinite period of time at the ordinary temperature without a trace of combination Nitric oxide is an extremely unstable substance at low temperature; on thermodynamical grounds we should expect that only an infinitesimal amount of it would be in equilibrium with nitrogen and oxygen at the ordinary temperature; yet it is so difficult to decompose by heat that even at 900° C it only decomposes slowly. Ammonia becomes progressively less stable as the temperature is raised. Thermodynamics indicates that in order to obtain high yields, its synthesis from nitrogen and hydrogen should be conducted at as low a temperature as possible. The reaction is, however, so slow that technical manufacture only becomes possible at temperatures so high that the yield of ammonia at atmospheric pressure is extremely small. The ill effects of the high temperature have to be counterbalanced by the use of high pressures. Nearly all gas reactions take place extremely slowly unless the temperature is very high Nearly all, too, take place more quickly in the presence of certain solids called catalysts. The nature of the catalyst to produce the best results varies with the nature of the reaction, and though many theories have been put forward to account for their action, there is no general theory which has been successful in predicting anything—which is the ultimate test of the real value of a theory

Free Energy.—The second law of thermodynamics deals with changes in the free energy of a system A system only possesses "free energy" when it is capable of doing work It is only capable of doing work if it will change spontaneously into another system of greater stability Only an unstable system has free energy A stable system can be changed into an unstable system by the performance of work, or by the transference of free energy from another system The whole of life, and of civilization as we know it, depends on thermodynamic instability, as Boltzmann (1886) put it, the struggle for existence is a struggle for free energy available for work Nearly all manufacturing processes depend essentially on using the free energy stored in coal to convert a useless stable system into a useful unstable system. For instance, the synthetic manufacture of fertilizers depends essentially on the use of a small part of the free energy available when coal is burnt, to convert the stable system nitrogen+water, into the unstable system ammonia+oxygen The ammonia in various forms can be made use of to fertilize plants, *i e*, to increase the free energy in the plant world which the animal world can convert again into useful work The enormous amount of energy which the earth continuously receives from the sun is theoretically almost completely available for useful work, for the energy leaves the sun at a temperature over 8,000° and is finally dissipated into space at a temperature of about 300° Absolute Calculation shows that the energy so received is at least a million times greater than the energy given by the world's power plants But unfortunately we know of no means for making use of anything more than a minute fraction of the sun's energy. A very small part of it is converted into mechanical energy by water power plants, another very small part is used by the plant world to build up "unstable" organic compounds, and thus to supply the free energy available in food. One of the chief tasks of the scientist of the future will be to devise means for converting into useful work, or storing, a greater part of the energy received from the sun The second law shows that this should be possible If he does not succeed the advance, and even the maintenance, of civilization may be impossible when the energy stored in coal through the agency of the plant world in past ages is exhausted.

The Third Law of Thermodynamics.—It has already been pointed out that although the Gibbs–Helmholtz equation enables us to calculate from purely thermal data the change in any equilibrium with the temperature, it does not give any information on the actual value of the equilibrium constant unless this is already known from experimental observations under one set of conditions To obtain the actual value from purely thermal data, it is necessary to integrate the fundamental equation $d\log_e K/dT=U/RT^2$, and integration introduces an unknown integration constant

In 1901 Nernst advanced a method of evaluating this constant, and his theorem is often referred to as the "third law" of thermodynamics, although its universal applicability is still open to some doubt

In Condensed Systems—Nernst postulates that in the case of chemical reactions in *condensed systems, i e.,* reactions in solids or between solids and liquids, not only does A become $=U$ at

absolute zero ($T=0$), as is required by the Gibbs-Helmholtz equation, but that they both reach their final (equal) value at temperatures not far removed from the absolute zero In mathematical language, $dA/dT=dU/dT=0$ when $T=0$ Now dU/dT is equal to the difference between the sum of the molecular heat capacities (C_v) of the reacting substances and of the products. Since it is found by experiment that the specific heats of substances can be expressed with sufficient accuracy by equations of the form $C_v=a+bT+cT^2+$ etc it follows that U can also be expressed in the form

$$U=U_0+\alpha T+\beta T^2+\gamma T^3+ .$$

But if $dU/dT=0$ when $T=0$, it follows that $\alpha=0$, or

$$U=U_0+\beta T^2+\gamma T^3.$$

If this expression for U is substituted in the fundamental equation $A-U=T\ dA/dT$, it follows that

$$A=U_0+aT-\beta T^2-\frac{\gamma}{2}T^3-\text{etc}$$

where a is an unknown constant But if $dA/dT=0$ when $T=0$, as Nernst postulates, a must also be equal to zero, and therefore

$$A=U_0-\beta T^2-\frac{\gamma}{2}T^3-\text{etc}$$

Hence if the heat of reaction, and the specific heats of the substances taking part in the reaction are known, it should be possible to calculate A for any temperature

Consider such a change as the melting point of a solid, or a transition from one modification to another such as the change from rhombic to monoclinic sulphur Then at the temperature when the solid and liquid, or the two forms of solid, co-exist in equilibrium, A, the work obtainable from the change, is zero If we know the heat of the reaction at this temperature (latent heat), and if we know the difference between the specific heats of the two forms over a wide range of temperature, we can express U in the form

$$U=U_0+\beta T^2+\gamma T^3+$$

and therefore T, the temperature where $A=0$ (melting point, or transition point), is given by

$$U_0=\beta T^2+\frac{\gamma}{2}T^3+\cdots$$

Nernst has shown how the transition point of sulphur can be calculated in this way from purely thermal data.

The difficulty of applying the theory to a wide range of such reactions is due to the fact that the all-important knowledge of the variation of specific heats with temperature is still lacking in the majority of cases. only in the case of regularly crystallizing elements do we now know the relation accurately Theory is insufficiently advanced to guide us in the other cases, and accurate experimental work over a great range of temperature is extremely difficult as well as laborious Nevertheless the application of the Nernst theorem to many different types of condensed systems has been so successful, and the theorem itself is supported in so many other indirect ways, that there is little doubt as to its essential truth

In Gas Reactions—It is, however, in its extension to gas reactions that the Nernst theorem has won its most significant successes. If we substitute for U in the van't Hoff equation, the expression

$$U=U_0+\alpha T+\beta T^2+\cdots$$

we get
$$\frac{d\log_e K}{dT}=\frac{U_0}{RT^2}+\frac{\alpha}{RT}+\frac{\beta}{R}+\cdots$$

Integration gives

$$\log_e K=-\frac{U_0}{RT}+\frac{\alpha}{R}\log_e T+\frac{\beta}{R}T\ \cdots+I,$$

where I is an unknown integration constant. Since the vapour pressure (p) of a liquid is similarly connected with the latent heat (λ) by the equation $d\log_e p/dT=\lambda/RT^2$, we can also write

$$\log_e p=-\frac{\lambda_0}{RT}+\frac{\alpha_0}{R}\log_e T+\frac{\beta_0}{R}T+\text{etc.}+i,$$

where i is the unknown integration constant of the vapour pressure curve.

Nernst shows that a consequence of his fundamental theorem is that $I=\Sigma ni$, where n is the number of molecular species taking part in the reaction; that is to say, if the reaction is

$$A+B+C+\text{etc.} = D+E+F+\text{etc.}$$

then $$I=i_A+i_B+i_C+\cdots-i_D-i_E-i_F\ \cdot\text{etc.}$$

This is a most important advance, for it means that it is possible to calculate any equilibrium between gases, provided the heat of the reaction is known, and the vapour pressure curves of the molecular species taking part in the reaction.

In the absence of sufficiently accurate data to make the strict application of the Nernst theorem possible, except in a very small number of cases, Nernst has also developed an approximation formula which is of great practical use It depends on the fact that the *vapour pressure* of most substances can be represented sufficiently accurately by the equation

$$\log_{10}p=-\frac{\lambda_0}{4{\cdot}57T}+1\ 75\log_{10}T-\frac{\beta T}{4\ 57}+C.$$

C, the so-called *conventional chemical constant*, is itself found to be approximately $0{\cdot}14\ \lambda/T_0$, where λ is the latent heat at the boiling point T_0. For most substances which are liquid at the ordinary temperature, $\lambda/T_0=22$ approximately, and therefore $C=3{\cdot}1$ Only a few substances give values for C under 3, mainly they vary between 3 and 3·5

On the basis of this semi-empirical vapour-pressure equation the corresponding formula for gaseous equilibria becomes·

$$\log_{10}K_p=-\frac{Q_p}{4{\cdot}57T}+\Sigma n{\cdot}1{\cdot}75\log_{10}T+\frac{\beta}{4\ 57}T+\Sigma nC$$

which may as a rule be further simplified by omitting the term $\frac{\beta}{4{\cdot}57}T$, thus giving·

$$\log_{10}K_p=-\frac{Q_p}{4{\cdot}57T}+\Sigma n{\cdot}1\ 75\log_{10}T+\Sigma nC.$$

Now it is not pretended that an equation of this form represents actual results with accuracy. Its claim of utility is that it is based generally on correct principles, and that in actual practice it represents with considerable success the effect of temperature on chemical equilibria. A few examples will show how this claim is borne out

(*a*) Consider the reaction:

$$2CO+O_2=2CO_2+136{,}000\text{ calories.}$$

K_p, the equilibrium constant, is $P^2_{CO}\times P_{O_2}/P^2_{CO_2}$, where P_{CO}, etc, represents the partial pressure of CO, etc., in the equilibrium mixture. Q_p, the heat of reaction at constant pressure and room temperature, is 136,000 calories. Σn is the difference between the number of molecules on the left and right hand sides of the chemical equation, *i.e.*, $\Sigma n=1$; ΣnC is twice the chemical constant of CO plus the chemical constant of O_2 minus twice the chemical constant of CO_2, *i.e*,

$$\Sigma nC=2\times3{\cdot}5+2{\cdot}8-2\times3{\cdot}2=3{\cdot}4.$$

$$\therefore\ \log K_p=-\frac{136{,}000}{4{\cdot}57T}+1\ 75\log T+3\ 4.$$

At 2,000° Abs. K_p calculated from this equation is 2×10^{-6} whereas the most recent results indicate that this value is reached at 2,020° Absolute. When CO_2 is half dissociated, there are 0·5 molecules of CO_2, 0·5 of CO, and 0·25 of O_2 present at equilibrium. If the total pressure is 1 atmosphere, the partial pressures of

CO and CO_2 are $\frac{0.5}{1.25}$ atmos., and of O_2, $\frac{0.25}{1.25}$ atmos., therefore, $K_p = 0.2$. The corresponding temperature is calculated from the above equation to be 2,930° Abs., whilst the temperature actually observed is 3,100°.

(*b*) If the reaction brings about no change in the number of molecules, the second term of the equation vanishes, and the third usually becomes very small. For instance

$$2NO = N_2 + O_2 + 43{,}200 \text{ cals}$$

and $$\log K_p = \log \frac{P^2_{NO}}{P_{N_2} \times P_{O_2}} = -\frac{43{,}200}{4.57T} + 1.6 = -\frac{9{,}450}{T} + 1.6.$$

This shows, in accordance with observation, that only at very high temperatures are appreciable quantities of nitric oxide formed from nitrogen and oxygen.

(*c*) If on the other hand, the change in the number of molecules is big, then the first term of the equation may be of little influence. For instance, the probability of a high-boiling paraffin hydrocarbon being formed from hydrogen and carbon can be calculated:

$$nC + (n+1)H_2 = C_nH_{2n+2} + Q \text{ calories}$$

Thomsen's experiments have shown that the heat of formation of such a hydrocarbon from its elements is given approximately by $Q_p = (7n+15)1{,}000$. As the chemical constant of H_2 is 1.6, and of C_nH_{2n+2} about 3.0 we have

$$\log K_p = \log \frac{P^{n+1}_{H_2}}{P_{C_nH_{2n+2}}} = -\frac{1000(7n+15)}{4.57T} + n \times 1.75 \log T + 1.6n - 1.4.$$

Suppose $T = 773°$, *i.e.*, 500° C. Then

$$\log \frac{P^{n+1}_{H_2}}{P_{C_nH_{2n+2}}} = -1.98n - 4.24 + 5.06n + 1.6n - 1.4 = 4.68n - 5.64.$$

If $n = 1$, *i.e.*, if the hydrocarbon formed is methane, CH_4, then

$$\log \frac{P^2_{H_2}}{P_{CH_4}} = -0.96 \quad \text{or} \quad \frac{P^2_{H_2}}{P_{CH_4}} = 0.11$$

from which it can be calculated that if hydrogen is passed over carbon at 500° C, the issuing gas should contain about 70% of methane if equilibrium is reached. Experimental results agree quite well with this. If, however, $n = 7$, *i.e.*, if the hydrocarbon is heptane, C_7H_{16}, which boils at about 100°C., $\log \frac{P^8_{H_2}}{P_{C_7H_{16}}}$ is over 27, or $\frac{P^8_{H_2}}{P_{C_7H_{16}}}$ is over 10^{27}, which means that the amount of heptane formed at atmospheric pressure will be quite negligible. All the higher liquid hydrocarbons, such as occur in natural petroleum oil, are thermodynamically unstable at ordinary temperatures. They tend to pass into carbon and methane, but the velocity of this reaction at ordinary temperatures is very slow. If they are heated, however, they are "cracked"; hydrocarbons of lower boiling point, such as occur in petrol, are formed, and coke and gas are formed at the same time. If the cracking is continued for a long time at atmospheric pressure, the whole liquid forms into coke and gas (mainly methane). But high pressure tends to prevent the formation of gas and coke, and to give therefore a higher yield of "petrol." This is in complete general agreement with the Nernst equation, which enables us to predict approximately the conditions for the best technical success.

The further development of the third law, and its quantitative application to chemical problems depends on the provision of accurate data on the specific heats of substances over a wide range of temperature. The increase in the specific heat of gases as the temperature is raised lacks at present any sound theoretical explanation. The classical kinetic theory of gases does not account for it, and the more recent developments of the quantum theory have hitherto failed to be of assistance. But there can be little doubt that the third law provides in principle a complete explanation of the connection between chemical equilibria and the thermal changes associated with chemical reactions.

(H. T. T.)

THERMODYNAMICS. The name thermodynamics (from Gr. θερμός, hot, δύναμις, power), was originally given to the branch of science dealing with the motive power of heat, or the transformations of heat into mechanical work, or vice versa. A summary of the historical development of thermodynamics from this point of view is included in the article HEAT. Further illustrations relating to heat-engines will be found in the articles GAS-ENGINE, and STEAM-ENGINE. The subject was soon extended to include other applications of the same general principles (1) the conservation of energy, and (2) Carnot's principle of the reversible cycle, which are commonly known as the first and second laws of thermodynamics. The present article is intended to deal mainly with applications of these principles to the relations between the physical properties of a simple substance. Further applications to physical chemistry, dealing with the conditions of equilibrium between different substances, are dealt with in a separate section.

THERMODYNAMICS AND HEAT ENGINES

Definitions of Symbols.—The principal physical properties of the working fluid with which we are concerned in the case of heat-engines are the specific volume V, the intrinsic energy E, the total heat H and the entropy Φ, all of which are measured per unit mass of the substance considered. The laws of thermodynamics require certain general relations between these properties and their derivatives, as affected by additions of heat Q per unit mass, or by variations in the imposed conditions of temperature T and pressure P. It should be observed that in all these relations P is the absolute pressure and not the gauge-pressure, and that T is measured on the absolute scale, as defined by Carnot's principle which differs very little from absolute temperature on the scale of a gas thermometer. Temperature measured on the same scale from 0° C is denoted by t, so that $T = t + 273.1°$. The total heat H is defined as $E + aPV$ in thermal units, including the equivalent aPV of the work PV done by the pressure P on the volume V of unit mass. The entropy Φ of a quantity of heat Q supplied at a temperature T is defined as Q/T. The entropy of a substance per unit mass is the property which remains constant in adiabatic expansion, when no heat is supplied by friction or otherwise, as will be more fully explained in a later section, in connection with the second law of thermodynamics.

Applications of the First Law.—The intrinsic energy E denotes the quantity of energy existing in unit mass of the substance in any given state, which may in general be specified by its volume V and temperature T. We have no means of measuring the total quantity of energy contained in any body in a given state, but it suffices to be able to measure changes of E from any convenient state E_o selected as the zero. Any such change from E_o to E may be measured by observing the quantity of heat Q required to produce the change and the work W done by the substance per unit mass in the process. Assuming that no energy is lost, the application of the first law to this case gives the obvious relation

$$Q = E - E_o + W/J. \tag{1}$$

In any equation of this kind it is tacitly understood that all the terms are reckoned per unit mass of the substance, and are expressed in terms of the same units, either units of work or units of heat as desired. The general practice in dealing with heat-engines is to measure Q, E, and H in thermal units per unit mass, and to reduce W to thermal units by dividing by the appropriate value of the mechanical equivalent J. In nearly all cases W represents work done by expansion $V - V_o$ against a uniform pressure P, in which case $W = P(V - V_o)$, if P remains constant during the expansion, and equation (1) takes the form

$$Q = E - E_o + aP(V - V) = H - H_o \text{ at const. } P, \tag{2}$$

where the total heat H is defined as $E + aPV$, and a is the factor required for reducing PV to heat units per unit mass. The factor

required for this purpose in practice is seldom $1/J$, because pressure-gauges are never graduated in lb./sq.ft. or kg./sq.m., but often in arbitrary units such as inches of mercury.

Specific Heats.—If the heat Q is added at constant volume, $V=V_o$, and $W=0$, so that $Q=E-E_o$. If $T-T_o$ is the rise of temperature, we observe that the increase of E per degree at constant volume V_o is equal to $Q/(T-T_o)$, which is by definition the specific heat S at constant volume. Similarly $(H-H_o)/(T-T_o)$ from (2) is equal to the specific heat S at constant pressure. Thus the values of E along a line of constant volume on any diagram may be found from observations of the specific heat s at constant volume. Similarly values of H along a line of constant pressure may be deduced from observations of the specific heat S at constant P.

Thus $H-H_o=S(T-T_o)$ at const. P,

and $\quad E-E_o=s(T-T_o)$ at const. V $\qquad$ (3)

These simple relations between H and S, and E and s, are exact for all substances at all temperatures in consequence of the definition of H, and are often very useful. But the specific heats S and s may vary widely with temperature and pressure, in which case it is usually better to measure H or E directly, in place of trying to deduce them from empirical formulae for S or s. In the case of solids or liquids, since V is small and varies little with T, the variation of E at constant *pressure*, such as atmospheric, does not differ appreciably from that of H. But the variation of H at *constant volume* may greatly exceed that of E under the same condition on account of the high pressures developed. In practice it is usually preferable to measure the value of H and deduce that of E, if required, by subtracting aPV.

Application to Gases.—In the case of ideal gases obeying the law $aPV=RT$, it follows directly from the general relations (3) that the difference $S-s$ is constant and equal to R. It will be shown later that the specific heats of such gases cannot vary with *pressure*, though they may vary considerably with *temperature*, while the difference $S-s$ remains constant, as in the case of hydrogen. (*See* HEAT.) On the other hand, vapours, like steam, though they usually approximate closely to the law $aPV=RT$ at low pressures, show large deviations from the gas-laws at high pressures near saturation, and the value of S shows a wide range of variation with *pressure*, especially near the critical point. Fortunately these variations can be deduced from the thermodynamical relations given in a later section of this article.

Cycle or Cyclical Process.—The application of the first law, as expressed in (1), to the cycle of a steam-engine, in which the working fluid is restored to its initial state of water at each repetition of the cycle, is fully considered in the articles already referred to. Briefly stated, if $E=E_o$ at the conclusion of the cycle Σ_o, it follows from (1) that the algebraic sum ΣQ of all the quantities of heat Q received and rejected by the working substance during the cycle must be equal to the net balance of work done by the engine per cycle, work done *by* the fluid in expansion being reckoned positive, and work done *on* the fluid in compression being reckoned negative. With this understanding the formula for the cycle may be expressed as follows,

$$\Sigma Q=\Sigma W=\int PdV \qquad (4)$$

In an ideal reversible engine, in which no heat is lost and no work is wasted in friction, the area of the cycle on the PV diagram, expressed by the integral of PdV taken round the cycle, will represent the maximum work obtainable from the cycle considered. In any actual engine some of the heat received by the working fluid is lost before it has contributed its full quota of work, and some of the work done is reconverted into heat by internal friction and is rejected in the form of heat. If the properties of the working fluid are known, such losses may be estimated in the reciprocating engine by comparing the ideal diagram, as calculated, with the actual diagram as observed with the indicator. (*See* STEAM-ENGINE.) In the case of a turbine, to which the indicator method is inapplicable, it is necessary to use a different kind of diagram, or the ideal output may be calculated from the properties of the working fluid, and compared with that actually realised.

Frictionless Adiabatic Expansion.—The term "adiabatic" implies that there is no gain or loss of heat by the working fluid. Putting $Q=O$ in (1) we see that in this case $E-E_o$ must be equal to $-W/J$, or the intrinsic energy of the working fluid is *diminished* by an amount equivalent to the work done. If no work is wasted in friction, this represents the most efficient method of conversion of heat into work, which is the ultimate aim of every heat-engine. To calculate the work done from the integral of PdV under this condition, it is necessary to know the form of the expansion curve on the PV diagram, or the adiabatic equation representing the relation between P and V for the working fluid employed, which requires an appeal to experiment. Watt made the first experiments of this kind with his indicator, but found the expansion curve for a slow speed engine using wet steam to be approximately $PV=$ constant, the same as Boyle's law for the expansion of a gas at constant temperature, whereas the fall of pressure in adiabatic expansion should have been more rapid than that given by Boyle's law owing to the fall of temperature. Watt was well aware that this anomaly was due to partial condensation of the steam on admission by the cool walls of the cylinder, followed by re-evaporation towards the end of the stroke, which made the conditions far from adiabatic. Laplace subsequently showed (*see* HEAT) that the rate of drop of pressure dP/dV in the adiabatic expansion of a *gas* must exceed that for the same state at constant temperature, in the ratio, $S/s=\gamma$, of the specific heats. Assuming Boyle's law for a gas at constant temperature, and $\gamma=$ constant in adiabatic expansion, it followed that the adiabatic equation must be of the form, $PV^\gamma=$ constant for a gas.

The adiabatic equation of Laplace and Poisson for a gas, was established long before the first law of thermodynamics was formulated, and has proved to be the most convenient type of equation for the purpose. But with the assistance of the laws of thermodynamics, the scope of the adiabatic equation in this form may be considerably extended. Thus with the assistance of the first law, in the form in which it is usually employed for mathematical purposes, namely

$$dQ=dE+aPdV=dH-aVdP \qquad (5)$$

the adiabatic equation, $PV^\gamma=$ constant, may be shown to apply generally to any kind of substance, not necessarily a perfect gas, for which the change of intrinsic energy in any transformation is proportional to that of aPV, or more generally that it will be of the form $P(V-b)^\gamma=$ constant, provided that the expression for the intrinsic energy E satisfies the condition,

$$E-B=naP(V-b) \qquad (6)$$

in which B, b, and n are constants depending on the substance, and $\gamma=1+1/n$.

To prove this relation, we put $dQ=0$ in (5) as the general condition for the adiabatic, and equate dE as obtained from (6) to $-aPdV$, which gives,

$$an(V-b)dP+a(n+1)PdV=0. \qquad (7)$$

Dividing by $aP(V-b)$ and integrating we obtain

$$n \log P+(n+1)\log(V-b)=\text{constant} \qquad (8)$$

which when put in the exponential form becomes

$$P(V-b)^{n+1/n}=\text{constant} \qquad (9)$$

It will be observed that the value of the index γ is *constant*, and is not necessarily equal to the ratio of the specific heats, which may vary widely with pressure. This is fortunate, because an equation of this type is of little practical use if the index is variable.

With the assistance of the second law of thermodynamics in addition to (5) and (6), it will be shown in a later section that the same adiabatic (9) may be put in either of the equivalent forms

$$P/T^{n+1}=\text{constant}=k_1 \text{ or } (V-b)T^n=\text{constant}=k_2 \qquad (10)$$

and that $P(V-b)/T=k_1k_2=$ constant, along an adiabatic, though it is not necessarily constant under other conditions.

Experimental Verification of the Adiabatic.—The most direct way of testing the adiabatic equation is to use a cylinder containing a constant charge of gas or vapour which is alternately compressed and expanded by a reciprocating piston. Indicator cards give fairly accurate values of the actual volume and pressure, if the clearance is carefully measured, the pressure scale calibrated, and everything in perfect adjustment. But in working

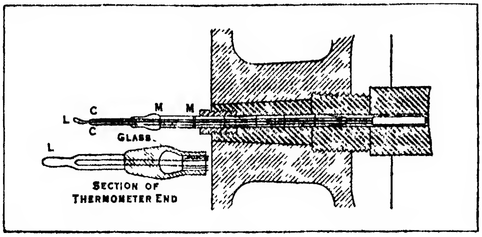


FIG. 1

over large ranges of pressure, as is necessary for a satisfactory verification, there are formidable difficulties due to the wide variation of heat exchanges between the charge and the walls of the cylinder at different points of the stroke. These effects are further complicated by accidental leakage past the piston, and, in the case of steam, by the risk of condensation, both of which affect V indirectly by reducing the apparent mass of the charge. The most complete method of eliminating these uncertain sources of error, which profoundly affect the uniformity of V throughout the cylinder, is to observe, instead of the relation between P and V, the relation between T and P, as given by the adiabatic equation in the form (10), deduced from the second law In this case the temperature observed in the middle of the cylinder will be practically unaffected by the action of the walls, and is determined solely by the *actual* pressure as observed with the indicator. We are no longer concerned with the *theoretical* pressure, corresponding to the compression ratio by volume, which might be realized in the absence of condensation or leakage or heat-loss to the walls These effects will still reduce the observed pressure below the theoretical value, but will not affect the relation between pressure and temperature. The success of the thermometric method depends on the construction of a thermometer sufficiently sensitive to follow the rapid variations of temperature without appreciable lag, and on obtaining simultaneous readings of the relative values of the pressure with the same order of accuracy at the maximum and minimum points of the cycle. It is easy to cover the range of temperature with a single thermometer. but, the pressure range being upwards of 10/1, it is necessary to use a separate indicator with a light spring for the low pressures. Applied in this manner the method is particularly suited to give the best average value of the index over large ranges of pressure and temperature. The procedure may be varied when it is desired to obtain the value of the index at some particular point of the scale, *e g.*, at high or low temperatures

The annexed figure 1 shows one of the thermometers employed for this purpose, mounted on the piston of a steam-engine for observing the adiabatic relation between P and T for dry steam The sensitive portion of the thermometer consisted of a differential loop L of fine platinum wire a thousandth of an inch in diameter and 1 inch in length. The fine wire was connected to thick platinum leads, insulated by being fused through a glass tube MM held in a gland in the centre of the piston. The platinum leads in the glass tube were connected to insulated copper leads, which were carried out to the measuring apparatus through a hole 2 ft. long bored through the piston rod. Since the ends of the fine wire, where it is attached to the thick platinum leads, cannot follow the rapid variations of temperature of the steam, it is necessary with this type of thermometer to compensate these end-effects by connecting a short loop of the same fine wire to the ends of the compensating leads CC. The quantity measured being the difference of resistance of the long and short loops, all such end-effects are automatically eliminated. Readings of temperature were taken with the aid of a periodic contact (mounted on the revolving shaft) which could be adjusted, while the engine was running, in such a way as to close the circuit of the galvanometer at any desired point of the stroke It was found possible to read the temperature to one or two tenths of 1° C at the maximum and minimum points, with the engine running at 100 rev./min and a range of temperature of about 300° C between maximum and minimum. Readings taken at intermediate points, where the temperature was changing at the rate of more than 500° C per second, showed very good agreement, but could not be utilised in the calculation because the simultaneous values of the pressure could not be located with sufficient accuracy on the steep part of the indicator curve, whereas the maxima and minima could be measured with the greatest precision. The ports of the cylinder used in these experiments were caulked with lead to prevent leakage, and the cylinder was heated by steam in the jackets and steam-chest to minimize condensation. The flywheel was belted to an electric motor and driven at a steady speed by a large storage battery. The observations covered a range of temperature from 100° to 420° C, but could not be extended beyond 150 lb pressure by this method, owing to deficient strength of the engine and driving gear. The results obtained with several different thermometers and indicators, showed that the adiabatic index for steam must be very nearly constant over this range of pressure and temperature with a value given by $n+1=13/3$ in (10), or $\gamma=1{\cdot}300$ in the relation (9) between P and V. Recent observations on the total heat H up to 4,000 lb. pressure, have shown that the same relation holds for dry steam with remarkable accuracy in the critical region, in spite of enormous variations in the ratio of the specific heats. The importance of this result in practice lies in the fact that it gives a very simple expression (6) for E or H in terms of P and V, or for V in terms of H and P, in addition to giving the simplest possible expressions for the work done in adiabatic expansion, or for the discharge through a nozzle, the utility of which can hardly be exaggerated in practical thermodynamics Similar relations, but with $\gamma=1{\cdot}40$ or $n=2{\cdot}5$, have long been applied to the case of atmospheric air, which forms the chief constituent of the working fluid in the internal combustion engine But in the case of air the application is much more simple and obvious, because air obeys the gas equation $aPV=RT$ very closely, and its specific heats vary very little with pressure under ordinary conditions.

The Energy Equation in Steady Flow.—The flow of a fluid through a pipe or any closed apparatus, is said to be "steady" when the mass M per second passing any cross-section X is the same at every point, and remains constant during the flow This implies that the fluid is supplied at a steady rate by some external agent (*e g.*, a pump or boiler) at a constant pressure and temperature, in which case the whole apparatus traversed by the fluid will soon settle down into a steady state in which the values of P, V, and T remain constant at each point, though they will not be the same at different points, if the section X varies from point to point, or if the fluid receives heat or does work at a steady rate during its passage. It follows from the law of conservation of mass that, when the mass-flow M is constant at every point, the velocity U of the fluid at any section X is given in terms of V by the relation

$$U=kMV/X \qquad (11)$$

where k is a constant depending on the units employed

A second relation follows from the law of conservation of energy, since the energy existing in any section must remain constant when the conditions are steady. The total energy carried into any section by the fluid per unit mass in thermal units will consist of its intrinsic energy E', together with the equivalent $aP'V'$ of the work done by the pump, and with the kinetic energy of flow, $K'=U^2/2Jg$, reduced to thermal units by the factor $1/Jg$. Thus the total energy carried in by the fluid may be represented briefly by $H'+K'$. Similarly the total energy carried out of the same section by the fluid may be represented by

$H''+K''$. But with the energy carried out we must include the equivalent W/J of any work done by the apparatus, and any heat Q lost by radiation or convection, both measured per unit mass of the fluid passing through Collecting the terms, the general equation may be written

$$H'-H''=K''-K'+W/J+Q \qquad (12)$$

The steam-turbine may be taken as a typical example. $H'-H''$ represents the drop of total heat of the fluid, or more briefly

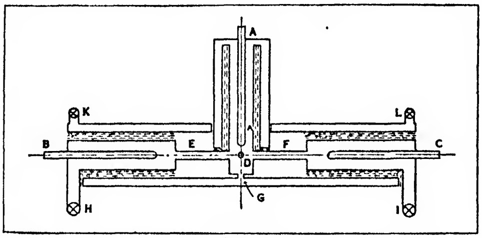


FIG. 2

the 'Heat-drop,' between the inflow and outflow of any section In an efficient machine, this heat-drop is very nearly equivalent to the external work W done by the steam on the revolving blades. The external heat-loss Q is a small percentage of the whole. The kinetic energy K'' of the steam leaving the section usually exceeds K', that of the steam entering and $K''-K'$ represents a similar percentage loss The greater part of the loss in a turbine is that due to internal friction, by which part of the available kinetic energy is reconverted into heat. This part of the loss is included in the total heat H'' carried out by the steam. If there were no friction or heat-loss, the drop of total heat, representing heat converted into kinetic energy or work, would be that obtainable in frictionless adiabatic expansion between the same limits of pressure, which may be found from the tables and compared with the actual performance to estimate the efficiency. The method of doing this will be explained later, when some of the simpler applications of equation (12) have been illustrated.

The Throttling Method.—The function of a throttle, or reducing-valve, is to regulate the flow, or change the state of the fluid, by lowering the pressure without altering the total heat The throttle, having no moving parts, cannot do any external work, so that $W=0$ in equation (12) In this case, most of the kinetic energy is reconverted into heat by friction, so that K'' can be made nearly equal to K' under favourable conditions. The equation then reduces to the form

$$H'=H''+Q \qquad (13)$$

The chief use of the equation in this form is to find the value of the total heat H' at a high pressure by throttling to a lower pressure, such as atmospheric, and observing the temperature T''. The total heat H'' at the lower temperature and pressure may be regarded as known by equation (3) in terms of the specific heat S. Thus the required value of H' at T' and P' is given by (13) if the heat-loss Q can be determined. The best way of doing this is to employ a differential calorimeter as shown in fig. 2. The high pressure steam enters the centre pocket at the back and circulates round the thermometer tube (A) for measuring the initial temperature The initial pressure is measured at the same point through the connection (D) to the high pressure gauge. The main current then divides right and left through the throttle tubes (E) and (F) to the side pockets (B) and (C) where the temperature of the throttled steam is measured. These pockets are precisely similar, and are lagged and jacketed with throttled steam in order to reduce heat-loss, which would otherwise be rather large at high temperatures. The throttle tubes are fitted with a progressive series of throttles and baffles, designed to give maximum friction and reduce the kinetic energy to a negligible quantity. Using single and double dashes to distinguish the two sides, the flows M' and M'' on either side, as defined above can be adjusted in any desired ratio. The *rate* of heat-loss $M'Q'$ per second will evidently be nearly equal to the rate of heat-loss $M''Q''$ from the other side. Hence Q' and Q'' (per unit mass) will be inversely as the flows, which are condensed and measured separately. For instance, if $M'=2M''$, we have $Q''=2Q'$, and $Q'=H'-H''$, by taking the difference between the two equations

$$H'+Q'=H_o=H''+Q'' \qquad (14)$$

where H_o represents the total heat in the centre pocket. Whence $H_o=2H'-H''$, both of which are known from the observed temperatures t' and t''. Since S is nearly constant for steam at atmospheric pressure, it usually suffices to correct the observed temperature t' for heat-loss by adding $(t'-t'')\ M''/(M'-M'')$, as in the following example. Starting with steam at 3,805 lb pressure and 426·6° C, the observed temperatures on either side after throttling to 16 lb. were $t'=120{\cdot}3°$ C and $t''=114{\cdot}1°$ C, the ratio $M''/(M'-M'')$ being 0·97. The correction to t' for heat-loss is $0{\cdot}97\times6{\cdot}2°=6{\cdot}0°$, giving 126·3° C for the corrected temperature, at which $H_o=652\ 4$ cal C, as given in the tables at 16 lb This method is one of the simplest for measuring H at high pressures and temperatures, but cannot be applied if H is less than 640 cal, because the throttled steam would be wet Thus in measuring H at the critical point, 374° C, and 3,222 lb, where its value is only 554 4 cal. it is necessary to use the jacketed condenser method as described in the article CALORIMETRY This method is rather more difficult, but has the advantage of applying equally to the case of water

Discharge Through a Nozzle.—The function of a nozzle in a turbine is to convert as much as possible of the total heat of the steam into kinetic energy for turning the wheels For this reason the nozzle is formed with a bell-mouth on the high pressure side tapering smoothly to a nearly parallel throat, so as to produce a uniform jet of high velocity with the least possible friction or turbulence. In this respect the nozzle is the opposite of the throttle which reconverts as much as possible of the kinetic energy into heat, leaving the total heat practically unaltered In one respect it is like the throttle, in that it has no moving parts and does no external work in itself, so that $W=0$ in equation (12), when applied to either nozzle or throttle The heat-loss Q in the case of a nozzle is also very small compared with the heat-flow, which is usually large owing to the high velocity of flow. Neglecting W and Q on this account, the heat-drop is the exact equivalent of the kinetic energy generated, thus equation (12) becomes

$$H_1-H_2=K_2-K_1=(U_2^2-U_1^2)/2Jg, \qquad (15)$$

in which the constant Jg is required for reducing $U^2/2$ to heat units. It may be observed that equation (15) remains true if any proportion of the kinetic energy generated is reconverted into heat by friction, since this has the effect of increasing H_2 exactly as much as it reduces K_2 As a rule the initial velocity is small and K_1 is almost negligible in comparison with K_2. The velocity generated may then be calculated from the heat-drop by the formula

$$U_2=(2Jg)^{\frac{1}{2}}\ (H_1-H_2)^{\frac{1}{2}} \qquad (16)$$

If H is taken in calories C and U in feet per sec., the value of the constant is 300·2, or a heat-drop of 1 cal. C will correspond to a velocity of 300 ft./sec.; or 100 cal. to 3,002 ft./sec. A velocity of 100 ft./sec., or 70 miles per hour, though not unimportant in meteorology, may often be neglected in dealing with turbines, as it corresponds to only $\frac{1}{9}$th of a calorie C. Other conditions being equal, the heat-drop and velocity will evidently be greatest in the absence of friction, or in frictionless adiabatic expansion as defined by putting $dQ=0$ in equation (5). This gives the condition $dH=aVdP$ for finding the heat-drop by integrating $aVdP$ along the adiabatic (9) between the given limits of pressure P_1 to P_2. Neglecting b, this reduces to the simple form,

$$H_1-H_2=(H_1-B)(1-T_2/T_1) \qquad (17)$$

where $T_2/T_1=(P_2/P_1)^{\frac{3}{13}}$, for steam by equation (10) with $n+1=13/3$.

Having found the heat-drop, which is preferably obtained from the Tables, the velocity U_2 follows from (15), or from (16) if U_1 is small. The discharge M is easily obtained from (11) in terms of the area of the throat X, and the volume V_2 at the same point. The latter is most easily obtained from H and P by the general relation (6), which may be put in the form,

$$V=(H-B)/a(n+1)P=2\cdot2436(H-B)/P. \qquad (18)$$

Maximum Discharge.—It results from the form of these equations that for any given nozzle or throat area X, for a given initial state of the steam as defined by P_o and V_o, the discharge M will at first increase as the final pressure P is lowered, but will ultimately reach a very definite maximum, when $P/P_o=0\cdot546$ in the case of steam Differentiating (11) to find the condition under which M is a maximum, we have $d(U/V)=0$, or $dU/dV=U/V$. Putting (15) in the form $U^2-U_o^2=2Jg(H_o-H_o)$, differentiating with regard to V, and remembering that U_o and H_o are constant, we obtain

$$-Jg(dH/dV)=U(dU/dV)=U^2/V. \qquad (19)$$

Since by (5) $dH/dV=aV(dP/dV)$ in adiabatic expansion, this may be written,

$$-aJg(dP/dV)=(U/V)^2=(kM/X)^2 \qquad (20)$$

giving the discharge M/X per unit area of throat in terms of dP/dV in the throat. Since equation (20) for $(U/V)^2$ in terms of dP/dV is the general expression for the velocity of sound U in any fluid, we infer that, when M/X is a maximum, the exit velocity of the fluid relative to the throat must be equal to the velocity of sound in the same fluid under the same conditions Thus no drop of pressure beyond the throat could travel back fast enough through the fluid to affect its state in the throat or increase the discharge In the case of any fluid like steam, having the adiabatic equation (9), $dP/dV=-\gamma P/(V-b)$, which when substituted in (20) gives the discharge in terms of P and V in the throat. To find a numerical formula for the maximum discharge in the case of steam (for which $\gamma=1\cdot3$) in terms of the *initial* conditions, P_o, V_o, we have the approximate relations (omitting b, which is very small), which follow from (20),

$$(H_o-H)/(H_o-B)=(\gamma-1)/(\gamma+1)=3/23 \qquad (21)$$

$$P/P_o=0\cdot5457,\ V/V_o=1\cdot5934 \qquad (22)$$

which give for the discharge M/X in lb. per sec. per sq in. of throat ($k=144$),

$$M/X=U/144V=0\cdot3155\ (P_o/V_o)^{1/2} \qquad (23)$$

when P is in lb per sq in., U in ft/sec. and V in cu ft. per lb. The correction for b is less than $\frac{1}{20}$ of 1 per cent when $P_o=300$ lb.

Applications of Carnot's Principle.—The whole science of thermodynamics may be said to date from the establishment by Sadi Carnot (1824) of the principle limiting the amount of work obtainable from heat under given conditions The reasoning by which Carnot established his principle is outlined in the article HEAT, and is justly regarded as one of the most remarkable triumphs of the deductive method, but the experimental data available at the time were far too scanty and inaccurate to supply conclusive proof. With the advance of experimental methods Carnot's predictions have been abundantly verified in every conceivable instance, and have formed the basis of the development of all kinds of heat-engines in theory and practice. The important applications to heat-engines are discussed elsewhere in their proper place. We are here concerned chiefly with the applications of the principle to the thermodynamical relations between the various properties of any substance, and to the conditions which determine the possible states of equilibrium. Carnot in applying his principle to such cases put it in the following form as being most convenient for the purpose. If a quantity of heat Q is supplied to any substance at a constant temperature t, the work dW obtainable from Q by an ideal reversible engine working in a cycle of range dt must be proportional to Qdt multiplied by some function of the temperature, $F't$, which must be the same for all substances. Putting this statement in the form of an equation, we find

$$dW/dt=QF't, \qquad (24)$$

as given by Carnot, and applied by him to the following simple cases:

Clapeyron's Equation—In the vaporisation of unit mass of steam in a boiler, the whole work of expansion W along the isothermal at constant pressure and temperature, would evidently be equal to $p(V-v)$, the product of the vapour-pressure p by the increase of volume from that of water v to that of steam V. Thus the work dW/dt obtainable in a cycle of range dt would be $(V-v)dp/dt$, where dp/dt is the rate of increase of the steam-pressure per degree rise of temperature The heat Q absorbed in the vaporisation of unit mass is the latent heat L Substituting these symbols in (24) we obtain the result commonly known as Clapeyron's equation,

$$(V-v)dp/dt=LF't, \qquad (25)$$

which evidently represents the condition of equilibrium between liquid and vapour at any temperature, and is applicable to any other substance with the same value of $F't$ at the same temperature, but with different values of L, V, and p, depending on the properties of the substance considered. Carnot employed this relation for calculating the value of his function $F't$ at 100° C from the properties of steam, which were roughly known at this temperature. Taking $L=540$ cal. $dp/dt=27\cdot2$ mm. of mercury, or 370 kg/sq metre, and $V-v=1\ 670$ cb m/kg, we find $F't=1\cdot135$ kilogram metres per kilocalorie for the work obtainable in a cycle of 1° range at 100° C. We may remark in passing that the value found is equal to 427/373, being the mechanical equivalent of the kilocalorie in kgm divided by the absolute temperature This implies that the whole of the heat could be converted into work if the range of the cycle were extended to the absolute zero with the same rate of production of work per degree fall But Carnot, who had at that time no knowledge of the value of the mechanical equivalent, naturally failed to notice this remarkable coincidence, though the result he obtained for $F't$ was correct

Lowering of the Freezing Point of Ice by Pressure.—The application of Carnot's equation (25) to the rate of increase of vapour-pressure dp/dt with temperature, or to the rise of the boiling-point dt/dp with pressure (which are merely different ways of expressing the same property of the substance) is easily made in any case in which the latent heat L and volume V of the vapour are known, and affords in fact one of the most direct methods of verifying Carnot's principle by experiment A more dramatic verification was that made by James Thomson (1851), who observed that equation (25) must apply just as exactly to the equilibrium between liquid and solid at the freezing-point, as to that between liquid and vapour at the boiling-point. In the case of solid and liquid, L is the latent heat of *fusion*, and $V-v$ is the increase of volume in melting, which is positive for a substance like wax which expands in melting, but negative for a substance like water which expands on freezing Thus in the case of wax, the sign of dt/dp should be positive, or the melting point should be raised by pressure (as is always the case for the boiling-point), whereas in the case of water the sign should be negative, or the freezing-point should be lowered by pressure. Taking the known values of L and $V-v$ for water and ice, he predicted that the freezing-point of water should be lowered 0·0075° C per atmosphere of pressure, a result which was immediately verified by his brother, Lord Kelvin, and materially assisted in the final establishment of the second law of thermodynamics.

Application to Gases, Absolute Scale of T.—The application of Carnot's equation (24) to the case of a gas obeying the law $PV=RT$, is equally simple. The whole work W done in isothermal expansion, is represented by the analytical expression $RT\ ln\ r$, where $ln\,r$ denotes the natural logarithm of the ratio of expansion. It immediately follows, as Carnot remarks, that $dW/dt=Rlnr$, or is simply equal to W/T. Thus equation (24) reduces to the form,

$$W/T=Q\ F't. \qquad (26)$$

Carnot deduced from this relation that the ratio W/Q of the work done to the heat absorbed in isothermal expansion must be the same for all gases at the same temperature, and that if equal volumes of different gases were taken at the same temperature

and pressure (or masses proportional to the molecular weights) the heat Q absorbed in isothermal expansion must be the same for all gases under similar conditions since the work W was the same for all It followed as a special case that the *difference* of the specific heats at constant pressure and volume, being the heat absorbed in an isothermal expansion equal to V/T, must be the same for equal volumes of all gases His endeavours to extract a value of $F't$ from this relation gave results similar to those obtained from steam and other vapours, but failed to give a decisive conclusion owing to the uncertainty of the ratios of the specific heats as deduced from the velocity of sound. At a later date when Joule (1845) proved by direct experiment that the heat absorbed by a gas in isothermal expansion was approximately *equivalent* to the work done, it became evident, by substituting $W=JQ$ in equation (26) that the value of $F't$ must be nearly equal to J/T for all substances But since according to Regnault's experiments (1847) the temperature scales of actual gases differed quite appreciably, different gases would give different values of T at the same temperature, and it was impossible to say which should be selected The essential point of Carnot's principle being that the value of $F't$ was *the same* for all substances at the same temperature, the most logical method was that proposed by Kelvin, to define absolute temperature T as being proportional to the reciprocal of Carnot's function Exact consistency with Carnot's principle and with the law of conservation of energy could thus be secured, while leaving the deviation of the scale of any particular gas from the absolute scale thus defined to be determined by experiment in each case

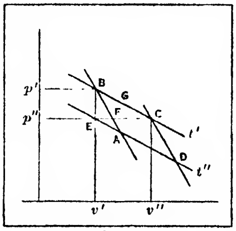


FIG 3

Carnot Cycle of Finite Range—If we substitute J/T for $F't$ in Carnot's equation (24) in accordance with the definition of absolute temperature T, and also write $W=JQ$ as required by the first law, the equation reduces to the form $dQ/dT=Q/T$, which tacitly involves the law of conservation of energy in addition to the adoption of Carnot's principle for the definition of the scale of temperature The relation in this form implies that, if the range of the cycle is extended to any lower temperature, the ratio Q/T will remain constant, and the heat converted into work will increase in direct proportion to the range of temperature, since the constant ratio Q/T is equal to dQ/dT representing the heat converted into work per degree fall Thus the formula for a Carnot cycle of finite range, in which a quantity of heat Q' is supplied to the working substance at T', and a quantity Q'' is rejected at T'', with the conversion of heat $Q'-Q''$ into work W, reduces to the simplest possible form, namely,

$$W/(T'-T'')=J(Q'-Q'')/(T'-T'')=JQ'/T'=JQ''/T'', \quad (27)$$

in which the reduction factor J may be omitted if Q is expressed in work units

Entropy—The quantity Q/T which remains constant in a Carnot cycle of any range bounded by two adiabatics, is called the entropy of the heat Q supplied at a temperature T According to (27) the entropy of the heat supplied at T', is equal to the entropy of the heat rejected at T''. The entropy difference between any two adiabatics is constant, or the adiabatics are lines of constant entropy, and are often called isentropics The thermal equivalent of the work done in any Carnot cycle is the product of the entropy supplied, namely Q'/T', by the range of temperature $T'-T''$. This relation is frequently the most convenient for calculating the work obtainable, not only in a Carnot cycle, but also in a cycle of any form

Clapeyron's Relations.—Clapeyron (1834) observed that Carnot's principle, as represented by equation (24), implied the existence of certain general relations between the quantity of heat absorbed in isothermal expansion and the pressure and expansion coefficients of the working substance He employed the indicator diagram, as illustrated in fig. 3, for the deduction of these relations by a method equivalent to that employed by Maxwell, *Theory of Heat* (1870). The coordinates of the point B are the pressure p', and the volume v' of unit mass of the substance at a temperature t'. Let the substance expand from B to C along the isothermal at t' absorbing a small quantity of heat dQ, while its volume increases from v' to v'', and its pressure diminishes from p' to p''. Draw the line of constant volume v' through B intersecting the line of constant pressure p'' through C in the point E Through E draw the isothermal EAD at the temperature t''. Complete the Carnot cycle by drawing the adiabatics BA and CD through B and C In the limit, when the difference of temperature $t'-t''$ is small, it may be represented by dt as in Carnot's equation (24), and the form of the cycle $ABCD$ will become a parallelogram as indicated in the figure. The area $ABCD$ represents the work dW done in the elementary cycle, and is equal to that of the rectangle $BE\times EC$, or to $(p'-p'')(v''-v')$. Making these substitutions in Carnot's equation (24), we obtain the general relation,

$$(p'-p'')(v''-v')/(t'-t'')=F't\times dQ \quad (28)$$

In order to interpret this relation in terms of the pressure coefficient at constant volume, or the expansion coefficient at constant pressure, as may be desired, we may in the first place transfer $v''-v'$ to the right hand side of the equation We then observe that $p'-p''$ is the increase of pressure BE at constant volume corresponding to the increase of temperature $t'-t''$, so that the ratio represents the familiar pressure-coefficient at constant volume, denoted by $(dp/dt)_v$ in the usual notation of partial differential coefficients Similarly $dQ/(v''-v')$, being the ratio of the heat absorbed at constant temperature to the corresponding increase of volume, may be denoted by $(dQ/dv)_t$ in the same notation If we also substitute J/T for $F't$ in accordance with the definition of absolute temperature, we obtain,

$$T(dp/dt)_v=J(dQ/dv)_t \quad (29)$$

which is often called the first thermodynamical relation, and was in fact employed by Kelvin as a general expression for Carnot's principle in his first exposition of the equations of thermodynamics (1851), except that he retained the symbol μ for $F't$, following Clapeyron, in place of substituting J/T, as in (29), according to modern practice

Pressure and Expansion Coefficients—The utility of a relation of this kind lies in the fact that small quantities of heat absorbed in expansion are very difficult to measure, but can usually be calculated with the aid of relations like (29) in terms of other coefficients, such as the pressure coefficient Many examples of this will be given later If the relation (29) itself is not directly applicable, it can usually be transformed by purely mathematical relations between the various coefficients into a different shape which is more convenient for the purpose required For instance the pressure coefficient $(dp/dt)_v$ is seldom directly measurable in the case of a solid or a liquid, owing to the difficulty of keeping the volume constant while the temperature is being raised. The difficulty of measuring the pressure-coefficient may be avoided by using the familiar relation,

$$(dp/dt)_v=-(dp/dv)_t(dv/dt)_p \quad (30)$$

giving the required value in terms of the isothermal elasticity and the coefficient of expansion at constant pressure, both of which can be measured. Relation (30) is one of the commonest examples in practice of the general relation between the partial differential coefficients of any three quantities, such as x, y, z, connected by a single equation, such that any one of the three may be regarded as a function of the other two. It is most easily remembered in the cyclical form,

$$(dx/dy)_z(dy/dz)_x(dz/dx)_y=-1. \quad (31)$$

from which any required relation of this type such as (30) may be written down by replacing p, v, t, by x, y, z, or *vice versa*. But as relations of this type are usually required in the form (30), it may be as well to explain how they are deduced from first principles. The volume v of unit mass of any substance depends on the temperature t and the pressure p either of which may vary independently of the other. Any expansion due to change

of temperature alone, is found by multiplying the rise of temperature dt by the expansion per degree at constant pressure, represented by the coefficient $(dv/dt)_p$. Similarly any change of volume due to increase of pressure alone, is given by the product of the increase of pressure dp by the isothermal compressibility $(dv/dp)_t$. In the general case, when both p and t change, the whole expansion dv is the sum of the two independent effects,

$$dv = (dv/dt)_p dt + (dv/dp)_t dp. \quad (32)$$

Similar formulae apply to all other properties of the substance depending on p and t and are frequently required in thermodynamics In the case of the volume v, it is immediately obvious from (32) that, if the compression due to increase of pressure dp is equal to the expansion due to increase of temperature dt, the volume will remain constant, or $dv=0$. The ratio of dp to dt at constant volume, or the required coefficient $(dp/dt)_v$, is obtained in terms of the other two by putting $dv=0$ in (32), dividing by dt and transposing, which gives the required relation in the form (30) if we observe that the isothermal elasticity $(dp/dv)_t$ is the reciprocal of the isothermal compressibility $(dv/dp)_t$.

Second Relation—From the first thermodynamical relation, as given in equation (29), Clapeyron deduced his second relation, for the heat evolved in isothermal compression, by substituting for $(dp/dt)_v$ the expression given in (30), which leads immediately to the corresponding expression for $(dQ/dp)_t$,

$$T(dv/dt)_p = -J(dQ/dp)_t \quad (33)$$

in terms of the coefficient of expansion at constant pressure. The negative sign in this relation indicates that heat is *evolved* by an increase of pressure, whereas heat is absorbed when the volume increases. There are several other thermodynamical relations, which are in effect equivalent to Carnot's equation (24), but the two originally given by Clapeyron are the most useful, and suffice for the majority of practical requirements. It will be observed that they are not independent relations, since one can be deduced from the other by a purely mathematical transformation, but either may be employed as required with the certainty of obtaining results consistent with the laws of thermodynamics

Specific Heats.—The specific heats are among the most familiar and useful coefficients in practice since they are commonly required for calculating quantities of heat. They are usually measured by observing the quantity of heat given up by a body in cooling through a large range of temperature, and are often treated as constants But in addition to the variation with temperature, as illustrated in the articles HEAT and CALORIMETRY, the results found may depend to a great extent on other conditions, such as pressure, in a manner subject to the laws of thermodynamics and amenable to calculation. In dealing with variable specific heats, the general expression for the specific heat of any substance at a temperature T is the ratio dQ/dT of the small quantity of heat dQ supplied per unit mass to the corresponding rise of temperature dT produced; but it is also necessary to specify the conditions under which the measurement is made, as these may affect the result. The two simplest cases are those in which the specific heat is measured, (a) at constant pressure, (b) at constant volume, though the latter condition can seldom be realised satisfactorily in the case of a solid or liquid For this reason it is useful to have a relation giving the specific heat at constant volume in terms of that at constant pressure. The required relation may be obtained most directly by the aid of Clapeyron's relation (33) in the following manner, which also gives incidentally the expression for any other variety of specific heat.

Difference of Specific Heats.—To find a general expression for the specific heat dQ/dT under any condition, write down the general expression for dQ in terms of dt and dp, exactly as for v in (32), by simply replacing the letter v in (32) by the letter Q, and divide each term in the expression by dt, thus we obtain,

$$dQ/dt = (dQ/dt)_p + (dQ/dp)_t dp/dt. \quad (34)$$

The first term on the right, namely $(dQ/dt)_p$, representing the heat absorbed per unit mass per degree rise of temperature at constant pressure, is obviously the specific heat as ordinarily measured at constant pressure, which may be denoted by S_p. The next coefficient, $(dQ/dp)_t$, represents the heat evolved per unit mass per unit increase of p in isothermal compression The value of this is given by Clapeyron's second relation (33) in terms of the coefficient $(dv/dt)_p$ Since the specific heat is usually required in thermal units, it is best to retain the reduction factor $1/J$, explicitly in equations expressed in thermal units, in which it is usually represented by the single letter a for convenience in writing or printing. The last factor dp/dt must be taken to correspond with the condition under which the specific heat dQ/dt is desired. Thus if we require the specific heat at constant volume $(dQ/dt)_v$, or S_v, we must also append the suffix v to dp/dt implying that it must be taken at constant volume Making these substitutions in (34) we obtain the required expression for S_v,

$$S_v = (dQ/dt)_v = S_p - aT(dv/dt)_p(dp/dt)_v \quad (35)$$

Saturation Specific Heat—As a further illustration of the same method, if we require the specific heat S_s of a wet vapour maintained in the state of saturation, implied by the suffix s, we have merely to replace the suffix v in (35) by the suffix s, thus,

$$S_s = (dQ/dt)_s = S_p - aT(dv/dt)_p(dp/dt)_s \quad (36)$$

in which $(dp/dt)_s$ represents the rate of increase of saturation pressure p with temperature, which is usually much larger than $(dp/dt)_v$ for the *dry* vapour. For this reason S_s is often negative, whereas S_v though smaller than S_p, is always positive. Thus, in the case of wet steam at 100° C, $S_s = -1\ 04$

By means of these and similar relations the variation of any specific heat can be calculated if one specific heat, such as S_p or S_v is known by experiment at the required temperature. In some cases these variations may be considerable, especially near the critical point of any substance In general, if the path on the indicator diagram along which the specific heat is to be measured approaches the isothermal, the specific heat will become very large. If the path coincides with the isothermal, the specific heat becomes infinite, because there is finite absorption of heat while $dt=0$ When the path on the diagram is a little steeper than the isothermal the specific heat becomes *negative*, changing from positive to negative infinity in crossing the line. For any path between the isothermal and the adiabatic the specific heat is negative, falling to zero when the path coincides with the adiabatic ($dQ=0$), and changing to positive again on the other side Such changes would be very troublesome to deal with in experimental work, if the thermodynamic relations did not afford a complete method of taking them into account.

Cooling Effect in Adiabatic Expansion.—The efficiency of any heat engine depends primarily on the range of temperature through which the working fluid can be cooled while converting its heat energy into work done in adiabatic expansion. It is important for this reason to be able to observe and calculate the cooling effect, which is most conveniently defined as the ratio of the drop of temperature dt to the drop of pressure dp under the condition that no heat is supplied to the working fluid, and that the expansion is frictionless and reversible The heating effect in compression is the same coefficient with the signs of both dp and dt reversed, so that its value is the same as that of the cooling effect in expansion. To find a thermodynamic expression for the cooling effect under the condition $dQ=0$, we may put $dQ/dt=0$ in the general expression (34) for the specific heat; in which case we must also take dp/dt in (34) under the same condition at constant Q, *i.e*, we must write $(dp/dt)_q$, which is the reciprocal of the required cooling effect $(dt/dp)_q$. Substituting as before from Clapeyron's relation (33), we obtain immediately,

$$S_p(dt/dp)_q = +aT(dv/dt)_p \quad (37)$$

which gives a general expression for the cooling effect, in terms of the specific heat and the coefficient of expansion, both at constant pressure, and comparatively easy to determine by experiment.

Thus if the specific heat of a *liquid* and its coefficient of expansion are known, as is the case for most liquids, it is easy to calculate the heating effect of a sudden compression. The effect is zero for water at its point of maximum density, but increases rapidly with the coefficient of expansion, since S is nearly constant.

In the case of a *gas or vapour*, which approximates to the equation $aPV=RT$ at low pressures, since (dV/dt) approaches the limit R/aP, the expression for the cooling effect becomes RT/SP, corresponding to the adiabatic equation in the form (10), with $S/R=n+1$. This shows that, if a vapour, like steam, obeys an adiabatic equation of this type with n constant, the limiting value S_0 of its specific heat at zero pressure must be constant, *i.e.*, independent of the temperature. Conversely in the case of a gas, such as hydrogen, which follows the law $aPV=RT$ very accurately, there will be no variation of S with pressure, but any variation of S with temperature requires a corresponding variation in the index $n+1$, and in the cooling effect, which is equal to $T/(n+1)P$ In such a case, it is often much easier to measure the cooling effect directly with a thermometer of a well adapted type, than it is to measure the specific heat itself at high or low temperatures. The variation of the specific heat with temperature may then be deduced from observations of the cooling effect. This method was applied by Makower (*Phil. Mag*, Feb. 1903) to verify the constancy of S in the case of steam by observing the cooling effect in a jacketed vessel, at 110° C By allowing the steam to expand suddenly from a pressure of 81 cm to atmospheric and observing the corresponding drop of temperature, he found a value of the index $\gamma=1\ 304$, agreeing closely with that deduced from the engine experiments at much higher temperatures and pressures, as previously described Brinkworth (*Proc Roy Soc*, 1925) employed a similar method for verifying the variation of the specific heat of hydrogen at low temperatures It will readily be understood that it is most important in all such cases to have an exact thermodynamical relation such as (37) between the coefficients to be measured Otherwise the interpretation of the results is apt to be uncertain Thus it is usually possible to allow for the small variations of dv/dt in reducing the results, and similarly for the variations of S with pressure.

The Joule-Thomson Cooling-effect.—This is the most important coefficient of its type, and is most easily measured in steady flow It was first measured by Joule and Thomson (1852), and was defined by them as the ratio of the drop of temperature to the drop of pressure in a pure throttling process, in which the kinetic energy generated by the pressure-drop is completely reconverted into heat without any external heat-loss Under these conditions, as explained previously, the value of H is the same after passing the throttle as in the initial state, except that in any actual experiment at high temperatures it is necessary to make a small correction for heat-loss Since H remains constant in a pure throttling process, the cooling-effect in throttling may be defined as the ratio of dT to dP at constant H and may be denoted by $(dT/dP)_H$ provided that we are dealing with small changes of temperature. In the example previously cited we were concerned only with the fact that the value of H at the high initial pressure and temperature must be the same as that observed at atmospheric pressure after throttling when corrected for heat-loss. The drop of temperature amounted to upwards of 300° C, but the cooling effect represented by the ratio, 300·3°/3789 lb, or 0·07925° per lb, does not enter explicitly into the calculation, though it might be described as the *mean* cooling effect over the given range. To find the limiting value of the cooling-effect *at* a particular temperature and pressure, it is of course necessary to make measurements over much smaller ranges of temperature.

Variation of H with P.—The cooling-effect C at constant H as thus defined, is the ration of the two partial differential coefficients of H with respect to P and T, thus,

$$C=(dT/dP)_H=-(dH/dP)_T/(dH/dT)_P \tag{38}$$

This does not involve thermodynamics, but is merely a special case of the formal relation (30), as is easily verified by writing H in place of V in (30). Putting S for $(dH/dT)_P$ the specific heat at constant pressure, we have the useful relation $(dH/dP)_T=-SC$, giving the variation of H with P at constant T in terms of the specific heat S and the cooling effect C, which are the most easily measured of all coefficients. Another expression for the same coefficient may be obtained by applying the two laws of thermodynamics. From the first law in the form $dH=dQ+aVdP$, as given in (5), dividing by dP at constant T, we find,

$$(dH/dP) = (dQ/dP)_T+aV=-aT(dV/dT)_P+aV \tag{39}$$

in which the second law is involved in the substitution for (dQ/dP) from Clapeyron's second thermodynamical relation (33).

Joule-Thomson Equation.—The utility of relation (39) lies in the fact that it supplies the necessary and sufficient condition which must be satisfied by any expressions selected to represent H and V (the two most important thermodynamical properties of any substance) in order to render such expressions consistent with the laws of thermodynamics. Joule and Thomson made use of (39) in the form

$$SC=aT^2(d(V/T)/dT)_p \tag{40}$$

in order to deduce an expression for V consistent with their observations on the cooling-effect. Their experiments showed that C was approximately independent of the pressure, but varied as $1/T^2$ with temperature for air and CO_2 over the range 0° to 100° C. Integrating (40) at constant P, with S constant, and $C=K/T^2$, they obtained the solution:

$$-SK/3T^3=aV/T-R/P \tag{41}$$

in which the constant of integration R/P was determined by the condition that the equation must approximate to the form $aPV=RT$ when T is very large. The small term $SK/3T^3$, which may be written $SC/3T$, represents the deviations of the actual gas, air or CO_2, from the ideal state, in terms of the observed values of S and C for the gas employed. Thus equation (41) makes it possible to deduce the absolute temperature T from the observed temperature by air thermometer as defined in terms of P and V, but the process of reduction (for which *see* the article THERMOMETRY), is far from being as simple as it might appear to be at first sight. Moreover the original Joule-Thomson equation as given in (41), though it showed that the deviations of air from the ideal state must be very small, was somewhat unsatisfactory in other respects. It failed to explain the heating-effect observed in the case of hydrogen, and made no allowance for the known variation of specific heat in the case of CO_2. These difficulties may be avoided in practice by reversing the procedure Assume a convenient type of equation for V, differentiate to find the expression for SC as in (39), and determine the constants by comparison with experimental results for S and C

Modified Equation—A suitable equation of a type similar to (41), is the following,

$$V-b=RT/aP-c, \text{ where } c=c_1(T/T)^n \tag{42}$$

The small constant b, called the covolume, may be regarded as representing the limiting volume of the molecules at high temperatures and pressures. The small correction term c, called the coaggregation volume, represents the defect from the ideal volume caused by coaggregation or pairing of molecules. This is assumed to vary inversely as the nth power of T, and c_1 is the value of c at any convenient temperature T such as 0_0 C On this assumption c is a function of the temperature only, and $dc/dt=-nc/T$ Differentiating equation (42) in order to find SC as given by (39) or (40), we obtain,

$$SC=aT(dV/dT)_P-aV=a(n+1)c-ab \tag{43}$$

from which the values of the constants c, n, and b, may be deduced, when the values of S and C are known by observations taken over a sufficient range. It is easy in this way to take account of any variations of S with temperature or pressure. The slope of the isothermals on the Amagat diagram, in which PV is plotted against P, is represented by $d(PV)/dP=-c+b$, and is *positive* in the case of hydrogen (for which PV increases with P) because b is so much larger than c at ordinary temperatures. For the same reason the cooling effect C is *negative*, as found by Joule and Thomson, who observed a *rise* of temperature with *drop* of pressure in throttling. This result is explained by (42), if b exceeds $(n+1)c$, as is actually the case with hydrogen.

Expression for the Total Heat H.—The same equation (42) may be employed as a simple illustration of the general method of deducing consistent expressions for the total heat and the entropy of a substance when an equation for V in terms of P and T has

been obtained by the above method. To find an expression for H we start with the general formula for dH in terms of S and C, thus,

$$dH = SdT - SCdP. \qquad (44)$$

Since the value of H depends only on the state, we may perform the integration along any convenient path, starting from any convenient zero The simplest method is to integrate the first term from 0 to T at zero pressure, since the value of S at zero pressure, denoted by S_0, is a function of the temperature only. We may denote this integral by S_mT where S_m is the mean value of S_0 from 0 to T. We then have to add the integral of the second term at constant T from $P=0$ to P. In the present case, since SC is a function of T only, as given by (43), the integral of $SCdP$ is simply SCP. Adding the two terms, we obtain the general expression for H at T and P,

$$H - B = S_mT - SCP \qquad (45)$$

in which the constant of integration B is determined by reference to any known value of H at some definite point, such as 100° C and atmospheric pressure In the case of steam, S_m may be taken as constant and equal to S_0.

Variation of the Specific Heat S with Pressure.—According to (45) the specific heat S at constant pressure will be a function of both temperature and pressure The required expression for S is easily obtained by differentiating (45) at constant pressure, thus,

$$S = (dH/dT)_p = S_0 + an(n+1)cP/T. \qquad (46)$$

This shows that, with an equation of the type (41) or (42), S cannot be constant, as assumed by Joule and Thomson in the integration of (40), and invalidates their method of deducing (41), but the same objection does not apply to the reverse procedure employed in deducing (42). The variation of S with pressure at constant temperature for any equation of this type can also be obtained from the consideration that H is a definite function of P and T depending only on the state, so that if we differentiate S as found in (46) with regard to P at constant T, we must obtain identically the same result, namely $d^2H/dPdT$, as by differentiating $(dH/dP)_T$ (or $-SC$) with regard to T at constant P. Using the general expression for SC given in (39), we obtain,

$$(dS/dP)_T = -(dSC/dT)_P = -aT(d^2V/dT^2)_P \qquad (47)$$

which shows that S cannot be independent of the pressure, if SC is a function of the temperature. From another point of view (47) represents the condition that dH as given in (44) should be the exact differential of a definite function of P and T, as must be the case if H is a property of the substance depending only on the state as defined by P and T. On the other hand if we apply the same condition to the general expression for dQ, namely,

$$dQ = SdT - aT(dV/dT)_P dP \qquad (48)$$

we observe that (47) cannot be satisfied in the case of dQ consistently with the second law of thermodynamics, because the heat added in any transformation is not simply a property of the substance depending on the initial and final states, but depends essentially on the process by which the transformation is effected In other words, dQ is not the exact differential of any function of P and T, and cannot be integrated without knowing the relation between P and T defining the process But if the path is given, Q can always be found from (48). Thus if the path on the indicator diagram is a straight line defined by $dP = kdT$, $dQ/dT = S - akT(dV/dT)_P$, and the required value of Q can be found for any substance for which the specific heat and the coefficient of expansion are known. The heat required for any transformation is often required in practice, and may always be obtained in this way, if the path is given.

Expression for the Entropy Φ.—If a small quantity of heat dQ per unit mass is supplied to any substance at a temperature T, the corresponding increase of entropy $d\Phi$ is dQ/T. Thus we obtain immediately from (48),

$$d\Phi = dQ/T = (S/T)dT - a(dV/dT)_P dP. \qquad (49)$$

If we apply the mathematical test for an exact differential, as in (47), we find,

$$(d[S/T]/dP)_T = (1/T)(dS/dP)_T = -a(d^2V/dT^2)_P \qquad (50)$$

which, it will be observed, is precisely the same as that found for dH. We conclude that Φ like H may be regarded as a property of the substance depending only on the state, and capable of tabulation in terms of P and T.

Since Φ itself cannot be measured in practice in any convenient manner, it is usually deduced for any substance from the expression found by experiment for H Since $dQ = dH - aVdP$, by (5), taking dH from (44), we obtain,

$$d\Phi = dQ/T = (S/T)dT - (SC/T + aV/T)dP \qquad (51)$$

which is seen to be identical with (49) if we substitute for SC from (39). This may be integrated, as in the case of H, from 0 to T at zero pressure, with $S = S_0$, and from 0 to P at constant T. Taking as an example the simple equation (42) for V, with SC from (43), we find the expression,

$$\begin{aligned}\Phi - A &= \int(S_0/T)dT - \int(R/P + anc/T)dP \\ &= S_0 \ln T - R\ln P - ancP/T \qquad (\ln = \text{rat. log}) \qquad (52)\end{aligned}$$

in which A is the constant of integration determined in the usual manner.

Use of the Entropy—It should be observed that the entropy is not an independent property of the substance, since it can be deduced from H and V, but it is most useful in practice for defining the process of frictionless adiabatic expansion, and for deducing the maximum work obtainable from a quantity of heat supplied to the working substance under specified conditions. As a simple example we may take the case of the steam-turbine. Any part of the heat received (e g , in the superheater) at the constant initial pressure P' is represented in virtue of relation (3) by the increase DH of the total heat of the steam over the range considered Let $D\Phi$ represent the increase of entropy taken from the tables over the same range of temperature In the ideal cycle after adiabatic expansion the corresponding part of the heat rejected at the constant temperature T'' of the condenser will be $T''D\Phi$. The difference $DH - T''D\Phi$ represents the work obtainable from this part DH of the heat supplied, and the ideal efficiency is given by $1 - T''D\Phi/DH$. Thus it becomes possible to estimate the thermal efficiencies of different stages of the heating system, as depending on the temperature T' of heat reception by the working fluid.

The equivalent of the work theoretically obtainable in any part of an ideal cycle included between two adiabatics may also be found by subtracting the heat-drop along the lower adiabatic from that along the higher adiabatic This gives the same result as subtracting the heat rejected from the heat received, but saves trouble in calculation if tables of adiabatic heat-drop are available.

If the "mean effective temperature" T_m of heat reception DH at constant pressure P is defined as being equal to $DH/D\Phi$, the expression for the ideal efficiency of the cycle between the two adiabatics differing in entropy by $D\Phi$ reduces to the form $1 - T''/T_m$, the same as that of a Carnot cycle in which all the heat is received at one temperature T_m. As G M Clarke has pointed out, the mean effective temperature thus defined affords a convenient method of expression for the ideal efficiency of any cycle as compared with the Carnot cycle. But it does not supersede the use of the entropy, which is required in order to be able to calculate T_m.

Efficiency of Expansion in a Turbine—The foregoing method of finding the efficiency of *an ideal cycle*, or part of a cycle, between two adiabatics, depends on assuming that the useful work done is equal to the excess of the heat received over that rejected by the working fluid, and is restricted to the case in which no losses are incurred in expansion, and all the heat is rejected at one temperature T'', as in the condenser of a steam-engine or turbine. The method gives the fraction of the heat received in any part of *the heating system* which could be converted into work by a *perfect* engine under the conditions imposed. On the other hand, in analysing the performance of an actual engine or turbine, it is necessary to take account of losses incurred *in the engine* during the expansion, and to compare the actual performance with that obtainable in adiabatic expansion under ideal conditions over the same range. The general principle of the method by which this may be accomplished in the case of a

turbine is as follows:

The Case of Dry Steam.—As explained previously, and implied by equation (12), the drop of H in expansion through a turbine, when corrected for the minor losses Q and K, is the equivalent of the useful work done by the steam. So long as the steam is *dry*, the value of H at any point of the expansion can be determined by observing the pressure and temperature, and the actual drop of H, denoted by DH, between any two points can be deduced. The work theoretically obtainable in frictionless expansion can also be found from the adiabatic equation as shown in (17). The ratio of the actual heat-drop DH, as corrected, to the adiabatic heat-drop for the same drop of pressure, gives the efficiency of any stage or section of the turbine. This simple method fails when the steam is *wet*, as usually happens towards the end of the expansion, because there is no satisfactory means of measuring the degree of wetness under these conditions at low pressures. But if the initial value Φ of the entropy is known, the adiabatic heat drop can still be found from the final temperature T'', with the aid of the tables giving H_s'' and Φ_s'' for *dry saturated* steam, since for *wet* steam in the state H'', Φ'', at any temperature T'' we have the simple relation,

$$H_s''-H''=T''(\Phi_s''-\Phi''). \quad (53)$$

Heat-Drop for Wet Steam—Putting $\Phi''=\Phi'$ in (53) the final H'' for wet steam at T'', in adiabatic expansion, is obtained in terms of the tabulated values H_s and Φ_s. Thus we obtain for the adiabatic heat-drop from the initial state H', Φ'.

$$H'-H''=H'-H_s''+T''(\Phi_s''-\Phi') \quad (54)$$

Equation (54) is also the appropriate equation to employ for finding the adiabatic heat-drop over the whole range of expansion in the turbine, from admission to exhaust, when the final state of the steam is wet, as is usually the case with a condensing engine. It is equally applicable to the case of a reciprocating engine, since the discontinuities involved in the operation of this type of engine are supposed to be absent from the ideal cycle. The heat-drop thus found may be compared with the work actually done per lb. of steam, as deduced from measurements of the feed and the power, for which *see* STEAM-ENGINE

Equation (53), with Φ'' constant and equal to Φ' may be regarded as the simplest and most useful form of the adiabatic giving the final value H″ of the total heat for a wet vapour, when tables of Φ and H are available It may be expressed if desired in terms of H and T only, but cannot be put in the usual form (9) or (10) (as is often attempted), because the value of the index γ varies so much with temperature and wetness as to make the equation difficult to use and less accurate in practice than measurements on a diagram

Types of Characteristic Equation.—The general relation between P, V, and T, which exists for any substance in various states is commonly called the characteristic equation, or equation of state, of the substance. It has often been thought possible to include both liquid and vapour states in a single equation, such as that of van der Waals, since the properties of the two states approximate to each other in the critical region, and show a continuous transition above the critical pressure This will be further discussed in the article VAPORIZATION dealing with the relations between the two states. For the present purpose we may confine our attention to a few simple types of equation for the gas or vapour state, which is of primary importance in practice in relation to heat engines. It appears that all simple substances with stable molecules tend to approximate in the vapour state at low pressures to the ideal gas equation $PV=RT$, in which the value of the constant R varies inversely as the molecular weight (if V is the volume of unit mass) and is equal to the difference of the specific heats in work units. An equation of this type receives a satisfactory physical explanation on the kinetic theory of gases, but it is the province of thermodynamics to indicate how the simple gas equation must be modified to take account of deviations from the ideal state, and to interpret the results of various experimental methods as applied to the problem.

One of the commonest methods of measuring these deviations is to observe the variation of the volume with pressure at constant temperature. The values of the product PV should then be constant if Boyle's law is obeyed, and should give a horizontal line on the $PV-P$ diagram. As a rule the isothermal lines thus plotted from observations at various constant temperatures, are nearly straight for a moderate range of pressure at each temperature, but have a downward slope, represented by $d(PV)/dP=-c$, where c diminishes with rise of temperature as the vapour approximates more closely to the ideal state. Observations of this kind could be represented by an equation of the type (42) by assuming PV to be proportional to T at low pressures, and choosing c, or $c-b$, to be a suitable function of the temperature But even if all the isothermals were found to be horizontal, this method by itself would not prove that PV was proportional to the absolute temperature, as in $PV=RT$, since Boyle's law would be perfectly satisfied by an equation of the type, $PV=F(T)$, with $F(T)$ any arbitrary function of the temperature

Fortunately the Joule-Thomson method, as described on page 98, affords an independent means of verifying the form of the characteristic equation. It has the additional advantages of being easy to apply and of measuring the small deviation itself, without requiring any absolute measurements of volume, which are essential to the Boyle's law method, and very exacting. As shown by the thermodynamic expression (40) for the cooling effect, any substance for which $C=0$ must have a characteristic equation of the general type $V/T=F(P)$, in which $F(P)$ represents any arbitrary function of the pressure. The ideal gas, $PV=RT$ is a special case for which $F(P)=R/P$. The condition $C=0$ by itself leaves the form of $F(P)$ indeterminate. But when the same gas also satisfies Boyle's law, which requires a characteristic equation of the form $PV=F(T)$, the two conditions can be simultaneously satisfied only by the ideal gas equation $PV=RT$. Joule and Thomson were therefore justified in their choice of the constant of integration R/P in equation (41), since the gases they employed also satisfied Boyle's law at low pressures

Type of Equation Required by Condition (6)—Another case of practical interest is to find the general form of characteristic equation compatible with condition (6), and with the simple form of adiabatic equation (9), which follows by the first law of thermodynamics from the assumption that the change of intrinsic energy is proportional to that of aPV as expressed in (6) Equations (6) and (9) make no mention of temperature, and it is obvious that the deduction of the relation between PV and T must essentially involve an appeal to the second law with its implicit definition of T. The most direct way of doing this is to find the two specific heats, S_p and S_v, from H and E as given by (6), and to equate the difference, S_p-S_v, thus found to the expression (35) for the difference of the specific heats as given by the second law Thus by differentiating (6) at constant volume we obtain for the specific heat S_v,

$$S_v=(dE/dT)_v=an(V-b)(dP/dT)_v \quad (55)$$

Similarly by adding aPV to (6) to give $H-B$ instead of $E-B$, and differentiating H at constant pressure, we obtain for the specific heat S_p,

$$S_p=(dH/T)_p=a(n+1)P(dV/dT)_p. \quad (56)$$

Substituting the difference of these two expressions for S_p-S_v in (35), and dividing by $a(dP/dT)_v(dV/dT)_p$, we obtain the required expression for T in terms of P and V in the form of a differential equation, namely,

$$T=(n+1)P(dT/dP)_v-n(V-b)(dT/dV)_p \quad (57)$$

which is a special case of Lagrange's linear equation, and is easily solved as follows.

(a) Write down the corresponding subsidiary equations of Lagrange, namely,

$$dT/T=dP/(n+1)P=-dV/n(V-b) \quad (58)$$

(b) Find any two independent solutions of these equations. The two simplest and most obvious solutions of (58) are those given in (10) above, which are alternative forms of the adiabatic equation, and are also solutions of (57). (c) To find the most general solution, including all other possible solutions, make one of these ex-

pressions an arbitrary function of the other. This will be the most general form of characteristic equation consistent with (6) and (9). The most convenient form for most practical purposes, giving V explicitly as a function of P and T, is as follows,

$$P(V-b)/T=F(P/T^{n+1}) \tag{59}$$

which is expressed in words by stating that $P(V-b)/T$ must be constant along any adiabatic represented by $P/T^{n+1}=$ constant Thus (59) includes all possible forms of characteristic equation consistent with the adiabatic found experimentally for steam, and with the expression (6) for the intrinsic energy, which was assumed as the basis of the equations first proposed for steam by the writer (*Proc. R S* 1900, p. 269) At that time none of the experimental evidence available, except that for the adiabatic, extended much beyond 200 lb pressure and 200° C, and the state of knowledge did not justify going further than the first approximation represented by equation (42), in which the arbitrary function F was assumed to be of the simple form $R/a-cP/T$ This proved to be a very good approximation and amply sufficient at moderate pressures or high superheats, but it appeared that higher powers of cP/T would be required at higher pressures, and that no equation of this type could represent the accepted theory of the critical state, as represented by the van der Waals equation

While retaining the fundamental assumption (6) it would evidently be possible to construct an equation of the van der Waals type, giving P as a cubic function of $1/(V-b)$, by replacing P/T^{n+1} in (59) by $1/(V-b)T^n$, as follows,

$$aP(V-b)/RT=1-c/(V-b)+c^2/3(V-b)^2 \tag{60}$$

which would give a critical point of the usual type defined by the conditions,

$$V-b=c=RT/3aP, \tag{61}$$

but in the absence of accurate experimental data it was impossible to predict that this would be more satisfactory than (59) in terms of P, whereas it would certainly be much less convenient for practical calculations

It has recently been found possible (*Proc. R S* Sept 1928), to extend the experimental range for water and steam to 400° C and 4,000 lb pressure, including the whole of the critical region Results obtained for water, by the steady flow method described in the article CALORIMETRY, verify the thermodynamic equation there given for the total heat with extreme accuracy up to the critical point Those for steam disagree materially on several fundamental points with the accepted theory of the critical state, and appear to show that an equation of the type (59) is capable of representing the critical phenomena with much greater accuracy than any equation of the van der Waals type Since the points in question are of primary importance with respect to the relations between the liquid and vapour states, they are further discussed in the article VAPORIZATION, though they also afford a good illustration of the application of the laws of thermodynamics to experimental research

As it would be impossible within the limits of this article to illustrate or explain adequately the applications which have been made of the principles of thermodynamics, it has been necessary to select such illustrations only as are required for reference in other articles, or could not be found elsewhere. For fuller details and explanations of the elements of the subject, the reader must refer to general treatises, such as Ewing's *Thermodynamics for Engineers* (Cambridge, 1920), Birtwistle's *The Principles of Thermodynamics* (2nd ed, Cambridge, 1927) or Preston's *Theory of Heat* (5th ed., 1928). One or two chapters on the subject are also generally included in treatises on the steam engine or other heat engines, such as those of Rankine, Ewing, or Perry. Of greater interest, especially from a historical point of view, are the original papers of Joule, Kelvin and Rankine A more elaborate treatment of the subject will be found in many foreign treatises, such as those of Clausius, Zeuner, Duhem, Bertrand, Planck and others. (H L C.)

THERMODYNAMICS AND PHYSICAL CHEMISTRY

Introductory.—The principles of thermodynamics (introduced in their modern form by Clausius in 1850) are the basis of a method of dealing with mechanical problems in which heat exchanges take place, without the necessity arising of considering the detailed mechanical structure of a system. The system may consist of an assemblage of an enormous number of molecules in agitated movement and exerting attractions and repulsions upon one another. Very little can be found out about the individual motions and positions of these particles Thermodynamics provides a means of examining certain properties of matter in bulk. The principles that are discovered form the basis of the preceding article and reference must be made to that article for their description and proof They are applied there mainly to the properties of steam and its applications to steam-engines In the present article which deals with the application to bodies in general we must be content with summarizing the fundamental facts which will be utilized

i. The intrinsic or internal energy of a body can change by the entry of heat (by conduction or radiation) and by the performance of external work, i e, $dE=dQ-dW$ provided the system remains sensibly in equilibrium (*Conservation of energy*).

ii. A body may get hotter even if no heat flows in. The energy depends on the temperature and this is increased if work is done upon the system even when dQ is zero (*Adiabatic changes*).

iii The energy, E, depends only upon the state, so that, in whatever way the system is changed, if the original state is returned to the initial value, E, is recovered

iv. The work done depends in general not only upon the initial and final states but also upon the path of transformation.

This results from the fact that three variables at least are necessary to specify the state, viz, pressure, volume and temperature, and they are connected by only one equation (the equation of state). The work done is in each case $\int pdV$. In a complete cycle the work done is equal to the area enclosed by the cycle on a p, V diagram For any given value of V, T and therefore p may have different values on the return and forward paths and the cycle encloses an area It follows that for an *isothermal* reversible cycle the pressure for any given volume is fixed and the work done must be zero for the path then returns on itself

v The energy E depends on both the temperature and the volume for internal work can be done against molecular attractions when the volume changes.

When the system is subjected to a uniform pressure the fundamental equation becomes $dH=CdT+ldv$.

We select unit mass for consideration. In this case C is the specific heat at constant volume and $l\left(=\frac{\Delta H}{\Delta v}\right)$ is the latent heat of expansion In the case of a perfect gas, for which the characteristic equation is $pv=RT$ and for which no internal attractions exist, so that the internal work is zero

$$dH=C_vdT+pdv$$

which can be put in the alternative forms (by using the characteristic equation)

$$dH=C_pdT-vdp=\frac{1}{R}(C_ppdv+C_vvdp)$$

where C_v and C_p are the specific heats at constant volume and at constant pressure.

From these for adiabatic changes ($dH=0$)

$$C_vdT+\frac{RT}{v}dv=0 \quad \text{or} \quad vT^{C_v/R}=\text{const}$$

$$C_pdT-\frac{RT}{p}dp=0 \quad \text{or} \quad \frac{T^{C_p/R}}{p}=\text{const.}$$

$$\text{and} \quad C_ppdv+C_vvdp=0 \quad \text{or} \quad pv^{C_p/C_v}=\text{const}$$

The work done is $\int pdv=-C_v\int dT=C_v(T_1-T_2)$

It is presumed that the changes are reversible throughout. A very quick change is always irreversible owing to the rushes of material that take place. The only way to bring about approximate reversibility is to keep the heat from getting in or out as well as possible by means of non-conducting boundaries.

vi. The second law of thermodynamics enables relations to be found between the several quantities (or their derived quantities). According to this law the work that can be done in a reversible Carnot cycle is the maximum possible for the two extreme temperatures concerned, and, *independently of the working substance*, the work done divided by the heat taken in at the higher temperature is equal to $(T_1 - T_2)/T_1$: where T_1 and T_2 are absolute temperatures on the perfect gas scale. This ratio is called the efficiency.

[This law is derived from the fact that heat can only flow *down* a gradient of temperature. Clausius showed that if a more efficient performance were obtainable it would be possible to make a hot body hotter while simultaneously a cold one became colder without any performance of work. This would entail that heat flowed *up* the temperature gradient.]

vii. Since the efficiency is also given by $\dfrac{W}{Q_1} = \dfrac{Q_1 - Q_2}{Q_1}$ we deduce that $\dfrac{Q_1}{T_1} = \dfrac{Q_2}{T_2}$.

Now in a Carnot cycle Q_1 and Q_2 are the only transfers of heat (each at constant temperature), if therefore we define a quantity ϕ such that $Td\phi = dQ$ this quantity ϕ undergoes zero change in any complete reversible cycle It is called the entropy of the system per unit mass.

For irreversible changes this definition is not complete In such changes there is kinetic energy of matter in bulk, and friction which is always present is continually frittering the motion down into heat If we regard the system as an assemblage of small elements rubbing against one another the heat produced flows across the boundaries of these elements. In doing so some has entered each element and produces the same changes of p, v, T and entropy as any heat entry would do. When this heat production and corresponding entropy change is summed up for the whole system we have

$$Td\phi = d(Q+q)$$

where q is the heat produced by friction inside the walls of the complete system. Since friction never produces "cold," dq is always positive and consequently for any change

$$Td\phi \geqq dQ.$$

Cases in which the equality sign holds are ideal cases only, but they are approximated to more nearly the nearer a system keeps in equilibrium states throughout.

The quantity T_1 is, as we have said, the absolute temperature according to a perfect gas scale. We could have defined it alternatively in terms of the efficiency equation and it is therefore called the *thermodynamic* temperature. It would have been necessary then to show that it is identical with the ideal gas scale.

The advantage gained by introducing the conception of entropy is that it provides us with a function of Q which depends (unlike Q itself) only upon the state of the system, provided that we measure it for reversible changes only.

viii. When any property of the state of a system (say E) is defined completely by two independent variables (say x and y) so that we can write

$$dE = adx + bdy$$

where $\quad a = \left(\dfrac{\partial E}{\partial x}\right)_y \quad$ and $\quad b = \left(\dfrac{\partial E}{\partial y}\right)_x$

the following mathematical relation must be valid, viz.:

$$\left(\frac{\partial a}{\partial y}\right)_x = \left(\frac{\partial b}{\partial x}\right)_y$$

the suffixes denoting quantities which remain constant during the partial differentiations to which they are appended

This mathematical relation can be applied in the case of reversible changes to E and ϕ which depend only on the state but it cannot be applied to Q or to W, which depend upon the path taken between the extreme states. In consequence some writers prefer not to use the expressions dQ and dW for small changes in Q and W because, for example, these may each acquire different values whether the "co-ordinates" of the system (e.g., v, T) have changed *on the whole* or not. Small changes in quantities which depend only upon the state are said to be perfect differentials.

When there are more than two independent variables we can apply the same theorem to any two of them in turn. For example, adding a third term cdz, we have the additional relations

$$\left(\frac{\partial a}{\partial z}\right)_{x,y} = \left(\frac{\partial c}{\partial x}\right)_{y,z} \quad \text{and} \quad \left(\frac{\partial b}{\partial z}\right)_{y,x} = \left(\frac{\partial c}{\partial y}\right)_{z,x}$$

where two of the independent variables are kept constant in each differentiation.

The employment of thermodynamics in the study of various systems consists very largely of the application of this important mathematical theorem. We shall apply it first to homogeneous systems in equilibrium.

Homogeneous Systems.—A homogeneous system is alike in all its parts. Its state can be defined in terms of its pressure, volume and temperature. Any one of these three may be eliminated by means of the so-called characteristic equation when it is known; so that Q, ϕ, E may be taken as functions of T and v, of T and p, or of p and v Since each portion is the same as any other we can deal with unit mass. Since equilibrium exists the temperature and pressure will be uniform throughout. No assumption will be made as to the molecular constitution of the system, nor, until applications are considered will any assumption be made as to the form of the characteristic equation.

For such a system we can write:

$$dQ = dE + pdv = C_v dT + ldv$$

also $\quad d\phi = (dQ)/T.$

so that $\quad dE = C_v dT + (l-p)dv$

and $\quad d\phi = \dfrac{C_v dT}{T} + \dfrac{l}{T}\,dv.$

It follows that (a) $\left(\dfrac{\partial C_v}{\partial v}\right)_T = \dfrac{\partial}{\partial T}(l-p)_v$

(b) $\dfrac{1}{T}\left(\dfrac{\partial C_v}{\partial v}\right)_T = \left(\dfrac{\partial}{\partial T}\,\dfrac{l}{T}\right)_v.$

The latter (b) multiplied by T gives

$$\left(\frac{\partial C_v}{\partial v}\right)_T = \frac{\partial l}{\partial T} - \frac{l}{T}$$

which, comparing with (a), gives $l = T\left(\dfrac{\partial p}{\partial T}\right)_v$

and $\quad \left(\dfrac{\partial C_v}{\partial v}\right)_T = T\left(\dfrac{\partial^2 p}{\partial T^2}\right)_v.$

For a perfect gas $pv = RT$, whence $T\left(\dfrac{\partial p}{\partial T}\right)_v = p$ and $\left(\dfrac{\partial C_v}{\partial v}\right)_T = 0.$

For a van der Waals gas $\left(p + \dfrac{a}{v^2}\right)(v-b) = RT$, so that

$$T\left(\frac{\partial p}{\partial T}\right)_v = p + \frac{a}{v^2} \quad \text{and} \quad \left(\frac{\partial C_v}{\partial v}\right)_T = 0;$$

whence $dQ = C_v dT + \dfrac{adv}{v^2} + pdv$; the term $\dfrac{a}{v^2}dv$ shows how the energy depends upon the volume.

It will be noticed that these are all cross-relations between different terms. There is no thermodynamical relation giving $\dfrac{\partial C_v}{\partial T}$ because C_v and T both refer to the same term. We know nothing about C_v as a function of T except from experiment and from tentative mechanical theory.

In a similar way if $dQ = C_p dT + l'dp$ (T and p being taken as independent variables) we have

(a) $\quad dE = C_p dT + l'dp - pdv$

and (b) $\quad d\phi = \dfrac{C_p dT}{T} + \dfrac{l'dp}{T}.$

Now $d(pv) = pdv + vdp$; and if this be added to both sides of (a) we have $d(E+pv) = C_p dT + (l'+v)dp$. Since, the product pv

returns to a fixed value whenever p and v do therefore $E+pv$ also depends on the state alone and its change is defined here in terms of dT and dp. Hence

$$\left(\frac{\partial C_p}{\partial p}\right)_T = \left[\frac{\partial}{\partial T}(l'+v)\right]_p$$

and

$$\left[\frac{\partial}{\partial p}\left(\frac{C_p}{T}\right)\right]_T = \left[\frac{\partial}{\partial T}\left(\frac{l'}{T}\right)\right]_p$$

which yield finally $l' = -T\left(\frac{\partial v}{\partial T}\right)_p$ and $\left(\frac{\partial C_p}{\partial p}\right)_T = -T\left(\frac{\partial^2 v}{\partial T^2}\right)_p$

It is to be noted that these equations in reality express the connections that must exist between the properties of a substance in order to bring about the universality of the value of the efficiency if the substances were employed as the working substances in reversible engines working between two given temperatures. A high vapour pressure or a low boiling point does not lead to higher efficiency, the variables being so interconnected that this is impossible.

The above equations hold for any homogeneous systems. The equation

$$dQ = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv$$

is exceedingly important, embodying all that can be learned from the two thermodynamical principles, and serving as a secondary starting point from which other relations may be obtained without further reference to the two principles. For example if x is any other variable we can write

$$\left(\frac{dQ}{dT}\right)_x = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \left(\frac{dv}{dT}\right)_x$$

the suffix x indicating that x is to be kept constant during the differentiation For example, if $x=p$ (the pressure), $\left(\frac{dQ}{dT}\right)_x = C_p$ (the specific heat at constant pressure) and we have

$$C_p = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \left(\frac{\partial v}{\partial T}\right)_p$$

which is an expression for the difference between the two principal specific heats For a perfect gas the right hand side equals R, the gas constant. For a van der Waals fluid it equals

$$R \Big/ \left(1 - \frac{2a}{v^3}\cdot\frac{(v-b)^2}{RT}\right).$$

Berthelot's equation of state is very widely used in calculating the difference of the specific heats. The equation is

$$\left(\alpha + \frac{16}{3\gamma\beta^2}\right)\left(\beta - \frac{1}{4}\right) = \frac{32}{9}\gamma.$$

It is given here in its "reduced" form; *i.e.*, the actual pressures, volumes and temperatures are given as the fractions α, β, γ of their respective critical values Calculating in the same way, this equation leads to

$$C_p - C_v = \frac{32}{9}\frac{p_c v_c}{T_c}\left(1 + \frac{6}{\gamma^2\beta}\right) \text{ approximately}$$

when β is large compared with unity. This can be written

$$C_p - C_v = R\left(1 + \frac{6}{\gamma^2\beta}\right) \doteq R\left(1 + \frac{27}{16}\frac{\alpha}{\gamma^3}\right)$$

where R is the characteristic constant of the gas.

Callendar's simplified equation, $v-b=RT/p-c/T^n$ leads to

$$C_p - C_v = R\left(1 + \frac{ncp}{RT^{n+1}}\right)^2.$$

The last two equations are only applicable when the density is moderate.

Saturation Values.—As a second application, let x denote a change along the line of saturated vapour; then $\left(\frac{dQ}{dT}\right)_x$ becomes σ, the specific heat of saturated vapour, and

$$\sigma = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \left(\frac{\partial v}{\partial T}\right)_{\text{sat.}}$$

Now $\left(\frac{\partial p}{\partial T}\right)_v$ is always positive and $\left(\frac{\partial v}{\partial T}\right)_{\text{sat}}$ is always negative so that σ is always less than C_v and it may even be negative This latter is the case for steam at all temperatures The values for sulphur dioxide have also been studied in detail experimentally by Mathias (*Comptes Rendus*, t cxix. p 849) The importance of this substance in mechanical refrigeration warrants quoting the values in some detail·

t° C	0	20	40	60	80	100	110
σ	−0 410	−0·357	−0 300	−0·235	−0·165	+0 027	+0·062
t° C	120	125	130	140	150	155	
σ	−0·078	−0·176	−0·306	−0 620	−1 253	−3·850	

It appears that for this substance σ is negative except between the temperatures 97·5° C and 114° C. When plotted against temperature the curve is an inverted unsymmetrical U. This is so for all substances but in many cases it lies wholly in the negative region. The value of σ for the liquid along the saturation line has also been studied by Mathias It is positive (because for the liquid $\left(\frac{\partial v}{\partial T}\right)_{\text{sat}}$ is positive) and changes from 0·315 at −20° C to 1·800 at 155° C

We can start equally well from the equation

$$dQ = C_p dT - T\left(\frac{\partial v}{\partial T}\right)_p dp$$

and find

$$\sigma = C_p - T\left(\frac{\partial v}{\partial T}\right)_p \left(\frac{dp}{dT}\right)_{\text{sat}}.$$

The thermodynamic equations employed above are exact. It should be noted, however, that the characteristic equations are only approximate at best. The underlying assumption that is made in deriving them is that the system consists of molecules alike in all respects. Even in such a case it is not to be expected that the p, v, T, equation should be of a simple form. It is much simplified by the fact that we are only concerned with average values No instrument is capable of measuring either the pressure or temperature at a single point and a single moment of time. Each quantity measured is an average value over such a volume or area or time as to maintain a constant value in the equilibrium state. For real fluids molecules may be of different kinds and may be associated with one another in different ways which change with the volume and temperature. In such cases the connection between p, v and T is bound to be of a more elaborate character The only assumption that has been made is that for a definite p, v, T, the constitution is the same whenever these return, after changes, to their original values

Entropy.—Since $dQ=C_v dT+pdv$ for a perfect gas the entropy change is

$$d\phi = \frac{dQ}{T} = C_v\frac{dT}{T} + \frac{R}{v}dv;$$

whence

$$\phi_2 - \phi_1 = C_v \log_e\frac{T_2}{T_1} + R\log_e\frac{v_2}{v_1}$$
$$= C_p \log_e\frac{T_2}{T_1} - R\log_e\frac{p_2}{p_1}.$$

For a van der Waals fluid

$$dQ = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv$$
$$= C_v dT + \frac{RT}{v-b}dv$$

and

$$\frac{dQ}{T} = C_v\frac{dT}{T} + \frac{R}{v-b}dv.$$

Now C_v for such a fluid may be a function of T but not of v, and

experiment shows that, for many gases, it is very nearly a linear function of T through a range of seven or eight hundred degrees centigrade If we write $C_v = c + gT$

$$\phi_2 - \phi_1 = c \log\frac{T_2}{T_1} + g(T_2 - T_1) + R\log\frac{v_2 - b}{v_1 - b}.$$

Thermodynamic Potentials.—It has been explained that, when the possibility of irreversible changes is taken into account the increase in entropy is always greater than that calculated from the heat entry from outside the system, *i.e.*, we may write

$$Td\phi = dQ + Pos$$

where *Pos* is a positive quantity In the ideal case of a reversible change this positive quantity becomes zero. For any change therefore

$$\begin{aligned} dE &= dQ - pdV \\ &= Td\phi - pdv - Pos. \end{aligned}$$

If we subtract $d(T\phi)$ from both sides

$$d(E - T\phi) = -\phi dT - pdv - Pos.$$

If the change is at constant temperature $\phi dT = 0$.

To the quantity brackets on the left Helmholtz gave the name *free energy*. Representing it by F we write, at constant temperature

$$-dF = +pdv + Pos,$$

i e, the isothermal decrease of free energy is equal to the work done by the system plus a positive quantity. Since, for a reversible change, Pos = zero, the work done is then a maximum *for a given isothermal diminution of free energy*. This is known as the principle of maximum work.

The isothermal change of free energy may be greater or less than the change of energy, E, because nothing is specified as to whether heat enters or leaves the system during the isothermal change For in such a change

$$dE = dF - Td\phi \quad (dT = 0)$$

and $Td\phi (= dQ)$ may be positive or negative

If the change is made at constant temperature and constant volume $-dF = Pos$. Hence in any such change the free energy can only decrease.

If the free energy reaches a minimum value in such a change no further decrease can occur. The system (at constant temperature and volume) *must then be in equilibrium*.

In ordinary mechanics a system is in equilibrium when its potential energy is a minimum. In this more general problem where thermal changes must be allowed for this property belongs to the free energy The theorem is general, no assumption has been made in regard to the constitution of the system. Unfortunately difficulties arise in attempting to apply it excepting in the case of an *ideal gas* mixture.

For such an ideal mixture the various components of the system are independent of one another The total pressure, energy, entropy, and free energy are given by the sums of the values for the separate components

Let the constant volume and temperature be V and T, and let the contents consist of a number of gases capable of reacting according to the general law of chemical combination

$$\nu_1 A_1 + \nu_2 A_2 + \cdots = \nu_s A_s + \nu_t A_t +$$

and let them be present when in equilibrium in the proportions

$$N_1 N_2 \cdots N_s N_t \quad .$$

where the values of N are the numbers of molecules of the various kinds present It is necessary, in the first case, to calculate the free energy *per molecule* of each component.

Now reckoning from any arbitrary temperature T_0 we may write

$$E = C_v(T - T_0)$$

$$\phi = C_v \log\frac{T}{T_0} + R(\log v - \log v_0)$$

$$= C_v \log T + R\log\frac{V}{N} + k$$

where k is a constant and the other quantities are the values per molecule. Hence

$$F = C_v T + TC_v \log T + RT\log\frac{V}{N} + kT - C_v T_0$$

Since the temperature is to be treated as constant we may conveniently divide by it and write

$$F/T = C_v + C_v \log T + R\log\frac{V}{N} + k - \frac{C_v T_0}{T}$$

and for N molecules of any one kind this must be multiplied by N Now the total value of the free energy is $\sum(NF)$ and this, or its value divided by the constant T, is to be a minimum for equilibrium, *i e.*,

$$\sum \frac{1}{T}\left(F + \frac{dF}{dN}\right) dN$$

must equal zero But owing to the laws of chemical combination any changes of the quantities must satisfy the equations

$$\frac{dN_1}{\nu_1} = \frac{dN_2}{\nu_2} = \cdots - \frac{dN_s}{\nu_s} = -\frac{dN_t}{\nu_t}.$$

Hence $$\sum_{1,2,\text{etc}} \left(F + \frac{dF}{dN}\right)\nu = \sum_{s,t,\text{etc}} \left(F + \frac{dF}{dN}\right)\nu.$$

Performing the operations after dividing by T it follows that

$$\sum_{1\ 2\ \text{etc}} \left(C_v + C_v \log T + R\log\frac{V}{N} + k - \frac{C_v T_0}{T} - \frac{RN}{N}\right)\nu = \sum_{s\ t\ \text{etc}} (\quad)\nu;$$

or $$\sum_{1,2,\text{etc}} R\nu \log\frac{V}{N} = \sum_{s\ t,\text{etc}.} R\nu\log\frac{V}{N} + \text{function of } T \text{ alone};$$

or $$\log\frac{V^{\nu_1 + \nu_2 \cdots - \nu_s - \nu_t}}{N_1^{\nu_1} N_2^{\nu_2} \cdots N_s^{-\nu_s} N_t^{-\nu_t}} = \text{function of } T$$

This is the equation of chemical equilibrium at constant volume and temperature If we write $\frac{N_1}{V} = n_1$, $\frac{N_2}{V} = n_2$, etc, it becomes

$$\log\frac{n_s^{\nu_s} n_t^{\nu_t} \cdots}{n_1^{\nu_1} n_2^{\nu_2} \cdots} = \text{function of } T$$

The quantity under the logarithm sign is the equilibrium constant for constant temperature and volume If the equation in terms of N_1, N_2 etc. is examined it will be seen that when

$$\nu_1 + \nu_2 + \cdots = \nu_s + \nu_t \quad .$$

a change of volume will not disturb the equilibrium On the other hand if $\nu_1 + \nu_2 + \cdots$ is the greater sum then an increase of V will increase the values of N_1, N_2, etc and diminish those of N_s, N_t, etc

The former case would be illustrated by a reaction such as

$$\begin{matrix} H_2 + & Cl_2 \rightleftharpoons & 2HCl \\ N_1 & N_2 & N_3 \end{matrix}$$

where $\nu_1 = 1$, $\nu_2 = 1$ and $\nu_3 = 2$, and the latter case by

$$2H_2 + O_2 \rightleftharpoons 2H_2O$$

in which the $\sum(\nu)$ on the left is one greater than of the one on the right. This is stated without prejudice to the question as to whether the above reactions usually occur or not.

The function of temperature involves the specific heats (or molecular heats), which depend upon the temperature in a way undeterminable by thermodynamics, as well as the constants of integration. The values of the specific heats can however be ascertained by experiment and thus the value of the equilibrium constant at any temperature can be calculated within a constant.

Any deviation that is found from these conclusions may leave it a moot point whether the reactions are not of the specified type or whether the deviations are due to departures from the ideal gas law

The equilibrium constant was first given by Guldberg and Waage. They based it on the laws of probability of encounters between the reacting molecules. Taking the probability of an encounter of any molecule of the first with one of another kind as proportional to N_1, the probability that ν_1 of them will simultaneously collide is $N_1 N_1 N_1 N_1 \cdots$ to ν_1 terms; that is, it is $N_1^{\nu_1}$. Similarly for N_2 the required probability is $N_2^{\nu_2}$. Further the

probability that the two groups shall collide simultaneously is $N_1^{\nu_1} N_2^{\nu}$, and so on Some slight departure from the gas law is needed in order that collisions may occur at all; for if the molecules had no volume there would be nothing to collide against. But if the volume occupies a sensible proportion of the total system, corrections are required to Guldberg and Waage's law; and any attractions between the molecules, which will necessarily increase the number of collisions, necessitates still further corrections, so that this method of attacking the problem lands us in difficulties. The same is true of the thermodynamic method which has been given in detail, when other characteristic equations are employed, even the total pressure is not the sum of the "partial" pressures as it would be according to Dalton's law. The additive law breaks down also for all the other functions (E, ϕ, etc). We shall return to the problem after dealing with heterogeneous equilibria

But first some of the other properties of the free energy must be stated Since for reversible changes $dF=-\phi dT-pdv$ it follows that

$$\left(\frac{\partial F}{\partial T}\right)_v=-\phi \text{ and } \left(\frac{\partial F}{\partial v}\right)_T=-p.$$

But $$F=E-T\phi=E+T\left(\frac{\partial F}{\partial T}\right)_v.$$

Therefore $$T\left(\frac{\partial F}{\partial T}\right)_v-F=-E$$

or $$\frac{\partial}{\partial T}\left(\frac{F}{T}\right)_v=-\frac{E}{T^2}.$$

It should be noted that the *decrease* of F in a reaction is often represented by A and the corresponding *evolution* of energy (*i e.*, the heat of reaction at constant volume) by U In terms of these quantities the equation becomes

$$T\frac{\partial A}{\partial T}-A=-U$$

which is of the same form as before.

Again, since F depends, in reversible changes, only upon the state (because E, T, and ϕ so depend) it follows that

$$\frac{\partial^2 F}{\partial v\,\partial T}=\frac{\partial^2 F}{\partial T\,\partial v}$$

and therefore $$-\left(\frac{\partial\phi}{\partial v}\right)_t=-\left(\frac{\partial p}{\partial T}\right)_v.$$

Since, we can write $Td\phi=dQ$ this is identical with the equation already found, viz.:

$$\left(\frac{\partial H}{\partial v}\right)_T=l=T\left(\frac{\partial p}{\partial T}\right)_v.$$

Heterogeneous Systems.—A heterogeneous system is one in which the whole system can be divided into discrete parts each of which is homogeneous but differs from its neighbours Each is called a "phase". Without at first considering such systems in general we may take the familiar case of a vessel containing a liquid and its vapour or a solid and a liquid. These can at certain temperatures be in equilibrium with one another. Putting aside the effects of gravity and other body forces, when equilibrium exists the pressure must be uniform throughout the system for mechanical reasons, provided there is no curved interface between the phases; and the temperature must be uniform throughout for reasons depending upon conduction and radiation The values of these variables are independent of the relative amounts of liquid and vapour. Let $1-m$ and m be the masses of the two phases in a system of unit mass; and let v_1 and v_2 be their specific volumes (*i.e.*, volumes per unit mass) then the total volume is $(1-m)v_1+mv_2$. The uniform pressure is the saturation pressure; we denote it by the symbol π the value of which experiment shows to be independent of the volume but dependent upon the temperature. The total energy is $E=(1-m)E_1+mE_2$ where E_1 and E_2 are the energies per unit mass of the respective phases. The entropy is $\phi=(1-m)\phi_1+m\phi_2$. Any heat that enters may be divided into two parts corresponding to the phases it passes into. Since the law of summation obviously applies throughout we can write

$$dQ=CdT+ldV \text{ as before}$$
$$=\{(1-m)\,\sigma_1+m\sigma_2\}\,dT+ld\,\{(1-m)\,v_1+mv_2\}$$

provided, at least, that neither of the phases vanishes. Now the same considerations as before give

$$l=T\left(\frac{\partial\pi}{\partial T}\right)_v=T\frac{\partial\pi}{\partial T}$$

since π is independent of V The change of volume is $(v_2-v_1)dm$ so that the equation becomes

$$dQ=\{(1-m)\sigma_1+m\sigma_2\}dT+T(v_2-v_1)\frac{d\pi}{dT}dm.$$

The heat taken in when unit mass evaporates at constant temperature is called the latent heat of evaporation, it is equal to the coefficient of dm and is therefore

$$L=T(v_2-v_1)\frac{d\pi}{dT}$$

This is the equation of latent heat for a change of phase first given in the present form in 1850 by Clausius but actually found to be verified by experiments made in the case of the change of ice into water by Lord Kelvin in 1850 before he had accepted the law of the conservation of energy These experiments were first interpreted in terms of a calculation made by his brother James Thomson in 1849 based upon Carnot's theory of the conservation of *heat* (not energy)—the effect to be expected from lowering a quantity of heat through one degree being determined, *not by theory*, but by comparison with results obtained from Regnault's experiments on steam The lowering caused by an increase of the equilibrium pressure π by 140 atmospheres is about one degree centigrade It is a lowering in the case of ice-water because $v_{ice}>v_{water}$; it is a rise in the transition temperature (*i.e.*, the boiling point) in the case of water-steam because $v_{steam}>v_{water}$ We can conveniently take the equation in the form

$$dQ=\{(1-m)\,\sigma_1+m\sigma_2\}\,dT+Ldm$$

so that the independent variables become T and m Consider now an adiabatic change, $dQ=0$, then

$$\frac{dm}{dT}=-\frac{(1-m)\sigma_1+m\sigma_2}{L}.$$

Since the symbols σ_1, σ_2 stand for saturation values, σ_1 is positive but σ_2 *may* be negative If we write $(-\sigma_2)$ in such case for its positive numerical value we find that dm will be negative when dT is negative provided that $(1-m)\sigma_1$ is numerically less than $m(-\sigma_2)$, *i.e.*, that liquid will form in the case of water-steam when the temperature lowers Since the water deposits most readily on particles of dust, etc , in the vessel a cloud will appear. This is obviously most likely to happen when the amount of water initially present $(1-m)$ is small compared with the amount of vapour (m) In the case of a positive value for σ_2 no cloud can form

A reversible *isothermal* expansion of a mixture of water and steam always causes evaporation.

Phase Rule.—We have considered the co-existence of water and steam and of ice and water in separate phases The possibility of this co-existence is determined by the *phase rule* due to Willard Gibbs The dividing surfaces between the phases are presumed to be plane so as to exclude effects arising from surface tension. The phase rule asserts that the number of independent variations of which a system of co-existent phases is capable is $C+2-P$ where C is the number of independently variable *components* in the whole system. The term *component* must be carefully distinguished from *constituent.* Thus in dealing with water and steam, hydrogen and oxygen are constituents of each phase, but since they can only vary in chemically combining proportions it would be sufficient to specify *either* of them or even the amount of water present Thus there is only one component in this case. If free hydrogen (or oxygen) were present as well in excess there would be an additional

component and there is again an arbitrary choice as to the two components to be selected. The proof of the rule is that the system of phases is completely specified by the temperature, pressure and the data for the C components and between these $C+2$ quantities there are P independent relations (one for each phase), which characterize the system of phases.

For example, in the case of water which can exist (not necessarily co-exist) as ice, water or steam there is one component and three possible phases so that if all are present $C+2-P=0$ and there is no disposable relation—their states (defined by v and T) are absolutely fixed If only two of the phases are present $C+2-P=1$, there is therefore one relation between various values of p and T for equilibrium This relation gives the vapour pressure line or, in the case of ice and water, the connection between pressure and freezing-point. Again if there is only one phase present, there are two disposable relations, in other words the pressure and temperature can vary independently of each other. The number of disposable relations is known as the number of degrees of freedom (F) so that

$$C+2-P=F$$

When the number of phases that co-exist is the greatest possible the value of F is zero Of these phases not more than one can be gaseous because the components mix in such a phase in all proportions, so that two gaseous phases would intermingle and reduce to a single phase.

In considering the equilibrium of such a system it is necessary to introduce a new function of the variables, this is done in such a way that the independent variables become T and p. As before we have

$$Td\phi=dQ+Pos.$$

where *Pos.* stands for a positive quantity. Hence

$$dE=dQ-pdv=Td\phi-pdv-Pos.$$

Adding to both sides $d\,(pv-T\phi)$

$$d(E-T\phi+pv)=-\phi dT+vdp-Pos.$$

It follows that if the quantity in brackets on the left is calculated for the whole system its value can only decrease in any change of the system that takes place at constant pressure and temperature. Or again, if an infinitesimal change, in which p' and T are kept constant, is made about a state of equilibrium, the change on the left hand side is zero. It is sometimes called the *thermodynamic potential at constant pressure and temperature* (Duhem); or since it is concerned with the equilibrium of co-existent phases it may be called the *paraphase potential* and will be denoted by ζ.

One Component System.—Let there be one component only ($C=1$). Then if there are two phases there is one degree of freedom. There must therefore be a connection between p and T; this connection is the vapour pressure curve if the two phases are liquid and vapour Let the values of ζ per unit mass be ζ_1 for liquid and ζ_2 for the vapour. The total potential is therefore

$$\zeta=(1-m)\zeta_1+m\zeta_2.$$

Now for equilibrium

$$d\zeta=-\zeta_1dm+\zeta_2dm=0.$$

Therefore $\qquad \zeta_1=\zeta_2$

that is the potentials per unit mass are the same for the two phases. Similarly for solid and liquid

$$\zeta_o=\zeta_1$$

and for solid and vapour.

$$\zeta_o=\zeta_2.$$

These three equations specify three curves on a pT diagram. The first two curves intersect at a point given by $\zeta_2=\zeta_1=\zeta_o$. This point also satisfies all three curves. Thus the three equilibrium curves must intersect at one point This point is called the *triple point*. Further they cannot all intersect at any other common point for according to the phase rule there are no degrees of freedom when the three phases meet—the point of meeting is absolutely determinate.

Now the equations for these potentials are:

$$d\zeta_2=-\phi_2dT+v_2dp,$$

$$d\zeta_1=-\phi_1dT+v_1dp,$$

$$d\zeta_o=-\phi_odT+v_odp.$$

Whence $\qquad d(\zeta_2-\zeta_1)=-(\phi_2-\phi_1)dT+(v_2-v_1)dp=0$

for all points on the curve connecting p and T which are common to both vapour and liquid. Hence this curve is also defined by

$$\phi_2-\phi_1=(v_2-v_1)\frac{dp}{dT}.$$

The left hand side is $\dfrac{latent\ heat}{T}=\dfrac{L_{12}}{T}$.

Therefore $\qquad L_{12}=T(v_2-v_1)\dfrac{dp_{12}}{dT}$; Liquid→Vapour.

Similarly for the two other curves,

$$L_{o1}=T(v_1-v_o)\frac{dp_{o1}}{dT};\ \text{Solid}\rightarrow\text{Liquid},$$

and $\qquad L_{o2}=T(v_2-v_o)\dfrac{dp_{o2}}{dT}$, Solid→ Vapour.

These are simply Clausius equations for the three possible changes of phase.

The trigonometric tangent to the slope of any one of the p, T, curves is given by the value of $\dfrac{dp}{dT}$ for the curve, i e ,

$$\frac{dp_{12}}{dT}=\frac{\phi_2-\phi_1}{v_2-v_1},\ \frac{dp_{o1}}{dT}=\frac{\phi_1-\phi_o}{v_1-v_o}\ \text{and}\ \frac{dp_{o2}}{dT}=\frac{\phi_2-\phi_o}{v_2-v_o}.$$

Hence at the triple point these are obviously connected by the relation

$$(v_2-v_1)\frac{dp_{12}}{dT}+(v_1-v_o)\frac{dp_{o1}}{dT}+(v_o-v_2)\frac{dp_{o2}}{dT}=0$$

and therefore, at the triple point,

$$L_{o2}=L_{o1}+L_{12}.$$

This relation does not hold at any other point

It must be emphasized that in the above no assumption is made as to whether the single component is associated or not, nor whether it is equally associated in the several phases nor that the degree of association remains unchanged when the temperature changes, nor even that the matter in the phase consists of molecules. The decision in regard to such questions has no bearing on the investigations of this part of the subject. What we do assume is that each of the homogeneous phases is quite definite when the temperature and the specific volume are definitely given.

Many Components.—When there are many components in each phase the subject becomes too complicated to be dealt with in this short article. The thermodynamics potential ζ for each phase will depend upon the masses of the components as well as upon T and p. When its value is differentiated at constant temperature and pressure and equated to zero an equation is obtained of the form $\mu_1dm_1+\mu_2dm_2+\cdots=0$. The coefficients μ_1, μ_2, etc., are called the chemical potentials of the several components in the particular phase. The final result is that the chemical potential of any one component must be the same for all the phases that are coexistent. The problem of heterogeneous equilibrium in the general case would therefore be solved if only it were possible to obtain ζ as an explicit function of all the masses. This is not possible unless the ideal gas laws are assumed.

OSMOTIC PHENOMENA

When a tube has its lower end stopped by a suitable membrane and is partly full of a solution; and the lower end is dipped in pure solvent, a difference of level is often maintained in the final state of equilibrium. It is necessary that the membrane shall be permeable to the solvent but not to the solute—it shall be only *semi-permeable* in fact. If it is permeable to both, equilibrium can only be attained when the concentration on both sides has come to the same value by diffusion. Semi-permeable membranes are easily obtained that will act for months with hundreds of atmospheres difference of pressure between the two sides.

Unglazed earthenware impregnated with colloidal ferrocyanide of copper by an electrolytic method constitutes such a membrane, impermeable to sugar and many salts but permeable to water. It is only the final state of equilibrium that will be considered in this place. When all flow is over, there is a difference of pressure between the two sides of the membrane: this difference of pressure is called the *osmotic pressure*. It is, in general, a property not of the solution alone but involves the solvent also. Loose definitions based upon the properties of dilute solutions should be carefully avoided. The thermodynamical study of osmotic pressure is based upon the impossibility of obtaining external work from an isothermal reversible cycle (The efficiency of such a cycle is zero) It is possible to evaporate a unit mass of the solvent from the solute, to change its pressure so that it can then be passed *reversibly* into the liquid solvent, and finally to pass it back into the solution through the osmotic membrane. This cyclic series of operations can all be conducted isothermally and reversibly In order that the concentration shall keep constant during the changes it is necessary that the mass of the solution shall be practically infinite or that the unit mass be infinitesimal The algebra can be much simplified if a modification is made in the process Any term, representing external work done is an expression of the type $\int_1^2 pdv$. Now, integrating by parts, $\int_1^2 pdv = p_2v_2 - p_1v_1 - \int_1^2 vdp$; and for a complete cycle of changes $\sum(p_2v_2 - p_1v_1)$ must equal zero and consequently adding expressions such as pdv comes, for the whole cycle, to the same thing as adding expressions such as $\int vdp$ for the several stages The imagined process can be supposed carried out in an arrangement such as is shown in fig 1 (called by van't Hoff an equilibrium box and used by him for dilute solutions only) The solution and solvent are on opposite sides of a semi-permeable membrane C and enclosed by means of ordinary pistons A and B. Lateral cylinders are also provided with pistons; these cylinders are connected with the main cylinders by means of membranes permeable to the *vapour* alone. The solution is at a hydrostatic pressure p and any vapour in its lateral cylinder at a pressure π_p which corresponds to the particular pressure of the solution; similarly for the solvent and its vapour we have the pressures π_0 and $\pi_{o_{p_0}}$. In making these provisions it is being definitely recognized that the vapour pressure depends, not only upon the temperature but also upon the pressure of the solution or solvent (an example of this will be dealt with in connection with interfacial effects).

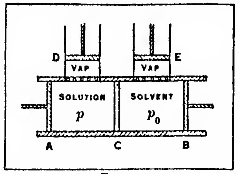


FIG. 1

The cyclic series of operations and the values of vdp corresponding to them are as follows:—(The value of $\int vdp$ in each stage is denoted by S).

i Remove unit mass (supposed infinitesimal compared with the total mass so as not sensibly to alter the concentration) of solvent from the solution by means of the lateral cylinder. Piston A requires to be moved to the right to effect this transfer. Since the pressures keep constant, $S_1 = 0$.

ii. Change the pressure of the vapour removed, from π_p to $\pi_{o_{p_0}}$: then $S_2 = \int_{\pi_p}^{\pi_{o_{p_0}}} vd\pi$ where v is the specific volume of the vapour.

iii. Pass the vapour into the solvent reversibly at constant pressure:

$$S_3 = 0.$$

iv. Pass unit mass of solvent into solution through C at constant pressures (by moving A and B suitably):

$$S_4 = 0.$$

Adding all the values of S we obtain

$$\int_{\pi_p}^{\pi_{o_{p_0}}} vd\pi = 0 \text{ whence } \pi_{o_{p_0}} = \pi_p.$$

Thus it appears that the vapour pressure of the solution when the latter is at the pressure p must equal that of the solvent when at a pressure p_0 where $p - p_0$ is the osmotic pressure It must be remembered that the standard vapour pressures as usually measured are for the cases when the liquids are at the pressures of their vapours alone.

It can easily be seen that this must be the case For if, otherwise, πp is greater than $\pi_{o_{p_0}}$ it would only be necessary to put the lateral cylinders into communication for a flow of vapour to take place from left to right This would cause fresh evaporation from the solution (to maintain the equilibrium value of vapour pressure) and (for a similar reason) condensation of vapour into the solvent. Since the evaporation from the solution would increase the concentration a flow through C from the solvent would take place to maintain the equilibrium This action would go on unceasingly and a particular kind of perpetual motion would be obtained. Unless we are prepared to admit the possibility of this type of perpetual motion, we must deny the assumption of any difference between the vapour pressures of the solvent and solution when measured under equilibrium conditions for the two *liquids*. That the vapour pressure of a pure liquid must depend upon the hydrostatic pressure was first shown by Sir William Thomson (Lord Kelvin). If a vertical capillary tube be placed in water, *e g*, under the bell jar of an air pump so that the air can be removed, the water stands in the tube at a higher level than outside by the amount h where $g\rho h = 2\sigma/r$, ρ = density of the liquid, σ the surface tension and r the radius of the tube. (*See* SURFACE TENSION) Now the vapour constitutes an atmosphere and between the inside and outside levels there is a difference of vapour pressure of $g\rho' h$ approximately where ρ' is the density of the vapour Now the essential difference between the liquid inside and out is that at the upper level inside it is at a less hydrostatic pressure than outside (equilibrium being maintained by the effects of the curvature of the surface).

$$\text{Hence} \qquad \frac{d\pi}{dp} = \frac{g\rho' h}{g\rho h}$$

$$= \frac{\rho'}{\rho} \text{ approximately.}$$

It is easy to show that this is not approximate merely but exact for a pure liquid. In the case of a solution however it requires modification (Porter, *Roy Soc. Proc.* A. 79, p 519 [1907]) To examine the case of a solution enclose a large volume V of solution in a cylinder, under pressure, fitted with a lateral chamber such as on the left of fig. 1 replacing the membrane C by a solid base. Conduct a cyclic series of operation as follows:—

i. Remove unit mass of vapour at constant pressure by means of the lateral cylinder: the volume of the solution diminishes by s (say) and the vapour increases by v:

$$S_1 = 0.$$

ii. Compress the vapour removed and the solution to new *equilibrium* values·

$$S_2 = \int_p^{p'} (V - s)\, dp + \int_{\pi_p}^{\pi_{p'}} vd\pi.$$

iii Pass the removed vapour back into the solution at constant pressure for each:

$$S_3 = 0.$$

iv. Compress solution by restoring the original pressure:

$$S_4 = \int_{p'}^{p} Vdp$$

If these changes are conducted isothermally and reversibly they must add to zero Hence

$$\int_{\pi_p}^{\pi_{p'}} vd\pi = \int_p^{p'} sdp \text{ exactly.}$$

Since this is true, however small the change of pressure, we can write it in the differential form

$$d\pi/dp = \frac{s}{v}$$

or more precisely (owing to the fact that all the quantities depend upon the pressures)

$$\frac{d\pi_p}{dp} = \frac{s_p}{v_\pi}.$$

The quantity s stands for the shrinkage of the volume of the solution when unit mass of solvent is removed from it, the unit mass being so small (or the volume so large) that no sensible change of concentration occurs. Combining this result with the proved fact that in the state of equilibrium $\pi_p = \pi_{o p_o}$ we can obtain an expression for the osmotic pressure, $p - p_o$. For, employing the integral form, the limits being from the standard values of the vapour pressures to the equilibrium values of the pressures

$$\int_{\pi_\pi}^{p} s dp = \int_{\pi_\pi}^{\pi_p} v d\pi \quad \text{and} \quad \int_{\pi_{o\pi_o}}^{p_o} u dp_o = \int_{\pi_{o\pi_o}}^{\pi_{o p_o}} v d\pi,$$

where π_π and $\pi_{o\pi_o}$ are the standard vapour pressures Subtracting these, we obtain an exact equation for the osmotic pressure

$$\int_{\pi_\pi}^{p} s dp - \int_{\pi_{o\pi_o}}^{p_o} u dp_o = \int_{\pi_\pi}^{\pi_p} v d\pi + \int_{\pi_{o p_o}}^{\pi_{o\pi_o}} v d\pi = \int_{\pi_\pi}^{\pi_{o\pi_o}} v dp$$

because $\pi_p = \pi_{o p_o}$.

From this equation simpler approximate equations can be deduced to fit particular cases

The equality in the equilibrium vapour pressures may be shown in another way. In fig. 2 is represented a domed chamber separated into two portions: in the lower part, by a membrane semi-permeable to solvent *liquid;* in the upper part, by one semi-permeable to solvent vapour. The lower part contains solution and solvent on the opposite sides of the membrane, the upper part contains, besides the vapour, sufficient air on each side to make up the total pressures to p and p_o respectively If the pressures due to the vapours are not equal it is easily seen as before that a *perpetuum mobile* will be set up

It ought to be added that, in the exact equation for the osmotic pressure, there is no assumption as to the molecular state in either the liquid or vapour phases. Any influence that the degree of association or dissociation may have is all taken into account by the numerical values that can be found by direct experiment for u, s, and the standard vapour pressures. When the approximate equation is used, the values of R and u (or s) both refer to unit mass and there is no reference to molecules If we consider (so-called) molecular values by multiplying u, s, and R by such a factor that R becomes the universal value of the gas constant it may be presumed that this multiplier is at least an approximation to the molecular weight of the vapour in *the vapour state* but still no information is obtained as to the molecular state of either solvent or solute in the liquids. Such information as we have concerning molecular states is obtained by the aid of gas theory as distinct from thermodynamics.

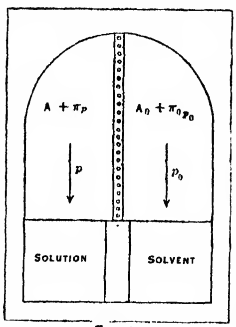


FIG 2

General Use of Semi-permeable Membranes.—Imaginary semi-permeable membranes are made great use of in theoretical investigations, as in the above case. Doubt has often been raised as to the validity of this procedure at any rate in those cases for which no real membrane of the kind has been manufactured. We know that such membranes are obtainable in certain cases, *e g.*, hot silica ("fused quartz") transmits helium and not nitrogen, hot cast iron transmits hydrogen; indiarubber is permeable to carbon dioxide. The curved surface to a liquid maintains a difference of pressure between the interior and exterior and thereby acts as a membrane semi-permeable to the *vapour;* and between a solution and the liquid solvent, as it has been already stated, very perfect membranes can be obtained. In reality, in order to employ the thermodynamical argument, it is unnecessary that it should be possible to make any such membrane. Clerk Maxwell introduced the idea of "demons" instructed to let very fast molecules pass through an opening and stop the slow ones, thereby increasing the effective temperature on one side of a partition and diminishing that on the other In this way he was able to show that the second law of thermodynamics does not hold for individual molecules but only for matter in the bulk In like manner we may suppose a row of good demons turning back all the sugar molecules and letting the water molecules through in such a way that the average distribution of the water molecules in the solvent region is maintained in equilibrium Such a row of demons will be doing precisely what our semi-permeable membrane is supposed to do and the average force per unit area they exert (viz $p - p_o$) corresponds exactly to the osmotic pressure. It should be noted that it is not exactly equal to the pressure the sugar molecules would exert if they were a gas with its molecules equally crowded, because there is a differential effect due to the difference of density of the water on the two sides, but in dilute solutions it is not far from this value. The most unsympathetic view that is permissible in connection with the use of membranes is that they provide a picturesque way of carrying out the virtual displacements of concentrations, etc , which are employed in the applications of the thermodynamic potentials to equilibrium problems

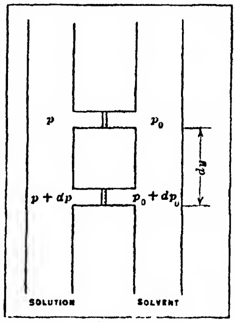


FIG. 3

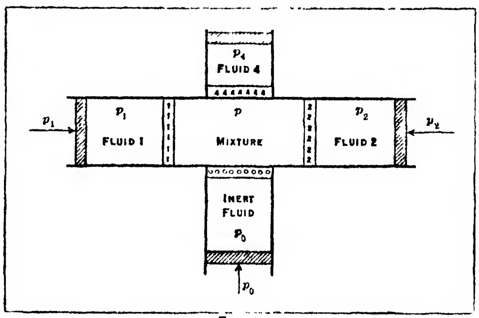


FIG. 4

Effect of Gravity.—We can apply the membrane method to the effect of gravity in producing a gradient of concentration with the depth in a solution. Columns of solution and solvent are connected across through semi-permeable membranes at two levels distant dy apart (fig 3). The densities being ρ and ρ_o we have, on the solution side, $dp = g\rho dy$ where dy is positive when measured downwards and, on the solvent side, $dp_o = g\rho_o dy$ so that $d(p - p_o) = g(\rho - \rho_o)dy$. But $p - p_o$ is the osmotic pressure, P, so the equation gives $dP/dy = g(\rho - \rho_o)$ or $dP/dp = \frac{\rho - \rho_o}{\rho}$.

If we differentiate, with respect to p, the exact equation for the osmotic pressure the result is $sdp = udp_0$

or
$$\frac{d(p-p_0)}{dp} = \frac{u-s}{s}.$$

This differs from the above value, but the value just given is the variation when the concentration is kept constant; the other is the total variation. In fact we can write

$$\frac{dP}{dp} = \frac{\partial P}{\partial p} + \frac{\partial P}{\partial c} \cdot \frac{dc}{dy}$$

where c is the concentration (measured in any convenient way); i e,

$$\frac{p-p_0}{p} = \frac{u-s}{s} + \frac{\partial P}{\partial c} \cdot \frac{dc}{dy}.$$

For dilute solutions $\frac{\partial p}{\partial c}$ follows nearly the gas law. If its exact value is known, either in consequence of this law or from experiment, the value of dc/dy can be determined. This result is of wide application There is no assumption that it is limited to true solutions. Applied to a gamboge suspension it gives Perrin's Law of the distribution with depth when the concentration is small, and allows also a calculation to be made of the very great deviations from Perrin's Law of distribution when the concentration is great (*Trans. Far. Soc.* XVIII. [1922]; XIX. [1923], XXI, 63, 66 [1925]).

Application of Membranes to Homogeneous Equilibrium.—An interesting application can be made of semi-permeable membranes to determine the equilibrium constant for homogeneous equilibrium Fig. 4 indicates the kind of equilibrium box required The equilibrium which is taken as the type is that for which the chemical equation is

$$\nu_1 A_1 + \nu_2 A_2 \rightleftharpoons \nu_3 A_3 + \nu_4 A_4;$$

and in addition an inert gas is supposed to be present, indicated by A_0; this takes no part in the reaction but modifies the total pressure of the mixture By appropriate movement of the semi-permeable membranes a cycle of changes is carried on leading eventually to the equation

$$\nu_1 \int^{p_1} u_1 dp_1 + \nu_2 \int^{p_2} u_2 dp_2 - \nu_3 \int^{p_3} u_3 dp_3 - \nu_4 \int^{p_4} u_4 dp_4$$
$$= \text{function of the temperature alone}$$

This reduces to the mass action law when gas values are inserted For detailed information in regard to its derivation reference must be made to the original paper (*Trans Far Society*, 1919) Since the membranes may be made permeable to the *vapours* of the respective components the values of u and p may be taken to stand for the specific volumes (or molecular volumes) and pressures of these vapours.

Duhem-Margules Equation.—This information is in part supplied for condensed systems by a theorem put forward by Duhem in 1887 and subsequently interpreted by Margules (1895). By means of an equilibrium box similar to that in fig. 4 we can produce the series of changes indicated in fig 5 The case of a homogeneous mixture of two components will be considered so that only two lateral cylinders are needed Fig 5 consists of three diagrams, one for each separated vapour and one for the liquid mixture. It should be mentioned that from a theoretical

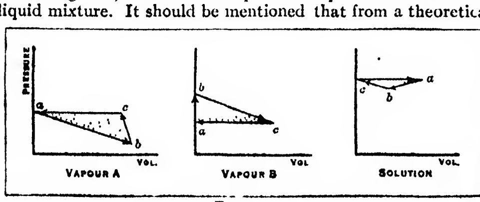


FIG. 5

point of view (thermodynamically) there is no difference between a solution and a mixture, at least, a mixture of molecular type (coarse emulsions must be excluded). Again, the operations must be isothermal and reversible. The presence of each component in the mixture lowers the vapour pressure of the other component. Throughout each change the pressure in the lateral chambers must be perpetually maintained in equilibrium with the mixture by suitably moving the pistons. The detailed changes are as follows:

i. Remove a definite fraction, say fn_1 of the molecules n_1 in the mixture. The pressure in A cylinder goes down along ab, that of B goes up—in both cases because the relative concentration of B is increased—along ab (on the B diagram) The mixture also changes along ab.

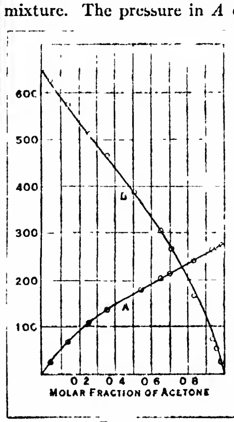


FIG. 6

ii. Remove the *same fraction* fn_2 of the molecules of B. The pressure in B goes down along bc (on B diagram) and that of A goes up along bc (on A diagram); and that of the mixture changes along bc (on the third diagram). The solution is now of the same concentration as at first and consequently the pressures at c must in each chamber be the same as at first, *i e.*, as at a.

iii Lastly return the vapours in A and B to the mixture adjusting the rates of transfer so that the concentration of the mixture remains constant. The changes in the three diagrams are in each case along ca and the original state is restored.

We will neglect the changes of volume of the solution because, for usual cases they are exceedingly small compared with the vapour changes The total work done is the difference of the areas of the triangles on A and B; or

$$fn_1 v_1 \frac{\partial \pi_1}{\partial n_1} + fn_2 v_2 \frac{\partial \pi_2}{\partial n_1}$$

and this sum must equal zero. So far we might have considered masses instead of numbers of molecules (for the problem has nothing essential to do with molecules) We can now put $\pi v_1 = n_1 RT$ and $\pi_2 v_2 = n_2 RT$, where R is the same for both The values of n_1 must now mean the numbers of molecules in the mixture reckoned as of the same constitution (*i e*, either single or double molecules, etc.) as in the *vapour* state, and similarly for n_2. So that

$$\frac{n_1}{\pi_1}\frac{\partial \pi_1}{\partial n_1} + \frac{n_2}{\pi_2}\frac{\partial \pi_2}{\partial n_1} = 0.$$

The differential coefficients are partials, the value of n_2 being constant during the change represented We can usefully represent the concentrations by molar fractions, that is, $\mu_1 = n_1/(n_1+n_2)$ and $\mu_2 = n_2/(n_1+n_2)$ so that $\mu_1 + \mu_2 = 1$

When this is done the equation becomes

$$\frac{\mu_1}{\pi_1}\frac{d\pi_1}{d\mu_1} + \frac{\mu_2}{\pi_1}\frac{d\pi_2}{d\mu_1} = 0$$

or
$$\mu_1 \frac{d}{d\mu_1} \log\pi_1 = \mu_2 \frac{d}{d\mu_2} \log\pi_2$$

since $d\mu_2 = -d\mu_1$. The advantage of the transformation to molar fractions is that the equation has been reduced to a symmetrical form the right hand being the same function of μ_2 that the left is of μ_1. This is the Margules-Duhem equation. It is not quite exact because the *vapours* have been treated as ideal gases and the changes of the volume of the mixture have been neglected. For practical purposes, however, it is probably very much more accurate than experiments require. The implication of the equation is that each side of it *must be the same symmetrical* function of μ_1 and μ_2; *i.e.*, it must be of the form $f(\mu_1\mu_2)$ and this must be the *same* for both vapours. Unfortunately the law imposes no further restriction upon this function so that an endless number

of cases can arise. Suitable simple values for the functions are 1, $\mu_1\mu_2$, $\mu_1^2\mu_2^2$, etc., each of which may be multiplied by an arbitrary constant and any number of terms may be taken simultaneously. For any such function the equation can be integrated and it takes the form

$$\log\frac{\pi_1}{\Pi_1}=\alpha\log\mu_1+\beta\mu_2^2+\gamma\mu_2^2(1+3\mu_1)\text{ etc.}$$

and $$\log\frac{\pi_2}{\Pi_2}=\alpha\log\mu_2+\beta\mu_1^2+\gamma\mu_1^2(1+3\mu_2)\text{ etc.}$$

where Π_1 and Π_2 are the vapour pressures of the pure components and the constants α, β, γ, etc must be the same for both. If the first term on the right is sufficient we have

$$\frac{\pi_1}{\Pi_1}=\mu^{\alpha 1}=\left(\frac{n_1}{n_1+n_2}\right)^{\alpha}=\left(1-\frac{n_2}{n_1+n_2}\right)^{\alpha}\doteq 1-\frac{\alpha n_2}{n_1+n_2}$$

when n_2 is small.

This is practically Raoult's law when allowance is made for dissociation. In very many cases two terms are necessary and α is often unity. The equation then becomes

$$\log\frac{\pi_1}{\Pi_1\mu_1}=\beta\mu_2^2.$$

In fig. 6 the curves for a mixture of acetone and ether are given. The value of β was determined from one point on the acetone curve but it fits equally well the curve for either. The base line gives the molar % of acetone when read from left to right but it equally well gives the percentage of ether when read from right to left. The experimental points were determined by J. Sameshima (*Amer. J. of Sc.* XL , 1482, 1918). Examination of the equation shows that in this group of examples there is only one parameter, viz : β. In fig. 7 the shapes of the curves are shown for different values of β, the ordinates being π/Π Examples can be found for many values of β For sulphuric acid and water $\beta=-0{\cdot}6$ except for dilute solutions, when a more complicated formula is necessary Fig 8 gives the case of gold in mercury. In this example four terms are required. If the base line is read from left to right the curve is the vapour pressure for mercury, if the base line is read from right to left the curve gives the vapour pressure (though exceedingly small) of gold in mercury. In both cases these are the values of π_1, π_2 which require to be inserted in the equations for the constant of homogeneous equilibrium. The central part of the curve, which slopes downward, is easily shown to be in an unstable region. Where the curve is horizontal (towards the right of the figure) is the concentration at which the equilibrium becomes unstable; in other words it represents the *saturation* concentration of the solution of gold. The vapour pressure of the *gold* should at that point be the same as that of pure gold and that is seen to be the case by examining the curve reversed. Calcium chloride in water also requires four terms; curves are shown on fig 9 for this case at two temperatures.

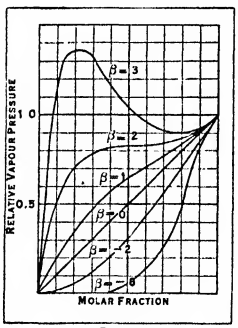


FIG 7

Taking these cases as examples there is little likelihood of the vapour pressures required for the calculation of the equilibrium constant being determinable by any *a priori* method and resort must be made to direct experiment—at any rate for the determination of a few typical values from which the constants can be deduced. Further information can be found in *Trans. Far. Soc.* 15, 1920; 24, 344, 405, 543 (1928). In the first of these papers a general form of equation is developed for three or more components.

Interfacial Effects.—In considering equilibrium the interface between any two phases was considered as being plane. It is only if it is plane that the pressure is uniform over the whole system. There is a change of pressure on crossing the boundary equal to $\sigma\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$ where σ is the surface tension and R_1 and R_2 are the radii of curvature in any two mutually rectangular planes. (*See* SURFACE TENSION.) The pressure is greater on the concave side (as in a soap bubble.) We have seen that it increases the vapour

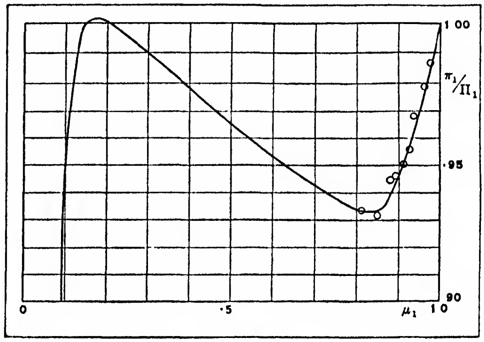


FIG. 8

pressure if convex outwards; it increases the density also and, indeed, it may be expected to change all the properties which depend upon these. For example, the position of the triple point is shifted when either the liquid or the solid phase has curved boundaries. An equivalent change of pressure produced in any way has the same effect. As a matter of fact, the independent atmosphere of air acting in addition to the vapour pressure on ice and water shifts the triple point from ·0075° C to exactly zero. It clearly must do so because the ice water line under the pressure

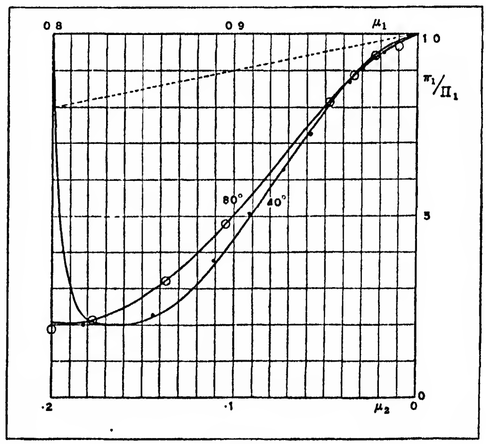


FIG. 9

of one atmosphere goes through 0° C, and not ·0075° C and the triple point lies on this line. (*Phil. Mag.* XXIX., 143, 1915.)

There is another effect at the interface which is present even if this surface is plane. Consider a solution in equilibrium with its vapour. The presence of the solute either increases or diminishes the surface tension; for most salts it is an increase, for many organic substances such as oils, soaps, etc., it is a decrease; and the change is greater the greater the amount of the solute. Now the existence of surface tension is a demonstration of the possession by a surface lamina of more potential energy than a

lamina in the body of the phase. The tendency being for the potential energy to take the lowest possible value, solute (being free to be displaced) will move toward the surface lamina or away from it according to which change will diminish the surface tension. In strictness therefore, the two phases are not delimited by mathematically sharp boundaries: there is an intervening lamina whose structure depends upon both phases and is different from that in the body of either. This subject was first studied in detail by Willard Gibbs. Following him, we replace the actual distribution of material by a *uniform* distribution in each phase and superimpose upon this an *extra* distribution (which may be negative) representing the excess per unit area of any component in this superficial lamina. This excess is called the surface concentration and is usually denoted by σ. When a surface tension is measured experimentally it is the value as modified by the surface layer which is actually determined. One effect of this non-uniform distribution of the solute is that when the solute tends to lower the surface considerably, small traces of it added to the pure solvent are sufficient to produce very considerable lowering. In fig. 10, the curve shows the change of surface tension with the amount of soap added to the solute. An amount of soap equal to a concentration of 0.2% produces a lowering to practically the same value as for a concentrated solution and a great part of this reduction is produced by the first traces of soap that are added and go almost completely to the surface layer.

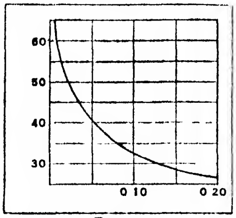


FIG. 10

Willard Gibbs investigated thermodynamically the "surface-concentration" to be expected. External work is done not only in expansion of volume (pd) but also in the extension of the surface area ($-\sigma dA$). Hence $dE = Td\phi - \pi dV + \sigma dA$ for reversible changes or $d(E - T\phi + \pi V) = -\phi dT + Vd\pi + \sigma dA$. Since $E - T\phi + \pi V$ depends only upon the state

$$\left(\frac{\partial V}{\partial A}\right)_\pi = \left(\frac{\partial \sigma}{\partial \pi}\right)_A$$

Representing quantities for the liquid and vapour phases with suffixes 1 and 2 respectively, we have $dV_2 = \frac{RT}{\pi} dN_2$ where V_2 is the volume of the vapour, π the vapour pressure and N_2 the number of molecules in the vapour. In the liquid let n_1 equal *total* number of molecules of the solute and N_1 those of the solvent in the solution. Imagine a virtual displacement from the liquid to vapour phase at constant temperature and concentration produced by an extension of the area. For unit increase of area n_1 changes by $-\frac{dn_1}{dA}$; and for the concentration to keep constant $\frac{dn_1}{n_1} = \frac{dN_1}{N_1}$ so that dN_1 molecules of solvent evaporate. But $dN_2 = -dN_1 = -\frac{N_1}{n_1} dn_1$. The change of volume dV is practically dV_2 (*i.e.*, neglecting change of volume of the liquid).

Hence
$$\left(\frac{\partial V}{\partial A}\right)_\pi = -\left(\frac{RTN_1 dn_A}{n\pi dA}\right)_\pi$$

Again
$$\left(\frac{\partial \sigma}{\partial \pi}\right)_A = \left(\frac{\partial \sigma}{\partial n} \cdot \frac{dn}{d\pi}\right)_A = -\frac{N_1}{\pi}\left(\frac{\partial \sigma}{\partial n}\right)_A$$

in which an approximate value of the change of π with n has been inserted. Hence finally

$$\frac{dn_A}{dA} = \Gamma = -\frac{n}{RT}\frac{d\sigma}{dn}$$

where n_A are the *excess* molecules of solute in unit surface layer. This is a maximum value for Γ, since more exact expressions for the vapour pressure tend to reduce it. For strong solutions of sugar the simple expression goes up to four times the more exact value; but for dilute solutions it must be very near the truth.

THERMAL EFFECTS

The thermal changes that take place in the case of dilution of solutions can be examined in a similar way to other latent heats. If we enclose a solution and the solvent on opposite sides of an osmotic membrane in an "equilibrium box" it is easy to carry out a Carnot cycle of changes for which the efficiency is $\frac{dT}{T}$. We deduce, for the reversible latent heat of dilution corresponding to unit mass of solvent entering, the expression,

$$H_{\text{reversible}} = T\left(s\frac{dp}{dT} - u\frac{dp_0}{dT}\right) \text{ exactly}$$

For the corresponding change of energy we must subtract the external work done, viz.: $sdp - udp_0$, whence

$$\Delta E = s\left(T\frac{dp}{dT} - p\right) - u\left(T\frac{dp_0}{dT} - p_0\right)$$

This latter must be very nearly the irreversible heat absorbed on stirring solvent into the solution instead of through an osmotic membrane, because in the stirring process, the whole being at ordinary pressure, there is very little external work done and the latent heat is practically the energy change. When p_0 is small throughout,

$$H_{\text{reversible}} \text{ is practically } Ts\frac{dP}{dT}$$

and
$$\Delta E \text{ is practically } s\left(T\frac{dP}{dT} - P\right)$$

where P is the osmotic pressure. Connecting P with the vapour pressure by the usual substitution $Ps = RT\log\frac{\pi_0}{\pi_\pi}$,

$$\Delta E = T^2 s\frac{\partial}{\partial T}\left(\frac{R}{s}\log\frac{\pi_0}{\pi_\pi}\right)$$

and, if s and R are independent of temperature, this becomes the same as an approximate equation given by Kirchhoff. If this irreversible heat of dilution is zero, $\log\frac{\pi_0}{\pi_\pi}$ must be independent of temperature.

This approximate law is known as von Babo's law.

Freezing Points.—When a solution is in equilibrium with the solid phase of the solvent it is at its freezing point, and must have the same vapour pressure as the solid. Different solutions in the same solvent must have the same freezing points if their vapour pressures (and therefore their osmotic pressures) are the same.

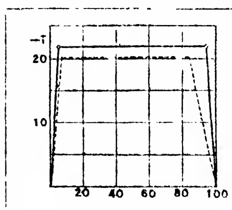


FIG. 11

Cryohydric Points.—If, at the freezing point, the solution of one is saturated it is then at a cryohydric point. A solution of common salt is at the point at about $-22°$ C.

Freezing mixtures depend upon the fact that if salt be added to ice it will dissolve and cool the system owing to the latent heat of solution. By adding fresh salt further cooling goes on until the solution becomes saturated at the final temperature reached. The effect of adding various quantities is shown in fig. 11. The experimental curve (dotted) differs from the curve, calculated from an approximate theory, mainly owing to the thermal capacity of the containing vessel. It will be seen that the relative proportions of ice and salt may be varied within wide limits and the cryohydric temperature will be approached. When the material cooled by the mixture has considerable thermal capacity the greatest chance of producing the lowest temperature is when

the amount of salt is about 30 per cent.

Irreversible Processes.—Owing to the universality of frictional forces every process that we can conduct is in reality irreversible Trains require to be driven even on the level, ocean waves subside and winds cease soon after the cause producing them has ceased to be effective The motion of the piston of an engine allows the steam to be set in motion and the kinetic energy that corresponds is ultimately transformed into molecular energy and is mainly unavailable for doing useful work. It is true that so far as a difference of temperature is set up by friction *some* of the temperature energy may be transferred into work but the amount is incommensurable with the loss

The most typically irreversible process is that in which a fluid is forced through a nozzle or a porous plug Considering the steady state of adiabatic flow only, we have (i) an equality of the mass leaving and entering the plug, (ii) an equality of the energy leaving and entering. The energy is in part the intrinsic energy E (per unit mass) and in part energy of motion in bulk, $\frac{1}{2}$ velocity squared (per unit mass). Further the incoming fluid does work p_1v_1 in forcing the fluid through and the outgoing fluid does work p_2v_2 in forcing out the fluid in front of it; the gain of energy on this account is $p_1v_1-p_2v_2$ Hence the total gain of energy inside the plug is

$$E_1+p_1v_1+\tfrac{1}{2}V_1^2-(E_2+p_2v_2+\tfrac{1}{2}V_2^2)$$

and in the steady adiabatic state of flow this is zero. We assume that the two positions at which the energies are reckoned are well outside the plug so that we can consider the velocity, etc , as uniformly distributed across the cross section When the 'narrows' inside the throttle or plug are reached the velocity attains a high value and a high viscous resistance is met with so that even V_2 may be small in spite of the great difference of pressure on the two sides and further dissipation of energy takes place in the eddies that form on emergence The result is that the fluid is much hotter on emergence than if it had expanded between the same extreme pressures reversibly and adiabatically in a cylinder. We suppose for simplicity only a small difference of pressure, etc , so that

$$d(E+pv)=-d(\tfrac{1}{2}V^2).$$

If the motion has been *linear* and *without friction* it is known from hydrodynamics that

$$d(\tfrac{1}{2}V^2)=-vdp$$

so that the equation would reduce to

$$dE+pdv=0,$$

which as we know represents the heat entry in a reversible process To consider such a process would be equivalent, for example, to discussing the oscillation of a frictionless pendulum. Such a pendulum would go on vibrating without loss of amplitude for ever and every half period it would perfectly reverse its path The lack of reversibility of a real pendulum is entirely due to its meeting with frictional resistance to its motion. The loss of kinetic energy on the average is represented by the extra temperature of the bob and air, together with the energy which is radiated out. This 'loss' of energy of visible motion corresponds to an increase in the internal energy of the system such as would be caused by an entry of heat from outside and it produces the same effects Similarly in the problem of the flow of fluid if we add the frictional heat dq to the actual value of $d(\frac{1}{2}V^2)$ it may be expected by the law of conservation to give $-vdp$. Hence

$$d(E+pv)=-d(\tfrac{1}{2}V^2)=-vdp+dq$$

or

$$dE+pdv=dq.$$

Hence the actual value of the change on the left side is precisely the same as it would be if heat dq had entered *reversibly from outside the system.* In reality no heat has entered from outside but the frictional heat produces precisely the same effect as if it had done so. The essential difference between the two cases is that if we were to reverse the reversible system the corresponding heat would be *given out;* but the frictional heat is always positive in whichever sense the transformation proceeds. Since dq produces the same effects as if it had come from outside reversibly it must increase the entropy by the amount dq/T although the change is really adiabatic so far as the whole system is concerned. This can be illustrated by supposing the fluid to be an ideal gas. In such a case the increase of entropy is $C_v\log\frac{T_2}{T_1}+R\log\frac{v_2}{v_1}$. But

$$dE=C_vdT \text{ and } pv=RT;$$

hence

$$d(E+pv)=(C_v+R)\,dT.$$

Neglecting $d(\frac{1}{2}V^2)$, as we can do when the flow is slow (because it depends upon the square of V and the other changes are of the first order of small quantities), this must be zero, i e., $dT=0$; so that no change of temperature occurs. Hence $T_2=T_1$ and $\phi_2-\phi_1=R\log\frac{v_2}{v_1}$. Further $v_2>v_1$ because $p_1>p_2$. So there is a positive increase of entropy, and its value is $R\log\frac{v_2}{v_1}=-\frac{1}{T}\int vdp$ as we inferred it to be Since $E+pv$ (which is called the *enthalpy*) is a quantity which depends only upon the state we can calculate it for *any* change (adiabatic or otherwise) between the extreme states. It is most convenient to calculate it for a reversible change (which may not be adiabatic) Starting from

$$dq=dE+pdv$$
$$d(E+pv)=dq+vdp$$
$$=C_pdT-T\left(\frac{\partial v}{\partial T}\right)_p dp+vdp$$

Hence if $E+pv$ has the same value as at first the right hand must also be zero or

$$\left(\frac{dT}{dp}\right)_{E+pv}=\frac{T(\partial v/\partial T)_p-v}{C_p}.$$

The left hand side is the amount the temperature falls in the plug experiment for unit fall of pressure It will be zero (as it is for a perfect gas) provided that

$$T\left(\frac{\partial v}{\partial T}\right)_p-v=0$$

or (by integration) $\qquad v=Tf(p),$

where $f(p)$ stands for *any* function of the pressure. Kelvin and Joule found experimentally that at moderate pressures air and carbon dioxide cool in the process while hydrogen warms In reality all fluids (gaseous or liquid) at certain temperatures and pressures undergo neither warming nor cooling in the process. At sufficiently high or sufficiently low temperatures all get hotter, in an intermediate region of temperatures they *may* get cooler but they fail to do so if the pressure is above a certain limit which appears to be at about 15 times the critical pressure (*Trans. Far. Soc., Discussion on the production and utilization of cold.* President's opening remarks, 1922)

General.—The conclusions drawn from thermodynamics can be confirmed and extended by the aid of the principles generalized in mechanics which enable problems to be approached from a different aspect. The two fields of enquiry overlap. The thermodynamical way ignores the precise mechanism of the various transformations: making use of principles which are independent of the particular mechanism. This does not exclude the possibility of information being obtained in other ways which are not as independent of it and by which it may ultimately be possible to formulate with some degree of precision the nature of that mechanism. Such methods are of course less abstract in the picture with which they present us but enormous difficulties are met with in dealing even with the simpler phenomena.

It is possible to examine the movements of the hands of a watch and to detect and discuss certain regularities of their movement; but it is another matter to predict (without taking the watch to pieces) what the precise mechanism inside may be. The problems that are met with in chemical and other reactions are much more complicated than the movements of the hands of the watch. It is only very gradually that an imperfect picture is being created. Such help as is being given it by statistical me-

chanics is exceedingly valuable; but it is outside the scope of this article.

BIBLIOGRAPHY.—The fundamental reference is to the collected papers of R Clausius, translated into English by W. R. Browne as *The mechanical theory of heat* (1879). In addition the following are the most important. Bertrand, *Thermodynamique* (1887); Duhem, *Traité élémentaire de méchanique chimique*, four volumes. Duhem, *Le potential thermodynamique et ses applications à la méchanique chimique* (1895), etc. (this is a more elementary treatise); J. Willard Gibbs, *Collected Papers*, 2 vols, especially the paper on Heterogeneous equilibrium (an edition published in 1928 includes his treatise on *Statistical Mechanics* which was previously published separately); Max Planck, *Treatise on thermodynamics* (translated by A Ogg) (3rd ed, 1927); O. Sackur, *Lehrbuch der Thermochemie und Thermodynamik* (1917) (and especially the English translation by Gibson which contains a large amount of additional matter). (A. W. Po)

THERMOMETRY, the art of measuring temperature or degree of heat (Gr. θερμός warm; μέτρον, a measure). The instruments used for this purpose are known as thermometers, or sometimes, when the temperatures to be measured are high, as pyrometers.

A brief sketch of the evolution of the thermometer is included in the article HEAT. The object of the present article is to discuss the general principles on which the accurate measurement of temperature depends, and to describe the application of these principles to the construction and use of the most important types of thermometer Special attention will be devoted to more recent advances in scientific methods of testing thermometers and to the application of electrical and optical methods to the difficult problem of measuring high temperatures.

Zero: Fundamental Interval.—In all systems of measuring temperature it is necessary (1) to choose a zero or starting-point from which to reckon, (2) to determine the size of the degree by subdividing the interval between two selected fixed points of the scale (called the "fundamental interval") into a given number of equal parts. The fundamental interval selected is that between the temperature of melting ice and the temperature of condensing steam, under standard atmospheric pressure. On the Centigrade system the fundamental interval is divided into 100 parts, and the melting-point of ice is taken as the zero of the scale We shall denote temperature reckoned on this system by the letter t, or by affixing the letter C. It is often convenient to reckon temperature, not from the melting-point of ice, but from a theoretical or absolute zero representing the lowest conceivable temperature. We shall denote temperature reckoned in this manner by the letter T, or θ, or by affixing the letters *Abs*. In practice, since the absolute zero is unattainable, the absolute temperature is deduced from the Centigrade temperature by adding a constant quantity, T_0, representing the interval between the absolute zero and the melting-point of ice; thus $T=t+T_0$

Arbitrary Scales.—An arbitrary scale can be constructed by selecting any physical property of a substance which varies regularly with the temperature, such as the volume of a liquid, or the pressure or density of a gas, or the electrical resistance of a metal. Thus if V denote the volume of a given mass at the temperature t, and if V_0, V_1 represent the volumes of the same mass at the temperatures 0° and 100° C, the size of 1° C on the scale of this arbitrary thermometer is one hundredth part of the fundamental interval, namely $(V_1-V_0)/100$, and the temperature t at volume V is the number of these degrees contained in the expansion $V-V_0$ between 0° and t° C. We thus arrive at the formula

$$t=100(V-V_0)/(V_1-V_0) \qquad (1)$$

which is the general expression for the temperature Centigrade on any such arbitrary scale, provided that we substitute for V the particular physical property selected as the basis of the scale. If we prefer to reckon temperature from an arbitrary zero defined by the vanishing of V, which may conveniently be called the *fundamental zero* of the scale considered, we have, putting V=0 in equation (1), the numerical values of the fundamental zero T_0, and of the temperature T reckoned from this zero

$$T_0=100V_0/(V_1-V_0), \text{ and } T=T_0V/V_0=t+T_0. \qquad (2)$$

It is frequently convenient to measure temperature in this manner when dealing with gases.

Absolute Scale.—It is necessary for theoretical purposes to reduce all experimental results as far as possible to the absolute scale, defined as explained in HEAT, on the basis of Carnot's principle, which is independent of the properties of any particular substance. This scale can be most nearly realized in practice by observing the temperature on the scale of a gas-thermometer, and making special experiments on the gas to determine how far its scale deviates from that of the thermodynamical engine. In the case of the gases hydrogen and helium, which can exist in the liquid state only at very low temperatures, the deviations from the absolute scale at ordinary temperatures are so small that they cannot be determined with certainty. Thermometers containing these gases are generally taken as the ultimate standards of reference in practical thermometry.

International Temperature Scale.—The experimental difficulties incident to the realization of the thermodynamic scale have made it expedient to adopt a practical scale designated as the International Temperature Scale This scale has been proposed as the result of discussion extending over a considerable period between the national laboratories of Germany, Great Britain, and the United States, and has been adopted provisionally by the Seventh General Conference of Weights and Measures, meeting in Paris in 1927 It is intended to represent the thermodynamic scale as closely as is possible with present knowledge for scientific and industrial purposes, and may be subject to revision as more accurate methods of measurement are evolved. It is based on a number of fixed and reproducible equilibrium temperatures to which numerical values are assigned, and upon the indications of interpolation instruments calibrated according to a specified procedure at the fixed temperatures A summary of the basic fixed points, and of the procedure to be adopted in realizing the practical scale, will be given at the end of this article

MERCURIAL THERMOMETRY

Mercurial thermometers will doubtless continue to be employed for the majority of measurements for which they are suited, especially in cases where facility of observation is more important than the highest attainable degree of precision. It is to be presumed, however, that the indications of such instruments will be reduced when necessary to the international scale by comparison with a suitable standard instead of being expressed in terms of the mercurial scale as previously defined The somewhat exacting process of the calibration of the bore of a standard mercurial thermometer, which was essential to the reproduction of the mercurial scale, becomes of secondary importance, since the calibration correction of each instrument will be automatically included in the table of corrections supplied by the testing laboratories Other corrections depend on the conditions under which the instrument is used.

Correction for Changes of Zero.—The *changes of zero* are of two kinds: (*a*) *Secular rise* of zero due to gradual recovery from changes or strains acquired by the bulb during the process of manufacture This process may be hastened and subsequent changes practically eliminated by annealing the bulb after manufacture, and before final adjustment, at a high temperature, such as that of boiling sulphur (about 450° C). A thermometer which has not been so treated may show a rise of zero amounting to as much as 20° or 30° when exposed for some time to a temperature of 350° C. (*b*) *Temporary depression* of zero after each exposure to a high temperature, followed by a slow recovery which may last for days or weeks The best thermometers of hard glass show a depression of zero amounting to about one-tenth of 1° C after exposure to 100° C In softer glass the depression is usually greater and more persistent, and may amount to half a degree after 100° C. At higher temperatures the depression generally increases roughly as the square of the temperature above 0° C. It may amount to 2° or 3° at 300° C. The effect cannot be calculated or predicted in any series of observations because it depends in so complicated a manner on the past history and on the time. It is a most serious difficulty in accurate mercurial thermometry, especially at high temperatures The most satisfactory method of correction appears to be to observe the zero

immediately after each reading, and to reckon the temperature from the variable zero thus observed. The rationale of this procedure is that the depression is produced at the high temperature much more rapidly than the subsequent recovery at the low temperature The thermometer is taken from the bath and allowed to cool rapidly by free exposure to the air As soon as it reaches 40° or 50° C, it is plunged in the melting ice, and the lowest point reached is taken as the temporary zero.

The following formulae have been proposed by various observers to represent the depression of zero for different kinds of glass —

$$\left.\begin{array}{l} \text{Pernet, French } \textit{cristal},\ dz=0{\cdot}0040(t/100)^2 \\ \text{Guillaume, } \textit{Verre dur},\ 0-100^\circ\text{ C},\ dz=(8886t+10{\cdot}84t^2)\,10^{-7} \\ \text{Bottcher, } \textit{Cristal dur},\ 0-190^\circ\text{ C},\ dz=(7970t+329t^2)\,10^{-7} \\ \quad\text{,,}\quad \text{Jena, 16, III.},\ dz=(7100t-8t^2)\,10^{-7}\ . \end{array}\right\} \quad (3)$$

The symbol dz in these formulae stands for the depression of zero produced by an exposure to a temperature t The depression is about three times as large in French crystal as in English flint glass, and varies roughly as the square of t. *Verre dur* and Jena, 16, iii., are varieties of hard glass chosen as standards in France and Germany respectively, on account of the comparatively small depression of zero to which they are liable. At low temperatures, up to 50° C, the depression is very nearly proportional to t, but at temperatures above 100° C it is necessary to adopt another formula in which the term depending upon t^2 is more important These formulae are useful as giving an idea of the probable size of the correction in any case, but they cannot be employed in practice except in the simplest cases and at low temperatures On account of these temporary changes of zero, a mercury thermometer intended for the most accurate work at ordinary temperatures (as in calorimetry) should preferably never be heated above 40° or 50° C, and certainly never above 100° C Above 100° C the changes of zero become more irregular and more variable, depending on the rate of cooling and on the sequence of previous observations, so that even if the method of observing the zero after each reading is adopted, the order of precision attainable rapidly diminishes

Correction of the Fundamental Interval.—The thermometer to be tested is exposed to steam condensing at atmospheric pressure in an apparatus which is often called a "hypsometer," constructed with double walls to protect the inner tube containing the thermometer from any cooling by radiation The standard atmospheric pressure at which the temperature of the steam is by definition equal to 100° C is equivalent to that produced by a column of mercury 760 millimetres high, having a density of 13·5951 $p/_{cm^3}$, at a place where the acceleration of gravity is 980 665 $cm/_{sec^2}$., giving a pressure equal to 1,013,250 $dyn/_{cm^2}$. The atmospheric pressure at the time of observation is reduced to these units by applying the usual corrections for temperature and gravitation If the pressure is near 760 mm , the temperature of the steam may be deduced by assuming that it increases at the rate of 1° C for 27·2 mm of pressure The following approximate formula for the temperature t of steam in terms of pressure p in mm. has been adopted for the range between 680 and 780 mm.

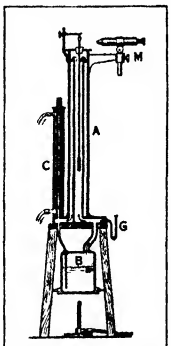


FIG. 1.—HYPSOMETER

$$t=100+0{\cdot}0367(p-760)-0{\cdot}000023(p-760)^2. \qquad (4)$$

A convenient type of hypsometer is shown in fig. 1. The boiler B is separate from the steam-jacket A surrounding the thermometer. A gauge G is provided for indicating the steam pressure (difference from atmospheric) and a condenser C for returning the condensed steam to the boiler The thermometer is observed by the microscope M.

If the barometer has a brass scale correct at 0° C, and p be the reading in millimetres, the correction for temperature is made approximately by subtracting 0·00163 p mm.

If L is the latitude and M the height of the station in metres above the sea-level, the correction for gravitation is approximately made by subtracting (0 0026 cos 2L+0·0000002M) p

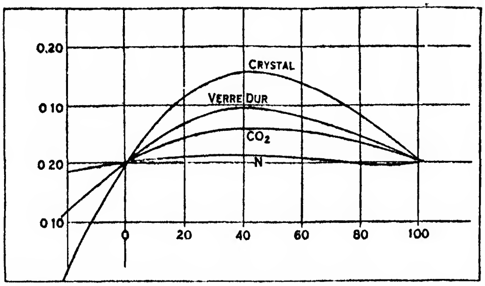
The zero of the thermometer is observed immediately after the steam point. If n be the interval in degrees of the scale between the two observations, and if t_1 be the temperature of the steam, the fundamental interval of the thermometer may be taken as 100 n/t_1, provided that t_1, is nearly 100° C. Since all the readings of a thermometer have to be corrected for the error of the fundamental interval, by dividing by the fundamental interval thus observed and multiplying by 100, it is a matter of some convenience in practice to have the instrument graduated so that the difference between the readings in ice and at 100° C is very nearly 100° of the stem. The correction can then be applied as a small percentage independently of the other corrections. The method of determining the fundamental interval above described applies to all other kinds of thermometers, except that it is not generally necessary to observe the zero *after* the steam point. The temperature of the steam t_1 should be expressed in the scale of the thermometer tested, if the scale differs appreciably from that of Regnault.

Pressure Correction.—The corrections for variations of internal and external pressure on the bulb are of some importance in accurate thermometry, but can be applied with considerable certainty at moderate temperatures. The correction for external pressure is assumed to be proportional to the change of pressure, and to be independent of the temperature. It is generally determined by enclosing the thermometer to be tested in a vessel of water, and observing the change of reading produced by varying the pressure. The correction is generally between one and two thousandths of a degree per centimetre of mercury change of pressure, but must be determined for each thermometer, as it depends on the nature of the glass and on the form and thickness of the walls of the bulb The coefficient of the correction for internal pressure is greater than that for external pressure by the difference between the compressibility of mercury and that of glass, and may be calculated from it by assuming this relation. If b_0, b_1, are the external and internal coefficients, expressed in degrees of temperature per centimetre of mercury, we have the relation

$$b_1=b_0+0{\cdot}00015,\ \text{degrees per cm. of mercury.} \qquad (5)$$

The coefficient of internal pressure can also be determined by taking readings in the horizontal and vertical positions when the thermometer is at some steady temperature such as that of ice or steam. The reading of the thermometer is generally reduced to an external pressure of one standard atmosphere, and to an internal pressure corresponding to the horizontal position. It is also possible to include the internal pressure correction in the scale correction, if the thermometer is always read in the vertical position. In addition to the variations of internal pressure due to the column of mercury in the stem, there are variations due to capillarity. The internal pressure is greater when the mercury is rising than when it is falling, and the reading is depressed to an extent depending on the fineness of the bore and the thinness of the walls of the bulb. The capillary pressure does not depend only on the bore of the tube, but also apparently to an even greater extent on the state of the walls of the tube. The least trace of dirt on the glass or on the mercury is capable of producing capillary pressures much greater than would be calculated from the diameter of the tube. Even in the best thermometers, when there are no inequalities of bore sufficient to account for the observed variations, it is seldom found that the mercury runs equally easily in all parts of the stem. These variations of capillary pressure are somewhat capricious, and set a limit to the order of accuracy attainable with the mercury thermometer. It appears that the difference of reading of a good thermometer between a rising and falling meniscus may amount to five or ten thousandths of a degree. The difference may be reduced by continuous tapping, but it is generally best to take readings always on a rising column, especially as the variations in the angle of contact, and therefore in the capillary pressure, appear to be much smaller for the rising meniscus. In ordinary work the zero reading and the steam reading would both generally correspond to a falling meniscus; the former necessarily,

the latter on account of the phenomenon of the temporary depression of zero, which causes the thermometer to read higher during the first moments of its exposure to steam than it does when the expansion of the bulb has reached its limit. It is easy to secure a rising meniscus at the steam point by momentarily cooling the thermometer. At the zero point the meniscus generally begins to rise after five or ten minutes The question, however,



FROM "PHILOSOPHICAL TRANSACTIONS" BY COURTESY OF ROYAL SOCIETY

FIG 2 —DIFFERENCES BETWEEN SCALES OF MERCURY, AND GAS THERMOMETERS AND HYDROGEN SCALE, ACCORDING TO GUILLAUME AND CHAPPUIS

is not of much importance, as the error, if any, is regular, and the correction for capillarity is necessarily uncertain

Stem-exposure Correction.—When the bulb of a mercury thermometer is immersed in a bath at a temperature t, and a part of the column of mercury having a length of n degrees is exposed to a lower temperature t_2, the reading of the thermometer will be lower by $a \times n \times (t-t_2)$ degrees (nearly) than it would have been if the whole of the mercury and stem had been at the temperature t The factor a in this expression is the apparent coefficient of expansion of mercury in glass, and varies from ·000150 to ·000165 for different kinds of glass In order to apply this correction, it is usual to observe t_2 by means of an auxiliary "stem-thermometer" with its bulb placed near the middle of the emergent column n Occasionally stem-thermometers with long thin bulbs are employed to give more nearly the average temperature of the whole emergent column Owing to conduction along the stem of the thermometer, and to heated vapours near the bath, the mean temperature determined in this manner is generally too low To allow for this empirically, an arbitrary reduction is often made in the value taken for n or a, but this cannot be regarded as satisfactory for work of precision The only practical method of reducing the correction is to limit the number of degrees n exposed, or, in other words, to work with thermometers of "limited range" Each of these thermometers must then be corrected by comparison with a standard thermometer free from stem-exposure correction, such as a platinum-resistance thermometer. To secure results of any value the correction must be determined at each point under the actual conditions of observation under which the thermometer is to be used. In work of precision it is necessary to use ten or twenty thermometers to cover a range of 300°, as this is the only method of securing an open scale and reasonable accuracy as regards stem-exposure.

GAS THERMOMETRY

The deviations of the gas thermometer from the absolute scale are so small that this instrument is now universally regarded as the ultimate standard in thermometry. It had, in fact, already been adopted for this purpose by Regnault and others, on a priori considerations, before the absolute scale itself had been invented. Although the indications of a gas thermometer are not absolutely independent of the changes of volume of the envelope or bulb in which the gas is contained, the effect of any uncertainty in this respect is minimized by the relatively large expansibility of the gas. The capricious changes of volume of the bulb, which are so great a difficulty in mercurial thermometry, are twenty times less important in the case of the gas thermometer. As additional reasons for the choice we have the great simplicity of the laws of gases, and the approximate equality of expansion and close agreement of the thermometric scales of all gases, provided that they are above their critical temperatures Subject to this condition, at moderate pressures and provided that they are not dissociated or decomposed, all gases satisfy approximately the laws of Boyle and Charles These two laws are combined in the characteristic equation of the gaseous state, viz, $pv = RT$, in which p is the pressure and v the volume of unit mass of the gas in question, and R is a constant which varies inversely as the molecular weight of the gas, and is approximately equal to the difference of the specific heats

Practical Conditions and Methods.—In practice it is not convenient to deal with unit mass, but with an arbitrary mass M occupying a space V, so that the specific volume $v = V/M$. It is also necessary to measure the pressure p in terms of mercury columns, and not in absolute units The numerical value of the constant R is adjusted to suit these conditions, but is of no consequence in thermometry, as we are concerned with ratios and differences only The equation may be written in the form $T = pV/RM$, but in order to satisfy the essential condition that T shall be a definite function of the temperature in the case of a gas which does not satisfy Boyle's law exactly, it is necessary to limit the application of the equation to special cases which lead to definite, but not necessarily identical, thermometric scales There are three special cases of practical importance, corresponding to three essentially distinct experimental methods.

Volumetric Method (constant-pressure)—In this method V is variable and p and M are constant This method was employed by Gay-Lussac, and is typified in the ideal thermometer with reservoir of variable capacity designed by Lord Kelvin. It corresponds to the method ordinarily employed in the common liquid-in-glass thermometer, but is not satisfactory in practice, owing to the difficulty of making a bulb of variable and measurable volume the whole of which can be exposed to the temperature to be measured

Manometric Method (constant-volume or density)—In this method p is variable and V and M are constant Variations of temperature are observed and measured by observing the corresponding variations of pressure with a mercury manometer, keeping a constant mass, M, of gas enclosed in a volume, V, which is constant except for the unavoidable but small expansion of the material of which the bulb is made.

Gravimetric Method (constant-pressure)—In this method M is variable and p and V are constant This method is generally confounded with (i) under the name of the constant-pressure method, but it really corresponds to the method of the weight thermometer, or the "overflow" method, and is quite distinct from an experimental standpoint, although it leads to the same thermometric scale In applying this method, the weight M of the vapour itself may be measured, as in Regnault's mercury-vapour thermometer, or in Deville and Troost's iodine-vapour thermometer. The best method of measuring the overflow is that of weighing mercury displaced by the gas The mass of the overflow may also be estimated by observing its volume in a graduated tube, but this method is much less accurate

In addition to the above, there are mixed methods in which both p and V or M are variable, such as those employed by Rudberg or Becquerel; but these are unsatisfactory for precision, as not leading to a sufficiently definite thermometric scale. There is also a variation of the constant-volume method (ii), in which the pressure is measured by the volumetric compression of an equal mass of gas kept at a constant temperature, instead of by a manometer.

Construction of Apparatus.—The manometric or constant-volume method was selected by Regnault as the standard, and has been most generally adopted since his time. His apparatus has not been modified except in points of detail. A description of his instrument will be found in most text-books on heat.

A simple and convenient form of the instrument for general use is Jolly's (described in Poggendorff's *Jubelband*, p. 82, 1874), and represented in fig. 3. The two vertical tubes of the manometer

are connected by an india-rubber tube properly strengthened by a cotton covering, and they can be made to slide vertically up and down a wooden pillar which supports them; they are provided with clamps for fixing them in any position and a tangent screw for fine adjustment The connection between the bulb and the manometer is made by means of a three-way tap. The scale of the instrument is engraved on the back of a strip of plane mirror before silvering, and the divisions are carried sufficiently far across the scale for the reflections of the two surfaces of the mercury to be visible behind the scale. Parallax can thus be avoided and an accurate reading obtained without the necessity of using a cathetometer In order to allow for the expansion of the glass of the reservoir a weight-thermometer bulb is supplied with the instrument, made from another specimen of the same kind of glass, and the relative expansion of the mercury and the glass can thus be determined by the observer himself The volume of the air-bulb and that of the capillary tube and the small portion of the manometer tube above the small beak of glass, the point of which serves as the fiducial mark, are determined by the instrument-makers The improvements introduced by Chappuis, of the International Bureau at Sèvres, in the construction of the constant-volume hydrogen thermometer selected by the committee for the determination of the normal scale, are described in the text-books (*e g*, Watson's *Physics*).

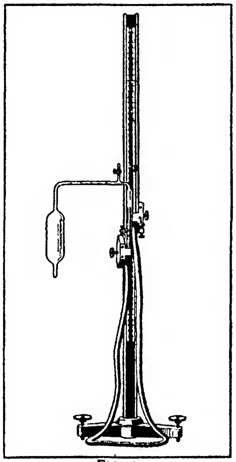


FIG 3

Pressure Correction.—In the practical application of the manometric method there are certain corrections peculiar to the method, of which account must be taken in work of precision. The volume of the bulb is not accurately constant, but varies with change of pressure and temperature. The thermal expansion of the bulb is common to all methods, and will be considered in detail later The pressure correction is small, and is determined in the same manner as for a mercury thermometer. The value so determined, however, does not apply strictly except at the temperature to which it refers If the pressure-coefficient were constant at all temperatures and equal to e, the pressure correction, dt, at any point t of the scale would be obtainable from the simple formula

$$dt = ep_0t(t-100)/T_2 \qquad (6)$$

where p_0 is the initial pressure at the temperature T_2 But as the coefficient probably varies in an unknown manner, the correction is somewhat uncertain, especially at high temperatures Another very necessary but somewhat troublesome correction is the reduction of the manometer readings to allow for the varying temperatures of the mercury and scale. Since it is generally impracticable to immerse the manometer in a liquid bath to secure certainty and uniformity of temperature, the temperature must be estimated from the readings of mercury thermometers suspended in mercury tubes or in the air near the manometer It is therefore necessary to work in a room specially designed to secure great constancy of temperature, and to screen the manometer with the utmost care from the source of heat in measurements of high temperature

Stem-exposure.—In all gas thermometers it is necessary in practice that the part of the gas in contact with the mercury or other liquid in the manometer should not be heated, but kept at a nearly constant temperature. The space above the mercury, together with the exposed portion of the capillary tube connecting the manometer with the thermometric bulb, may be called the "dead space." If the volume of the dead space is kept as nearly as possible constant by adjusting the mercury always up to a fixed mark, the quantity of air in this space varies nearly in direct proportion to the pressure, *i.e.*, in proportion to the temperature of the thermometric bulb at constant volume. This necessitates the application of a stem-exposure correction, the value of which is approximately given by the formula

$$dt = rt(t-100)/T_2 \qquad (7)$$

where r is the ratio of the volume of the dead space to the volume of the thermometric bulb, and T_2 is the mean temperature of the dead space, which is supposed to be constant. The magnitude of the correction is proportional to the ratio r, and increases very rapidly at high temperatures If the dead space is 1 per cent of the bulb, the correction will amount to only one-tenth of a degree at 50° C, but reaches 5° at 445° C, and 30° at 1,000° C It is for this reason important in high-temperature work to keep the dead space as small as possible and to know its volume accurately. With a mercury manometer, the volume is liable to a slight uncertainty on account of changes of shape in the meniscus, as it is necessary to use a wide tube in order to secure accurate measurements of pressure

It is possible to avoid this difficulty, and to make the dead space very small, by employing oil or sulphuric acid or other non-volatile liquid to confine the gas in place of mercury (*Phil Trans*, A. 1887, p 171). The employment of a liquid which wets the tube makes it possible to use a much smaller bore, and also greatly facilitates the reading of small changes of pressure At the same time the instrument may be arranged so that the dead space correction is automatically eliminated with much greater accuracy than it can be calculated This is effected as shown diagrammatically in fig 4, by placing side by side with the tube AB, connecting the bulb B to the manometer A, an exact duplicate CD, closed at the end D, and containing liquid in the limb C, which is of the same size as the branch A of the manometer and in direct communication with it The tube CD, which is called the compensating tube, contains a constant mass of gas under exactly similar conditions of volume and temperature to the tube AB. If therefore the level of the liquid is always adjusted to be the same in both tubes AB and CD, the mass of gas contained in the dead space AB will also be constant, and is automatically eliminated from the equations, as they contain differences only

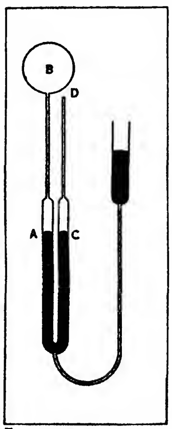


FIG 4—METHOD OF COMPENSATION

Gravimetric Method.—In the writer's opinion, the gravimetric or overflow method, although it has seldom been adopted, and is not generally regarded as the most accurate, is much to be preferred to the manometric method, especially for work at high temperatures It is free from the uncertain corrections above enumerated as being peculiar to the manometric method The apparatus is much simpler to manipulate and less costly to construct. If the pressure is kept constant and equal to the external atmospheric pressure, there is no strain of the bulb, which is particularly important at high temperatures There is no dead space correction so long as the temperature of the dead space is kept constant The troublesome operation of reading and adjusting the mercury columns of the manometer is replaced by the simpler and more accurate operation of weighing the mercury displaced, which can be performed at leisure. The uncertain correction for the temperature of the mercury in the manometer is entirely avoided

The reasons which led Regnault to prefer the constant-volume thermometer are frequently quoted, and are generally accepted as entirely conclusive, but it is very easy to construct the constant-pressure or gravimetric instrument in such a manner as to escape the objections which he urges against it.

Compensated Differential Gas Thermometer.—The chief

advantage of the gravimetric method, which Regnault and others appear to have missed, is that it is possible to make the measurements altogether independent of the atmospheric pressure and of the observation of mercury columns. This is accomplished by using, as a standard of constant pressure, a bulb S, fig. 5, containing a constant mass of gas in melting ice, side by side with the bulb M, in which the volume of the overflow is measured. The pressure in the thermometric bulb T is adjusted to equality with the standard by means of a delicate oil-gauge G of small bore, in which the difference of pressure is observed by means of a cathetometer microscope This kind of gauge permits the rapid observation of small changes of pressure, and is far more accurate and delicate than the mercury manometer. The fundamental measurement of the volume of the overflow in terms of the weight of mercury displaced at o° C involves a single weighing made at leisure, and requires no temperature correction. The accuracy obtainable at ordinary temperatures in this measurement is about ten times as great as that attainable under the best conditions with the mercury manometer At higher temperatures the relative accuracy diminishes in proportion to the absolute temperature, or the error dt increases according to the formula

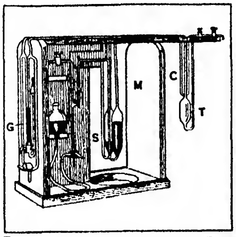


FIG 5—COMPENSATED DIFFERENTIAL GAS THERMOMETER

$$dt/t = -(T/T_o)dw/w, \tag{8}$$

where w is the weight of the overflow and dw the error This diminution of the sensitiveness of the method at high temperatures is commonly urged as a serious objection to the method, but the objection is really without weight in practice, as the possible accuracy of measurement is limited by other conditions. So far as the weighing alone is concerned, the method is sensitive to one-hundredth of a degree at 1,000° C, which is far beyond the order of accuracy attainable in the application of the other corrections.

Method of Using the Instrument—A form of gas thermometer constructed on the principles above laid down, with the addition of a duplicate set of connecting tubes C for the elimination of the stem-exposure correction by the method of automatic compensation already explained, is shown in fig 5.

In setting up the instrument, after cleaning, and drying and calibrating the bulbs and connecting tubes, the masses of gas on the two sides are adjusted as nearly as possible to equality, in order that any changes of temperature in the two sets of connecting tubes may compensate each other. This is effected with all the bulbs in melting ice, by adjusting the quantities of mercury in the bulbs M and S and equalizing the pressures The bulb T is then heated in steam to determine the fundamental interval. A weight w_1 of mercury is removed from the overflow bulb M in order to equalize the pressures again If W is the weight of the mercury at o° C which would be required to fill the bulb T at o° C, and if $W+dW_1$ is the weight of mercury at o° which would be required to fill a volume equal to that of the bulb in steam at t_1, we have the following equation for determining the coefficient of expansion a, or the fundamental zero T_o,

$$at_1 = t_1/T_o = (w_1+dW_1)/(W-w_1) \tag{9}$$

Similarly if w is the overflow when the bulb is at any other temperature t, and the expansion of the bulb is dW, we have a precisely similar equation for determining t in terms of T_o, but with t and w and dW substituted for t_1 and w_1 and dW_1. In practice, if the pressures are not adjusted to exact equality, or if the volumes of the connecting tubes do not exactly compensate, it is only necessary to include in w a small correction dw, equivalent to the observed difference, which need never exceed one part in ten thousand.

It is possible to employ the same apparatus at constant volume as well as at constant pressure, but the manipulation is not quite so simple, in consequence of the change of pressure. Instead of removing mercury from the overflow bulb M in connection with the thermometric bulb, mercury is introduced from a higher level into the standard bulb S so as to raise its pressure to equality with that of T at constant volume The equations of this method are precisely the same as those already given, except that w now signifies the "inflow" weight introduced into the bulb S, instead of the overflow weight from M. It is necessary, however, to take account of the pressure-coefficient of the bulb T, and it is much more important to have the masses of gas on the two sides of the apparatus equal than in the other case The thermometric scale obtained in this method differs slightly from the scale of the manometric method, on account of the deviation of the gas compressed at o° C from Boyle's law, but it is easy to take account of this with certainty.

Another use to which the same apparatus may be put is the accurate comparison of the scales of two different gases at constant volume by a differential method. It is usual to effect this comparison indirectly, by comparing the gas thermometers separately with a mercury thermometer, or other secondary standard But by using a pair of bulbs like M and S simultaneously in the same bath, and measuring the small difference of pressure with an oil-gauge, a higher order of accuracy may be attained in the measurement of the small differences than by the method of indirect comparison.

Expansion Correction.—In the use of the mercury thermometer we are content to overlook the modification of the scale due to the expansion of the envelope, which is known as Poggendorff's correction, or rather to include it in the scale correction In the case of the gas thermometer it is necessary to determine the expansion correction separately, as our object is to arrive at the closest approximation possible to the absolute scale. It is a common mistake to imagine that if the rate of expansion of the bulb were uniform, the scale of the apparent expansion of the gas would be the same as the scale of the real expansion—in other words, that the correction for the expansion of the bulb would affect the value of the coefficient of expansion $1/T_o$ only, and would be without effect on the value of the temperature t deduced. A result of this kind would be produced by a constant error in the initial pressure on the manometric method, or by a constant error in the initial volume on the volumetric method, or by a constant error in the fundamental interval on any method, but *not* by a constant error in the coefficient of expansion of the bulb, which would produce a modification of the scale exactly analogous to Poggendorff's correction The correction to be applied to the value of t in any case to allow for any systematic error or variation in the data is easily found by differentiating the formula for t with respect to the variable considered Another method, which is in some respects more instructive, is the following:—

Let T be the function of the temperature which is taken as the basis of the scale considered, then we have the value of t given by the general formula (1), already quoted in § 3 Let dT be the correction to be added to the observed value of T to allow for any systematic change or error in the measurement of any of the data on which the value of T depends, and let dt be the corresponding correction produced in the value of t, then substituting in formula (1) we have,

$$t+dt = 100(T-T_o+dT-dT_o)/(T_1-T_o+dT_1-dT_o),$$

from which, provided that the variations considered are small, we obtain the following general expression for the correction to t,

$$dt = (dT-dT_o)-(dT_1-dT_o)t/100 \tag{10}$$

It is frequently simpler to estimate the correction in this manner, rather than by differentiating the general formula

In the special case of the gas thermometer the value of T is given by the formula

$$T = pV/RM = pV/R(M_o-M_2), \tag{11}$$

where p is the observed pressure at any temperature t, V the volume of the thermometric bulb, and M the mass of gas remaining in the bulb. The quantity M cannot be directly observed, but is deduced by subtracting from the whole mass of gas M_o con

tained in the apparatus the mass M_2 which is contained in the dead space and overflow bulb In applying these formulae to deduce the effect of the expansion of the bulb, we observe that if dV is the expansion from 0° C. and V_o the volume at 0° C, we may write

$$V=V_o+dV,\ T=p(V_o+dV)/RM=(pV_o/RM)\ (1+dV/V_o),$$

whence we obtain approximately

$$dT=TdV/V_o \qquad (12)$$

If the coefficient of expansion of the bulb is constant and equal to the fundamental coefficient f (the mean coefficient between 0° and 100° C), we have simply $dV/V_o=ft$; and if we substitute this value in the general expression (14) for dt, we obtain

$$dt=(T-T_1)ft=ft(t-100) \qquad (13)$$

Provided that the correction can be expressed as a rational integral function of t, it is evident that it must contain the factors t and $(t-100)$, since by hypothesis the scale must be correct at the fixed points 0° and 100° C, and the correction must vanish at these points It is clear from the above that the scale of the gas thermometer is not independent of the expansion of the bulb even in the simple case where the coefficient is constant The correction is by no means unimportant. In the case of an average glass or platinum reservoir, for which f may be taken as 0·000025 nearly, the correction amounts to $-0·0625°$ at 50° C, to 3·83° at 445° C, and to 22 5° at 1,000° C

The value of the fundamental coefficient f can be determined with much greater accuracy than the coefficient over any other range of temperature The most satisfactory method is to use the bulb itself as a mercury weight thermometer, and deduce the cubical expansion of the glass from the absolute expansion of mercury as determined by Regnault. Unfortunately the reductions of Regnault's observations by different calculators differ considerably even for the fundamental interval The values of the fundamental coefficient range from 00018153 Regnault, and ·00018210 Moss, to ·00018257 Chappuis The extreme difference represents an uncertainty of about 4 per cent. (1 in 25) in the expansion of the glass This uncertainty is about 100 times as great as the probable error of the weight thermometer observations. But the expansion is even less certain beyond the limits of the fundamental interval. Another method of determining the expansion of the bulb is to observe the linear expansion of a tube or rod of the same material, and deduce the cubical expansion on the assumption that the expansion is isotropic It is probable that the uncertainty involved in this assumption is greater in the case of glass or porcelain bulbs, on account of the difficulty of perfect annealing, than in the case of metallic bulbs

Except for small ranges of temperature, the assumption of a constant coefficient of expansion is not sufficiently exact. It is therefore usual to assume that the coefficient is a linear function of the temperature, so that the whole expansion from 0° C may be expressed in the form $dV=t(a+bt)V_o$, in which case the fundamental coefficient $f=a+100b$. Making this substitution in the formula already given, we obtain the whole correction

$$dt=(f+bT)t(t-100). \qquad (14)$$

It will be observed that the term involving b becomes of considerable importance at high temperatures. Unfortunately, it cannot be determined with the same accuracy as f, because the conditions of observation at the fixed points are much more perfect than at other temperatures Provided that the range of the observations for the determination of the expansion is co-extensive with the range of the temperature measurements for which the correction is required, the uncertainty of the correction will not greatly exceed that of the expansion observed at any point of the range. It is not unusual, however, to deduce the values of b and f from observations confined to the range 0° to 100° C, in which case an error of 1 per cent., in the observed expansion at 50° C, would mean an error of 60 per cent. at 445°, or of 360 per cent at 1,000° C. (Callendar, *Phil. Mag* December 1899) Moreover, it by no means follows that the average value of b between 0° and 100° C should be the same as at higher or lower temperatures. The method of extrapolation would therefore probably lead to erroneous results in many cases, even if the value could be determined with absolute precision over the fundamental interval. It is probable that this expansion correction, which cannot be reduced or eliminated like many of the other corrections which have been mentioned, is the chief source of uncertainty in the realization of the absolute scale of temperature at the present time The uncertainty is of the order of one part in five or ten thousand on the fundamental interval, but may reach 0 5° at 500° C, and 2° or 3° at 1,000° C.

Thermodynamical Correction.—Of greater theoretical interest, but of less practical importance on account of its smallness, is the reduction of the scale of the gas thermometer to the thermodynamical scale. The deviations of a gas from the ideal equation $pv=R\theta$ may be tested by a variety of different methods, which should be employed in combination to determine the form of the characteristic equation The principal methods by which the problem has been attacked are the following:—

(1) By the comparison of gas thermometers filled with different gases or with the same gas at different pressures (employing both gravimetric and manometric methods) the differences in their indications are observed through as wide a range of temperature as possible Regnault, employing this method, found that the differences in the scales of the permanent gases were so small as to be beyond the limits of accuracy of his observations. Applying greater refinements of measurement, Chappuis and others have succeeded in measuring small differences, which have an important bearing on the type of the characteristic equation They show, for instance, that the equation of van der Waals, according to which all manometric gas thermometers should agree exactly in their indications, requires modification to enable it to represent the behaviour of gases even at moderate pressures

(2) By measuring the pressure and expansion coefficients of different gases between 0° and 100° C the values of the fundamental zero (the reciprocal of the coefficient of expansion or pressure) for each gas under different conditions may be observed and compared The evidence goes to show that the values of the fundamental zero for all gases tend to the same limit, namely, the absolute zero, when the pressures are indefinitely reduced The type of characteristic equation adopted must be capable of representing the variations of these coefficients.

(3) By observing the variations of the product pv with pressure at constant temperature the deviations of different gases from Boyle's law are determined Experiment shows that the rate of change of the product pv with increase of pressure, namely $d(pv)/dp$, is very nearly constant for moderate pressures such as those employed in gas thermometry This implies that the characteristic equation must be of the type

$$v=F(\theta)/p+f(\theta) \qquad (15)$$

in which $F(\theta)$ and $f(\theta)$ are functions of the temperature only to a first approximation at moderate pressures The function $F(\theta)$, representing the limiting value of pv at zero pressure, appears to be simply proportional to the absolute temperature for all gases. The function $f(\theta)$, representing the defect of volume from the ideal volume, is the slope of the tangent at $p=0$ to the isothermal of θ on the pv, p diagram, and is sometimes called the "angular coefficient." It appears to be of the form $b-c$, in which b is a small constant quantity, the "co-volume," of the same order of magnitude as the volume of the liquid, and c depends on the cohesion or co-aggregation of the molecules, and diminishes for all gases continuously and indefinitely with rise of temperature This method of investigation has been very widely adopted, especially at high pressures, but is open to the objection that the quantity $b-c$ is a very small fraction of the ideal volume in the case of the permanent gases at moderate pressures, and its limiting value at $p=o$ is therefore difficult to determine accurately.

(4) By observing the cooling effect $d\theta/dp$, or the ratio of the fall of temperature to the fall of pressure under conditions of constant total heat, when a gas flows steadily through a porous plug, it is possible to determine the variation of the total heat with pressure from the relation

$$Sd\theta/dp=\theta dv/d\theta-v. \qquad (16)$$

(*See* THERMODYNAMICS.) This method has the advantage of directly measuring the deviations from the ideal state, since $\theta dv/d\theta = v$ for an ideal gas, and the cooling effect vanishes. But the method is difficult to carry out, and has seldom been applied. Taken in conjunction with method (3), the observation of the cooling effect at different temperatures affords most valuable evidence with regard to the variation of the defect of volume $c-b$ from the ideal state. The formula assumed to represent the variations of c with temperature must be such as to satisfy both the observations on the compressibility and those on the cooling effect It is possible, for instance, to choose the constants in van der Waals's formula to satisfy either (3) or (4) separately within the limits of experimental error, but they cannot be chosen so as to satisfy both. The simplest assumption to make with regard to c is that it varies inversely as some power n of the absolute temperature, or that $c = c_0(\theta_0/\theta)^n$, where c_0 is the value of c at the temperature θ_0. In this case the expression $\theta dv/d\theta - v$ takes the simple form $(n+1)c-b$. The values of n, c and b could be calculated from observations of the cooling effect $Sd\theta/dp$ alone over a sufficient range of temperature, but, owing to the margin of experimental error and the paucity of observations available, it is better to make use of the observations on the compressibility in addition to those on the cooling effect. It is preferable to calculate the values of c and b directly from equation (16), in place of attempting to integrate the equation according to Kelvin's method because it is then easy to take account of the variation of the specific heat S, which is sometimes important

Having found the most probable values of the quantities c, b and n from the experimental data, the calculation of the correction may be effected as follows The temperature by gas thermometer is defined by the relation $T = pv/R$, where the constant R is determined from the observations at 0° and 100° C The characteristic equation in terms of absolute temperature θ may be put in the form $\theta = pv/R' + q$, where q is a small quantity of the same dimensions as temperature, given by the relation

$$q = (c-b)p/R. \qquad (17)$$

The constant R′ is determined, as before, by reference to the fundamental interval, which gives the relation $R'/R = 1 + (q_1 - q_0)/100$, where q_1, q_0 are the values of q at 100° and 0° C respectively.

The correction to be added to the fundamental zero T_0 of the gas thermometer in order to deduce the value of the absolute zero θ_0 (the absolute temperature corresponding to 0° C) is given by the equation,

$$\theta_0 - T_0 = q_0 - (q_1 - q_0)\theta_0/100 \qquad (18)$$

The correction dt to be added to the centigrade temperature t by gas thermometer reckoned from 0° C in order to deduce the corresponding value of the absolute temperature also reckoned from 0° C is given by the relation, deduced from formula (10),

$$dt = (q - q_0) - (q_1 - q_0)t/100, \qquad (19)$$

where q is the value at t° C of the deviation $(c-b)p/R$ The formulae may be further simplified if the index n is a simple integer such as 1 or 2. The values of the corrections for any given gas at different initial pressures are directly proportional to the pressure.

Values of the Corrections.—If we take for the gas hydrogen the values $c = 1{\cdot}5$ c.c. at 0° C, $b = 8{\cdot}0$ c.c., with the index $n = 1{\cdot}5$, which satisfy the observations of Joule and Thomson on the cooling effect, and those of Regnault, Amagat and Chappuis on the compressibility, the values of the absolute zero θ_0, calculated from Chappuis's values of the pressure and expansion coefficients at 100 cms. initial pressure, are found to be 273·10° and 273·05° respectively, the reciprocals of the coefficients themselves being 273·03 and 273·22. The corrections are small and of opposite signs. For nitrogen, taking $c_0 = 1{\cdot}58$, $b = 1{\cdot}14$, $n = 1{\cdot}5$, we find similarly 273·10° and 273·13° for the absolute zero, the correction $\theta_0 - T_0$ in this case amounting to nearly 1°. The agreement is very good considering the difficulty of determining the small deviations c and b, and the possible errors of the expansion and pressure-coefficients. It appears certain that the value of the absolute zero is within a few hundredths of a degree of 273·10°. Other observations confirm this result within the limits of experimental error. The value of the index n has generally been taken as equal to 2 for diatomic gases, but this does not satisfy either the observations on the cooling effect or those on the compressibility so well as $n = 1{\cdot}5$, although it makes comparatively little difference to the value of the absolute zero The value deduced from Travers's observation of the pressure-coefficient of helium is 273·13°, taking $n = \frac{1}{2}$, which is the probable value of the index for a monatomic gas The application of the method to the condensible gas carbonic acid is interesting as a test of the method (although the gas itself is not suited for thermometry), because its deviations from the ideal state are so large and have been so carefully studied. The observations of Joule and Thomson on the cooling effect give $c_0 = 3{\cdot}76$ c.c., $b = 0{\cdot}58$ c c., $n = 2$, provided that allowance is made for the variation of the specific heat with temperature as determined by Regnault and Wiedemann. Chappuis's values of the pressure and expansion coefficients agree in giving 273·05° for the absolute zero, the values of the corrections $\theta_0 - T_0$ being 4·6° and 5·8° respectively.

The values of the scale correction dt deduced from these formulae agree with those experimentally determined by Chappuis in the case of carbonic acid within the limits of agreement of the observations themselves. The calculated values for nitrogen and hydrogen give rather smaller differences than those found experimentally, but the differences themselves are of the same order as the experimental errors. The deviations of hydrogen and helium from the absolute scale between 0° and 100° C are of the order of ·001° only, and beyond the limits of accuracy of experiment. Even at −250° C (near the boiling-point of hydrogen) the corrections of the constant volume hydrogen and helium thermometers are only a tenth of a degree, but as they are of opposite signs, the difference amounts to one-fifth of a degree at this point, which agrees approximately with that observed by Travers. For a fuller discussion of the subject, together with tables of corrections, the reader may refer to papers by Callendar, *Phil. Mag.* v. p. 48 (1903), and D. Berthelot, *Trav. et Mém. Bur. Int. Paris*, xiii. (1903). Berthelot assumes a similar type of equation to that given above, but takes $n = 2$ in all cases, following the so-called law of corresponding states. This assumption is of doubtful validity, and might give rise to relatively large errors in the case of monatomic gases.

Limitations.—In the application of the gas thermometer to the measurement of high temperatures certain difficulties are encountered which materially limit the range of measurement and the degree of accuracy attainable. These may be roughly classified under the heads—(1) changes in the volume of the bulb; (2) leakage, occlusion and porosity; (3) chemical change and dissociation. The difficulties arise partly from defects in the materials available for the bulb, and partly from the small mass of gas enclosed. The troubles due to irregular changes of volume of glass bulbs, which affect the mercury thermometer at ordinary temperatures, become so exaggerated at higher points of the scale as to be a serious source of trouble in gas thermometry in spite of the twentyfold larger expansion.

The difficulties of leakage and porosity occur chiefly with porcelain bulbs, especially if they are not perfectly glazed. A similar difficulty occurs with metallic bulbs of platinum or platinum-iridium, in the case of hydrogen, which passes freely through the metal by occlusion at high temperatures. The difficulty can be avoided by substituting either nitrogen or preferably argon or helium as the thermometric material at high temperatures With many kinds of glass and porcelain the chemical action of hydrogen begins to be appreciable at temperatures as low as 200° or 300° C. In any case, if metallic bulbs are used, it is absolutely necessary to protect them from furnace gases which may contain hydrogen. This can be effected either by enclosing the bulb in a tube of porcelain, or by using some method of electric heating which cannot give rise to the presence of hydrogen. At very high temperatures it is probable that the dissociation of diatomic gases

like nitrogen might begin to be appreciable before the limit of resistance of the bulb itself was reached It would probably be better, for this reason, to use the monatomic and extremely inert gases argon or helium

On account of these and similar difficulties, it appears probable that the extreme limit of gas thermometry, even with the best metallic bulbs, must be placed in the neighbourhood of 1,600° C A great deal of valuable work has been done in recent years in this direction, especially at the Reichsanstalt and the U S A. Bureau of Standards, by which the limitations of our knowledge of the absolute scale in this region have been materially narrowed The methods employed in these researches do not involve any fresh questions of principle, and it would be impossible in the limits of the present article to give an intelligible account of the intricate details and results But it may be doubted whether any advantage gained by the extension of the bulb method, as usually practised, from 1,100° to 1,600° is not more than neutralised in point of accuracy by the subsidiary corrections, such as that for the expansion of the bulb, most of which increase in uncertainty more rapidly than as the square of t. At these and higher temperatures it would appear that the accurate extension of the absolute scale must rest primarily on improvements in the measurement of total radiation for which the fourth power law is now firmly established by comparison with the gas thermometer at lower temperatures over a very wide range (*See* HEAT)

Other Methods.—Many attempts have been made to overcome the difficulties of gas pyrometry by adopting other methods of measurement Among the most interesting may be mentioned: (i) The variation in the wave-length of sound The objection to this method is the difficulty of accurately observing the wave-length, and of correcting for the expansion of the material of the tubes in which it is measured There is the further objection that the velocity varies as the square root of the absolute temperature. (ii) A similar method, but more promising, is the variation of the refractivity of a gas, which can be measured with great accuracy by an interference method Here again there is difficulty in determining the exact length of the heated column of gas, and in maintaining the temperature uniform throughout a long column at high temperatures. These difficulties have been ingeniously met by D Berthelot (*Comptes Rendus*, 1895, 120, p. 831) But the method is not easy to apply, and the degree of accuracy attainable is probably inferior to the bulb method (iii) Methods depending on the effusion and transpiration of gases through fine orifices and tubes have been put in practice by Barus and by the writer The method of transpiration, when the resistance of the tube through which the current of gas is passed is measured on the Wheatstone bridge principle (*Nature*, 23rd March 1899), is extremely delicate, and the apparatus may be made very small and sensitive, but the method cannot be used for extrapolation at high temperatures until the law of increase of resistance has been determined with certainty. This may be successfully accomplished in the near future, but the law is apparently not so simple as is usually supposed

ELECTRICAL THERMOMETRY

The convenience of the mercurial thermometer lies in the fact that it is complete in itself, and can be read without subsidiary appliances beyond a magnifying glass. Its weakness lies in the very limited range of each single instrument, and in the troublesome and often uncertain corrections which must be applied to its readings in all work of precision. Electrical thermometers have the disadvantage of requiring auxiliary apparatus, such as galvanometers and resistances, the use of which involves some electrical training. But they far surpass the mercurial thermometer in point of range, delicacy and adaptability, and can be applied to many investigations in which ordinary thermometers are quite useless

There are two kinds of electrical thermometers, which depend on different effects of heat on the electrical properties of metals: (1) The *Thermocouple*, or *Thermopile*, which depends on the production of a thermoelectric force when the junctions of different metals in an electric circuit are at different temperatures; and (2) the *Electrical Resistance Thermometer*, the action of which depends on the fact that the resistance of a pure metal to the passage of an electric current increases very considerably when the temperature is raised. The theory of the thermocouple is discussed in the article THERMOELECTRICITY, as it possesses many points of interest, and has been studied by many skilful experimentalists. The electrical resistance thermometer is of more recent origin; but although the theory has been less fully developed, the practice of the method bids fair to surpass all others in the variety and accuracy of its applications. In order to secure the widest possible range and the greatest constancy, in either variety of electrical thermometer, advantage is taken of the great stability and infusibility characteristic of the metals of the platinum group. Other metals are occasionally used in work at low temperatures with thermocouples for the sake of obtaining a larger electromotive force, but the substitution is attended with loss of constancy and uncertainty of reduction, unless the range is greatly restricted

Applications of the Thermocouple.—The principal uses of the thermocouple in thermometry are for measuring high temperatures, and for measuring small differences of temperature, more particularly when the temperature is required to be measured *at a point*, or in a very small space. The electromotive force of the couple depends only on the temperature at the plane of junction of the two metals, which can be very exactly located A typical instance of a measurement to which the thermocouple is peculiarly suited is the determination of the cyclical variations of temperature at accurately measured depths from one-tenth to one-hundredth of an inch in the metal of the cylinder of a heat engine, the interior surface of which is exposed to cyclical variations of temperature in the working of the engine The exact depth of the plane of junction can be measured without difficulty to the thousandth of an inch The insertion of the wire makes the least possible disturbance of the continuity of the metal There is no lag, as the thermometer itself is part of the metal The instantaneous value of the temperature at any particular point of the stroke can be measured separately by setting a periodic contact to close the circuit of the galvanometer at the desired point A further advantage is gained by measuring only the difference of temperature between two junctions of a thermocouple at different depths, instead of the whole interval from some fixed point. None of these advantages could be secured by the use of any ordinary thermometer; some depend on the fact that the method is electrical, but some are peculiar to the thermocouple, and could not be otherwise attained

On the other hand, the thermocouple is not well suited for thermometry of precision on account of the smallness of the electromotive force, which is of the order of ten microvolts only per degree for the most constant couples By the use of very delicate galvanometers it is possible to read the hundredth or even in special cases to the thousandth of a degree on this small difference, but unfortunately it is not possible to eliminate accidental thermal effects in other parts of the circuit due to small differences of temperature and material These accidental effects seldom amount to less than one or two microvolts even in the best work, and limit the accuracy attainable in temperature measurement to about the tenth of a degree with a single platinum thermocouple. This limit can be surpassed by using couples of greater thermoelectric power and less permanence, or by using a pile or series of couples, but in either case it is doubtful whether the advantage gained in power is not balanced by loss of simplicity and constancy A method of avoiding these effects, which the writer has found to be of great use in delicate thermoelectric researches, is to make the whole circuit, including all the terminals and even the slide-wire itself, of pure copper. Platinoid, german silver, constantan and other alloys most commonly used for resistance and slide-wires, are particularly to be avoided, on account of their great thermoelectric power when connected to copper. Manganin and platinum-silver are the least objectionable, but the improvement effected by substituting copper is very marked. It is clear that this objection to the use of the couple does not apply so strongly to high temperatures, because the

electromotive force of the couple itself is greater, and the accuracy attainable is limited by other considerations.

The Resistance Thermometer.—In practice the resistance thermometer is almost invariably made of platinum, since there is very seldom any advantage to be gained by the substitution of baser metals. The instrument is for this reason often referred to simply as the "platinum thermometer." It is important that the platinum should be pure, both for the sake of uniformity and also because the change of electrical resistance with temperature is greatly diminished by impurities. The observation of the fundamental coefficient, which is ·00390 (or rather larger than the coefficient of expansion of a gas) for the purest metal hitherto obtained, is one of the most delicate tests of the purity of the metal. In addition to the constancy and infusibility of the metal, a special advantage which is secured by the use of platinum is the close agreement of the thermo-dynamical scale with the platinum scale of temperature, as defined by the formula

$$pt = 100(R - R_o)/(R_1 - R_o), \qquad (20)$$

in which the symbol pt stands for the temperature on the platinum scale centigrade, and R, R_1 and R_o are the observed resistances of the thermometer at the temperatures pt, 100° and 0° C respectively. A platinum thermometer is generally arranged to read directly in degrees of temperature on the platinum scale, just as a mercury thermometer is graduated in degrees on the mercury scale. The reduction to the scale of the gas thermometer is most conveniently effected by the difference formula

$$t - pt = dt(t - 100)/10{,}000, \qquad (21)$$

in which d is a constant, called the difference-coefficient, the value of which for pure platinum is 1·50, but varies somewhat for commercial specimens. This formula was first given by H. L. Callendar as the result of a series of comparisons of different platinum wires with each other and with other metals, and also with an air thermometer over the range 0° to 625° C. The platinum wire in these comparisons was enclosed inside the bulb of the air thermometer itself, and disposed in such a manner as to be at the mean temperature of the bulb in case the temperature was not quite uniform throughout (*Phil. Trans.* A. 1887, p. 161). The formula was subsequently verified by C. T. Heycock and F. H. Neville (*Journ. Chem. Soc.* February 1895), by the observation of a number of higher points up to the freezing-point of copper at 1,082° C, which they showed to agree with the most probable means of all the best determinations by various methods of gas thermometry.

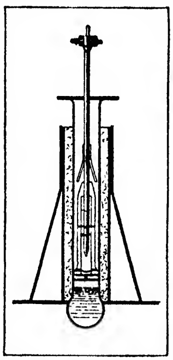


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FIG. 6.—MEYER TUBE APPARATUS

The difference-coefficient d in formula (21) could evidently be determined by reference to any fixed point on the absolute scale which was known with sufficient accuracy by observations with a gas-thermometer. The boiling-point of sulphur happens to be most convenient for this purpose, as first proposed by Callendar and Griffiths (Phil. Trans. A. 1891, p. 119) and adopted by all subsequent observers. The annexed figure 6 shows the form of apparatus they proposed for the standardization of platinum thermometers on this basis. Similar forms are still employed with slight variations in points of detail. Sulphur is boiled in the bulb B at the base of a hard glass tube about 4cm. in diameter, such as is used for vapour-density determinations by the method of Victor Meyer, and is often called a "Meyer" tube. An asbestos board CD prevents the flame reaching the sides of the tube above the level of the liquid, and minimises the risk of superheating of the vapour. The upper part of the tube is lagged with about 2 cm. of asbestos wool to reduce external loss of heat, except for 3 or 4 cm. at the top which is left bare to serve as a condenser. The top is covered with a sheet of asbestos through which the thermometer M is inserted. The gas is adjusted to keep the sulphur vapour at a steady level A near the top of the tube. A cone of asbestos board surrounds the lower half of the lagging to give it greater stability and further diminish the rate of cooling. The condensed liquid trickles down the sides of the tube, and also to some extent down the stem of the thermometer. It was found that a naked thermometer inserted in the tube under these conditions might indicate a temperature nearly 2° lower than that of the condensing vapour owing to loss of heat by radiation to the sides in addition to the cooling effect of the liquid. These losses could be practically eliminated by fixing an umbrella E on the upper part of the thermometer tube to divert the liquid stream, and two concentric screens round the bulb to protect it from loss by radiation to the sides. The bulb was also protected from the boiling liquid below by two perforated screens H, but this seemed to make little difference, as the liquid was little if at all superheated, and boiled very quietly. This apparatus gave very consistent results, to nearly 0·01° C, with three different thermometers constructed from the wire spiral which had been directly compared with the gas-scale in the bulb of the air thermometer employed in 1887, and which gave the value d = 1·57. This value was again verified by comparing one of these thermometers with the same air thermometer in a bath of sulphur vapour. Employing this value, the temperature of the boiling point of sulphur at a pressure of 760 mm was found to be 444·53° C on the scale of the constant-pressure air thermometer. Chappuis and Harker (1902) found the value 445·2° C on the scale of the *constant-volume* nitrogen thermometer, but this was subsequently corrected to 444·7° C to allow for a probable error in the expansion of the bulb. Eumorfopoulos (1908) found the value 444·55° using a constant-pressure air thermometer of the type shown in figure 5, with a glass bulb, but later in 1914 using the same thermometer with a bulb of fused quartz, having a much smaller coefficient of expansion, he found 444·13 on the same scale, and 444·61 on the thermodynamic scale.

Construction of Platinum Thermometers.—Figure 7 gives an enlarged view of the platinum spiral of the thermometer shown in the sulphur apparatus in figure 6. This was one of the first thermometers constructed by the writer with platinum leads and mica insulation for use at high temperatures. The fine wire of the coil was fused on to the platinum leads without employing any gold or silver solder, which might contaminate the wire, and would limit the temperature to which it could be exposed. This particular thermometer was constructed primarily for testing how closely the scales of two pieces of wire from the same reel would agree with each other. With this object the two spirals were wound in a double helix, being threaded through fine holes in a thin plate of mica AB to keep them in place, without contact at any point, but so close together that their mean temperatures would be the same even if the distribution of temperature in the tube were not quite uniform. One of the wires is shown by a dotted line in the figure to distinguish the two. Each coil has three leads, one of the leads being double in each case, for the purpose of securing automatic compensation of the resistance of the leads, and freedom from stem-exposure correction. The platinum leads were insulated and held in place by being threaded through mica discs, one of which is shown at C. This method is still generally adopted, and has the advantage of giving very perfect insulation at high temperatures, besides preventing convection currents up and down the tube. No difference exceeding 0·01° C could be detected between the scales of the two spirals, by differential measurements up to 600° C. Owing to the double winding, the insulation of the coils could be verified with great accuracy at any moment during the observations. This pattern was intended for use with a duplex compensated bridge, made for Lea and Gaskell (*Jour. Phys.*, 1887), giving double the sensitivity of a single bridge, and capable of calibration without the use of external resistances. It was found however that the single bridge could be so easily calibrated against another similar bridge, and that the thermometer with a single coil had such a large excess of sensitivity, that the duplex combination was abandoned as being unnecessarily complicated and expensive.

A thermometer with a single coil, wound on a serrated plate or cross of mica, is much easier to make than the duplex pattern, and has the advantage of superior immunity from damage if the tube is broken. It differs from the duplex pattern illustrated in the figure by having four leads instead of six, the pair for the compensator being separate from the pair connected to the coil, but otherwise exactly similar, and similarly insulated with mica discs The insulation of the *coil* cannot be tested in this pattern except by inspection after removing the tube, but is not likely to give trouble unless the tube is cracked or damp The insulation of the leads is easily tested, and usually gives sufficient warning of any trouble of this kind. The potentiometer method, which is sometimes used for measuring the resistance, requires that a pair of leads should be connected *to each end* of the coil This method eliminates the resistance of the leads, if the balance is perfect, but does not permit a satisfactory insulation test, and depends too much on the constancy of the current, besides being inapplicable to differential measurements, or to the exact elimination of accidental thermoelectric effects On the other hand in the Wheatstone bridge method, the equality of the compensator and pyrometer leads must be carefully tested in the construction of the thermometer, but is not likely to give trouble if the resistance of the coil is large compared with that of the leads, as is usually the case in thermometers employed for work of precision at moderate temperatures, such as 500° C. The leads are often connected to terminals at the head of thermometers, as indicated at M in figure 6. For work of the highest precision these terminals are better omitted, and the leads directly soldered to a flexible cable in order to avoid possible errors from thermoelectric effects and changes of resistance of the screw terminals For temperatures above 600° C the protecting tube should be of porcelain, and the leads of platinum throughout that part of the tube which is exposed to high temperatures For lower temperatures a tube of hard glass and leads of gold or silver may be employed, but it is better in any case to make the lower part of the leads of platinum in order to diminish the conduction of heat along the stem. For laboratory work a tube 30 or 40 cm in length usually suffices, but for large furnaces the length of the protecting tube is often 5 to 10 ft. In the latter case it is usual to protect the porcelain tubes with an external steel tube, which may be removed for delicate measurements.

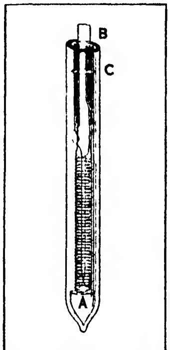

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FIG 7—SPIRAL OF THERMOMETER M

Special Forms of Thermometer.—In the measurement of linear expansion it is a great advantage to employ a thermometer with the bulb or sensitive portion equal in length to the bar or column under test, so as to obtain the mean temperature of the whole length. In measuring the linear expansion of a standard metre or yard, a fine platinum wire enclosed in a glass capillary, or otherwise insulated, is employed, its length being equal to that of the bar. The same method has been applied by Callendar (*Phil. Trans.* A, 1887) and Bedford (*Phil. Mag*, 1898) to the expansion of glass and porcelain at high temperatures, employing a fine wire supported along the axis of the tube under test An equivalent method, applied to the expansion of silica by Callendar, is to enclose a rod of the material inside a platinum tube which is heated by an electric current. This is a very rapid and convenient process, since the mean temperature of the rod must be equal to that of the enclosing tube. Any temperature up to the melting-point of platinum is readily obtained, and easily regulated The temperature may be obtained by observing either the resistance of the platinum tube or its linear expansion Either method may also be employed in J. Joly's meldometer, which consists of an electrically heated strip for observing the melting-points of minerals or other substances in small fragments. In observing the temperature of a long column of mercury, as in the method of equilibrating columns for determining the absolute expansion of mercury, a platinum thermometer with a bulb equal in length to the column may similarly be employed with advantage (Callendar & Moss, *Phil. Trans.* A, 1911, p 1). The application is here particularly important because it is practically impossible to ensure perfect uniformity of temperature in a vertical column, 6 ft. or more in length, at high temperatures.

Sensitive Thermometers.—Where quickness of reading is essential, the mercury thermometer, or the tube form of electric thermometer, is unsuitable In cases where the thermometer has to be immersed in a conducting liquid or solution, the fine wire forming the bulb may be insulated by enclosing it in a coiled glass capillary. This method has been employed by Callendar and Barnes and by Jaeger, but the instrument is necessarily fragile, and requires careful handling. For non-conducting liquids or gases the bare wire may be employed with great advantage. This is particularly important in the case of gases owing to the extreme sensitiveness thus obtained and the almost complete immunity from radiation error at moderate temperatures. Thermometers constructed in the form of a flat grid of bare wire mounted on a mica and ebonite frame have been employed by H Brown (*Proc R S*, 1905, B 76, p 124) for observing the temperature of leaves and of air currents to which they were exposed They have also been employed for observing the air-temperature for meteorological purposes in Egypt and Spain with very satisfactory results (*Proc R.S*, 1905, A 77, p 7). The fine wire, owing to its small size and bright metallic surface, very rapidly acquires the temperature of the air, and is very little affected by radiation from surrounding objects, which is one of the chief difficulties in the employment of mercurial thermometers for the observation of the temperature of the air.

For the observation of rapidly varying temperatures, such as those occurring in the cylinder of a gas- or steam-engine, an electrical thermometer with very fine wire, of the order of ·001 in. diameter is practically the only instrument available. The temperature at any particular moment may be obtained by setting a mechanical contact-maker to close the circuit at the desired point The sensitive part of the thermometer consists simply of a loop of fine wire from half an inch to an inch long, connected by suitable leads to the measuring apparatus as employed by Burstall (*Phil Mag*, October 1895) in the gas-engine, and Callendar and Nicolson (*Proc. Inst.* C E, 1898) in the steam-engine The explosion temperatures cannot be satisfactorily measured in a gas-engine in this manner, because the radiation error at high temperatures is excessive unless the wire is very fine, in which case it is very soon melted even with weak mixtures. Callendar and Dalby accordingly devised a mechanical valve (*Proc R S*, A 80, p 57) for exposing the thermometer only during the admission and compression strokes, and have deduced the actual explosion temperatures from the indicator diagram B. Hopkinson (*Proc. R S.*, A 77, p. 387) succeeded in following the course of an explosion in a closed vessel by means of a similar thermometer connected to a galvanometer of short period giving a continuous record on a moving photographic film. When the flame reached the wire the temperature rose 1,200° C in about ·01, of a second, which illustrates the order of sensitiveness attainable with a fine wire of this size. O. R Lummer and E Pringsheim, in their measurements of the ratio of the specific heats of gases by observing the fall of temperature due to sudden expansion, employed a very thin strip of foil with the object of securing greater sensitiveness. This was a somewhat doubtful expedient, because such a strip is extremely fragile and liable to be injured by air currents, and because the sensitiveness is not as a matter of fact appreciably improved, whereas the radiation error is increased in direct proportion to the surface exposed One of the principal sources of error in employing a short loop of fine wire for observing rapidly varying temperatures is that the ends of the loop close to the thick leads are affected by conduction of heat to or from the leads, and cannot follow the rapid variations of temperature. This error may be readily avoided by the method, first employed by Callendar and Nicolson, of

connecting the compensating leads with a short length of the same fine wire. (*See* THERMODYNAMICS.)

Errors and Corrections.—It is most instructive to consider the errors and corrections involved in platinum thermometry on the same lines as those on which the corresponding errors of the mercury thermometer have already been treated

I. The changes of zero of the mercury thermometer arise chiefly from the small expansibility of mercury combined with the imperfect elasticity of the containing tube In platinum thermometry, the containing tube has nothing to do with the reading, and the effect of any possible strain of the fine wire of the coil is minimized by its small dimensions and by the large temperature-coefficient of the increase of resistance, which is more than twenty times greater than the coefficient of apparent expansion of mercury in glass. It is not surprising, therefore, that the changes of zero of a platinum thermometer should be practically negligible, provided that the wire is not strained or contaminated with impurities. It is probable that with ordinary care the changes of zero due to exposure to any given limits of temperature are in all cases less than the limit of accuracy of observation, due to other causes at the extreme limit of the range considered

II *The fundamental interval* of each thermometer must be determined as usual by observations in ice and steam, and a correction must be applied by the method already described in the case of the mercury thermometer The difference of the temperature of the steam from 100° C should be determined on the platinum scale by the formula

$$dpt_1 = 985dt_1 = \cdot 0362(H-760) - \cdot 000020(H-760)^2 \quad (22)$$

III *Pressure Correction*—The effect of change of pressure on a platinum thermometer of the ordinary tube form is of course nothing, as the wire itself is not exposed to the pressure. Even if the wire is naked and directly exposed to large changes of pressure, the change of reading is almost inappreciable Similarly there is no source of error analogous to the effects of capillarity, which are so troublesome with delicate mercury thermometers

IV *Stem Exposure*—The reading of a platinum thermometer with compensated leads depends only on the temperature of the coil of wire forming the bulb, and not on the temperature of the stem, provided that the immersion is sufficient to avoid errors due to conduction or convection along the stem It is desirable that the top of the bulb should be immersed to a depth equal to from three to ten times the diameter of the tube, according to the accuracy required

V. *Scale Correction.*—The reduction to the thermodynamical scale may be effected, within the limits of probable error of the most accurate measurements at present available, by the very simple difference formula (21) already given, over the whole range from −100° C to + 1,100° C This is in striking contrast with the mercury thermometer, which requires a cubic formula to cover the range 0° to 200° C with equal accuracy The value of the constant d in the formula varies but little, provided that the wire be fairly pure and the thermometers properly constructed

VI. *Calibration Correction*—The calibration of the resistance box and the bridge-wire corresponds to the calibration of the stem of the mercury thermometer, but the process is much simpler for several reasons It is more easy to obtain a uniform wire than a uniform tube The scale of the wire is much more open, it corresponds to a very small part of the whole scale, and the process of calibration is easier One box when calibrated will serve for any number of thermometers of different ranges and scales, and covers the whole range of temperature (*See* CALIBRATION)

Electrical Precautions.—The platinum thermometer is so far superior to the mercury thermometer in all the points above enumerated that, if there were no other difficulties, no one would ever use a mercury thermometer for work of precision. In using a platinum thermometer, however, some electrical training is essential to obtain the best results The manipulation and adjustment of a delicate galvanometer present formidable difficulties to the non-electrical observer. Bad contacts, faulty connections, and defective insulation, are not likely to trouble the practised electrician, but present endless possibilities of error to the tyro. Trouble from bad contacts generally arises from the use of plugs for the resistance coils. If plugs are used, they must be specially designed so as not to disturb each other, and must be well fitted and kept very clean. Mercury cups with large copper terminals, well amalgamated, as used with standard resistance coils, are probably the simplest and most satisfactory method of changing connections Accidental thermoelectric effects in the circuit are a possible source of error, as with the thermocouple, but they are

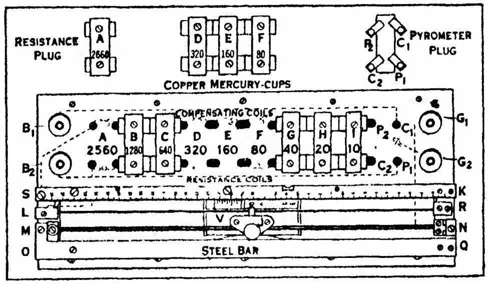


FIG 8—COMPENSATED RESISTANCE BOX FOR USE WITH PLATINUM THERMOMETERS

always very small if the thermometer is properly constructed, and are relatively unimportant owing to the large E M F available. In any case they may be completely eliminated by reversing the battery. The heating effect of the current through the thermometer is often negligible, but should be measured and allowed for in accurate work

Methods and Apparatus.—The methods of electrical thermometry may be roughly classified under two heads as (1) deflection methods, in which the temperature is deduced from the observed deflection of a galvanometer; and (2) balance methods, in which the resistance or the electromotive force is balanced against a known adjustable resistance or potential difference The former methods are most suitable for rough work and rapid reading, the latter for accurate measurements In the practice of the deflection method it is customary to use a moving-coil galvanometer, the sensitiveness of which can be varied by varying the resistance in circuit, or by varying the stiffness of the suspension The accuracy attainable is of the order of one-half of 1 per cent on the deflection, and is limited by variations of resistance of the galvanometer, and by the imperfect elasticity of the suspension In any case the scale of the galvanometer should be calibrated or tested for uniformity In this kind of work the thermocouple has the advantage over the resistance thermometer in that the latter requires an auxiliary battery to supply the current; but in many cases this is no disadvantage, because it permits a greater latitude of adjustment, and makes it possible to obtain greater power than with the thermocouple

In cases where it is desired to obtain greater accuracy without abandoning the quickness of reading which is the principal advantage of the deflection method, it is possible to combine the two methods by balancing part of the potential difference by means of a potentiometer and using the galvanometer for the small changes only In cases where the greatest accuracy is required, a very sensitive galvanometer should be used, and the whole of the potential difference should be balanced as nearly as possible, leaving very little to depend on the deflection of the galvanometer The degree of sensitiveness and accuracy obtainable depends primarily on the delicacy of the galvanometer, on the power available, and on the steadiness of the conditions of experiment. For thermometry of precision the resistance thermometer possesses three very great advantages over the thermocouple: (1) The power available, owing to the use of a battery, is much greater; (2) it is possible completely to eliminate the errors due to accidental thermal effects by reversing the battery; (3) the Wheatstone bridge method can be employed in place of the potentiometer, so that the constancy of the battery is immaterial, and it is not necessary to use a standard cell. Another disadvantage of the potentiometer method as applied to resistance thermome-

ters, is that it is unsuited for differential measurements, which are so commonly required in calorimetric work.

Compensated Bridge Method and Apparatus.—The type of Wheatstone bridge illustrated in figure 8, page 123, though one of the oldest, is still in use for work of precision, and illustrates most of the essential points to be aimed at in work of this kind. The box measures only 15″×6″×3″, and was designed primarily with a view to cheapness and portability at a time when apparatus for research was scarce and had often to be moved from one laboratory to another The figure shows a plan of the ebonite lid, on the top of which the connections are marked in dotted lines. B_1, B_2 are the battery terminals, which are connected through a reversing key and a rheostat of about 200 ohms to a 2-volt storage cell. G_1, G_2 are the galvanometer terminals, connected to a moving-coil galvanometer of about 10 ohms resistance, which is critically damped by a suitable shunt to save time in reading the deflections. The four leads of each pyrometer, several of which may be read in succession, are permanently connected to a 4-point plug consisting of an ebonite block with amalgamated copper rods, P_1, P_2 for the pyrometer leads from the platinum coil, and C_1, C_2 for the compensator leads, fitting the corresponding mercury cups in the bridge. It is a matter of a few seconds only to change pyrometers, and there is very little risk of error from bad contacts The least defect of insulation of the leads can be detected at any moment by shifting the pyrometer plug so that the points P_1, C_2 are inserted in the cups C_1, P_2 leaving P_2, C_1, disconnected This test is apt to be neglected unless it is made very easy. It puts nearly the whole voltage of the battery on to the galvanometer through the defective insulation The cups C_1, P_1, are directly connected to the battery terminals as indicated, and also to a pair of equal resistances of about 6 ohms each forming the ratio arms of the bridge, the middle point between the two being connected to the galvanometer terminal G_2. These ratio coils are separately wound with bare wire on mica plates to secure perfect insulation, and are very carefully annealed and tested for equality of temperature coefficient They are fixed symmetrically side by side so that both are always at nearly the same temperature The cup C_2 is connected to one end of a series of 9 resistance coils, A, B, C, D, etc , the other end of which is connected to the left side of the bridge-wire LR The cup P_2 is similarly connected to one end of a series of compensating coils, the other end of which is connected through the millimetre scale SK to the right side R of the bridge-wire LR The double wire MN stretched parallel to LR is connected to G_1, and to any point of LR through the sliding contact J, which carries a vernier V, reading to 0·01 mm. on the scale SK.

Temperature Compensation of Resistance Coils—In order to obtain accurate measurements of changes of resistance of the thermometers, it is necessary, either that the box coils should not change, or else that the readings should be corrected for any variation of temperature of the box. This can be done by observing the temperature of the box and applying a correction if the temperature coefficient of each individual coil is known with sufficient accuracy, and if they are all at the same temperature immersed in a well-stirred oil bath It is also possible to regulate the temperature of the oil bath with a thermostat. But these methods are very troublesome, and would be quite unsuitable for a portable apparatus A method of equal, if not superior, accuracy is to compensate each individual resistance coil with a compensating coil, as shown in the figure, connected on the opposite side of the bridge-wire, both coils being cut in or out of circuit simultaneously by a 4-point mercury plug. The effective resistance of the pair is the difference between them, which will remain constant if their values are so adjusted that the increment of each per 1° is the same. The resistance coils are made of platinum-silver alloy, which has a temperature coefficient about 14 times smaller than that of platinum. The wire is wound on mica and enclosed in a glass tube like a platinum thermometer. The compensator is a loop of platinum wire of the same length as the platinum-silver coil, but has a resistance 14 times smaller The two are tested together in the glass tube at temperatures between 10° and 30°, and are adjusted until their difference has the desired magnitude and shows no detectable change over this range of temperature The glass tube and leading wires are then cut to a suitable length, and the compensated pair is connected in its proper place in the box. The platinum compensating coils may be regarded as peculiarly delicate and appropriate thermometers for measuring the mean temperature of each individual coil, which would otherwise be difficult. But they go a step further, and apply the necessary correction automatically, without any waste of time or attention on the part of the observer.

The effective values of the compensated coils are adjusted to give a range of resistances from 0·1 to 25·6 ohms on the binary scale in order to facilitate calibration, since their relative values are required with the greatest possible accuracy (*See* CALIBRATION) The smallest coil, marked I, is equivalent to 10 cm. of the bridge wire, or to 1° C with a thermometer having a fundamental interval of 10 ohms, and a zero resistance of approximately 25·6 ohms, which is that of the largest coil in the box

Adjustment of Bridge-wire—In using the bridge by the balance method, the resistance is balanced with the coils A, B, C, D, etc , to the nearest 0·1 ohm The next three figures may be obtained by finding the balance point on the bridge wire to 0·1 mm The bridge-wire is made of platinum-silver and is drawn down to a resistance slightly exceeding 0·005 ohm per cm , giving an effective resistance (in terms of shift of the balance point) equal to double its actual resistance, or a little more than 0·01 ohm per cm , so that a length of *less* than 10 cm. is equivalent to the smallest coil I Its whole length from L to R is then shunted with a suitable resistance until a length of 10 cm near the middle of the wire is precisely equivalent to the coil I The whole length may then be tested for uniformity against coil I, but should not vary by more than 1 in 1,000 if the wire is of uniform quality and carefully drawn It is seldom necessary to calibrate the bridge-wire more accurately than this, since it is employed only for measuring small differences, averaging 0·0025 ohm, for which an accuracy of about 0·0000025 ohm usually suffices It is most important, however, to keep it stretched at a uniform and constant tension, and to ensure that it is not damaged by the sliding contact, and does not shift relatively to the scale SK This cannot be secured by fixing it with reference to the ebonite base at both ends, because the coefficient of expansion of ebonite is so much larger than that of the wire Accordingly the bridge-wire LR is mounted on a frame, with the brass scale SK on one side and a steel bar OQ on the other, in a position corresponding approximately with its coefficient of expansion, which is intermediate between that of brass and that of steel The right hand ends K,Q of these bars are fixed to the ebonite lid, but the left hand ends S,O, are free to slide so as to maintain the tension constant The galvanometer wire MN is also of platinum-silver and similarly mounted Contact is made between the two wires LR and MN at the sliding contact J by means of a short length of the same platinum-silver wire, with a sharp edge, rigidly fixed to the vernier carriage at right angles to the scale Normally the bridge-wire is held just clear of the contact piece by the flanges of the carriage, and the galvanometer circuit is open Contact is made at any desired point by turning an ebonite screw, which locks the carriage, and presses the bridge wire down on the contact piece by means of an ebonite finger, with a renewable sleeve of soft rubber tubing, so that neither the wire, nor the sharp edge of the contact, is damaged. The contact is held by the screw while the battery is reversed to test the balance and eliminate thermal effects. If the balance is not exact, the deflection of the galvanometer is noted, and the contact is released and moved in the required direction. After two readings of deflection, the balance point may be found by interpolation

Mercury Plug Mechanism—Some of the plugs are removed from the box in figure 6 to show the mercury cups and connections. In practice the plugs are not removed, but merely raised vertically and kept suspended about half an inch above their respective cups, so that any mercury that may drip from the amalgamated rods falls back into the cup from which it came. To the centre of each 4-point plug is attached a brass rod sliding vertically in an overhead bar running the length of the box, and supported on pillars at either end. The plug is held in the raised position and

prevented from turning by a ball and spring catch sliding in a groove in the brass rod. Four or five of the plugs can be raised or depressed simultaneously with one hand, so that the manipulation involved in changing the resistance is far quicker than with any other type of plug box. The mercury plugs and cups give more perfect contact and are much easier to clean than ordinary brass plugs and sockets The overhead bar, together with all the plugs, can be removed in a few seconds by unscrewing two thumb-nuts, on the rare occasions when the cups require refilling or cleaning These provisions are of special importance in industrial work, where the apparatus may be exposed to damp, or dust, or gas fumes, and the object is to save time In such an environment it is often advisable to enclose the whole box in a dust-proof case, leaving only the operating rods exposed, and to abandon the use of the bridge-wire and balance method under such conditions in favour of the deflection method next described.

Deflection Method (for Fractions of 1°).—The method of finding the balance point on the bridge-wire as above described is the most sensitive and accurate for measuring a *constant* resistance, as in testing the coils, or calibrating the box, or observing the fixed points of a thermometer in ice or steam But it requires at least two accurate settings of the contact, and recording two readings of the vernier and of the corresponding deflections of the galvanometer, in addition to the coils in circuit. In many cases the highest degree of accuracy is unnecessary, and the use of the balance method is inexpedient, especially at high temperatures, where an accuracy of 0·01° C is usually ample, and the resistance is seldom sufficiently constant to permit more exact readings In such cases the most convenient and rapid method of operation is to fix the bridge-wire contact at any convenient zero, set the coils to the nearest whole degree, and read the fraction of a degree by observing the deflection of the galvanometer on reversing the battery current This takes about a tenth of the time and trouble involved in a balance reading, and is the most appropriate method to employ in reading a number of different thermometers at regular intervals If the thermometers are at widely different temperatures, as often happens in practice, the balancing coils as well as the thermometers must be changed at each observation But since the coils required for any particular thermometer usually remain the same for an hour or so, these can be recorded before commencing observations as soon as the temperature is sufficiently steady The change from one thermometer to the next can be effected very quickly with the box and connections as illustrated in figure 8, and it is possible to read and record the deflections at the rate of 2 or 3 a minute. The coils required for each thermometer can be readily reduced to degrees of temperature from a knowledge of the fundamental intervals, which seldom differ by as much as 1 in 1,000. But the reduction of the observed deflections to the corresponding fractions of a degree, requires different factors for each thermometer in this method of operation, depending on the coils in circuit. The required factors are readily observed under any conditions by observing the change of deflection on reversal produced by putting the smallest coil I in or out of circuit But it saves a good deal of trouble in practice to keep the galvanometer deflection constant at 100 mm per 1° in all cases. This can be done automatically by adding a simple accessory, called a differential connector, which makes it possible to use the box for the direct observation of the difference between any two thermometers, and also permits the enclosure of the box itself in a dust-proof case

Differential Measurements.—Accurate measurements of difference of temperature between two thermometers are often required in calorimetric work, and are most readily secured by using a pair of platinum thermometers, connected on opposite sides of the bridge, so that the difference is obtained by a single reading, which is necessarily simultaneous for the two, and saves more than half the time required for reading each separately. The arrangement of connections for reading two thermometers differentially could easily be made on the bridge itself by omitting the resistance I and inserting a second pyrometer plug R_2 in its place, side by side with the plug R_1 belonging to the first pyrometer. The bridge reading would then give the difference R_2-R_1 and the difference R_1-R_2 could similarly be obtained by simply interchanging the plugs R_1 and R_2 The most accurate method of finding the difference is by observing the shift of the balance point on the bridge-wire, as in Carey Foster's method, when R_1 and R_2 are interchanged. But it is preferable in dealing with large differences to observe the coils and the galvanometer deflection, and to subtract a zero reading, taken when R_2 is at the same temperature as R_1 This zero should be verified daily as a matter of precaution for any pair of thermometers, but is not likely to vary appreciably unless the contacts require cleaning

Instead of making any such changes of connections on the box itself, it is more convenient in practice, for differential measurements and similar purposes, to employ an external set of mercury cups similar to those on the top of the box, but with fewer cups Such an arrangement may be called a differential connector The left side of the series of cups is connected through a pyrometer plug to the cups C_2, P_2 on the bridge, and the right side to the cups C_1, P_1 by the same plug The effect is the same as if the series of cups in the differential connector were interpolated between the points C_1P_1 and C_2P_2 on the bridge But this would be inconvenient on the bridge itself, because the mechanism required for the resistance plugs cannot perform the manipulation of interchanging pyrometer plugs Spaces for 4 pyrometer plugs are usually provided on the differential connector No 1, on the left, is usually occupied by a pyrometer in steam at atmospheric pressure, serving as a convenient standard of reference in many cases Any pyrometer R_2 inserted in No 2, can be read by difference from 100° C if spaces 3 and 4 are short-circuited with resistance plugs As a rule spaces 3 and 4 are occupied by auxiliary resistances in the form of compensated coils, made like those in the box, and enclosed in glass tubes, but provided with plug connectors like a pyrometer

Constant-current Method.—It is a great convenience in practice, especially for differential measurements over considerable ranges of temperature, to keep the sensitivity of the galvanometer automatically constant at a convenient figure, such as 100 mm per 1°, in spite of any variation of resistance of the pyrometers This requires that the measuring current should be kept constant, or that the whole resistance in circuit should remain the same, to about a half of 1 per cent, or less, if an accuracy of 0·01° is required with a scale deflection of 100 mm per 1°. This is effected by inserting in spaces Nos 3 and 4 on the differential connector one or two compensated coils having a total resistance larger than the difference to be measured, say 19·2 ohms, equivalent to the sum of coils B and C in the box, or to 384° C on the platinum scale, if the differential thermometers R_1 and R_2 have each a fundamental interval of 5 ohms With R_1, R_2 at the same temperature in a hypsometer, the bridge should then balance with B and C up in the box, and the bridge-wire contact fixed at zero Observe the deflection, if any, produced by reversing the battery. Raise coil I, which is equivalent to 2°. Observe the deflection again The difference of the two deflections should be 200 mm. If not, adjust the resistance of 200 ohms in the battery circuit until the desired sensitivity of 100 mm per 1° is secured This will remain constant for a week or so if the battery is good It will also be unaffected by any variation of R_2 (or by the substitution of other similar thermometers in the place of R_2) provided that the coils-up in the box are *reduced* as R_2 increases so as to keep the total resistance on the left side of the bridge wire balanced against the constant resistance $19·2+R_1$ on the right within 1° C. It is very easy to read to 0·01° C by this method on the galvanometer deflection, but the galvanometer deflection is less than a quarter of 1 per cent of the difference measured at 500° C, and it will be understood that it is essential that the resistance coils and thermometers must be most perfectly *compensated*, and that the deflection must be observed by *reversing* the battery in order to eliminate accidental thermoelectric effects, if an accuracy of 0·01° C is expected in the final result Neglect of the last precaution alone may easily cause an error of 1° if the thermometer is badly made.

Optical or Radiation Pyrometers.—Since the intensity of radiation increases very rapidly with the temperature of the

source of radiation, instruments for measuring radiation may be applied for measuring temperature, assuming that the laws connecting radiation and temperature are known. The advantage of this method is that the measurement may be made from a distance without exposing any part of the measuring apparatus to the destructive action of high temperatures. Apart from the difficulty of calibrating the measuring apparatus to give temperature in terms of radiation, the chief source of uncertainty in the application of the method is the emissive power of the source of radiation The methods principally employed may be divided into two classes.—(1) Radiation methods, depending on the measurement of the radiant energy by means of a radiometer, thermocouple or bolometer; (2) optical or photometric methods, depending on the colour or luminous intensity of the radiation as compared with a suitable standard.

Of the radiation methods the simplest in theory and practice depends on observing the total intensity of radiation, which varies as the fourth power of the absolute temperature according to the Stefan-Boltzmann law (*see* HEAT) for a perfectly black body or full radiator. In applying this method it is very necessary to allow for the emissive power of the source, in case this does not radiate as a black body Thus the emissive power of polished platinum at 1,000° Abs. is only 10 per cent, and that of black iron oxide about 40 per cent. of that of a black body; and the percentage varies differently for different bodies with change of temperature, and also for the same body according to the part of the spectrum used for the measurement. Owing to the rapid increase of radiation with temperature the error due to departure from black body radiation is not so serious as might be imagined at first sight. If the temperature of a polished platinum strip at 1,500° C were estimated by the radiation formula, assuming the constant for a perfectly black body, the error for red light would be about 125°, for green about 100°, and for blue about 75°. Such errors may be corrected when the emissive power of the source at various temperatures is known from previous experiments, but it is preferable to observe, whenever possible, the radiation from the interior of a uniformly heated enclosure which approximates very closely to that of a black body. (*See* HEAT)

Radiation pyrometers of this type are generally calibrated by the method of sighting on the interior of an electric furnace containing a thermocouple or gas-thermometer by which the temperature is measured The gas-thermometer has been employed for verifying the law of radiation up to 1,500° C, but the difficulties of obtaining accurate results with the gas-thermometer increase so rapidly above 1,200° C that it is questionable whether any advantage is gained by using it beyond this point. The law of radiation has been so closely verified by observations at lower temperatures that the uncertainty involved in applying it at higher temperatures, in the case of a black body is probably less than the uncertainty of the gas-thermometer measurements, and much less than the uncertainty of extrapolating an empirical formula for a thermocouple. Thus L. F. C. Holborn and W. Wien (*Wied. Ann.*, 1895, 16), by extrapolating their thermoelectric formula, found the value 1,587° C for the melting-point of palladium, whereas Violle found 1,500° C by the calorimetric method, and Callendar and Eumorfopoulos (*Phil. Mag.*, 1899, 48) found 1,540° and 1,550° C by the methods of the expansion and the change of resistance of platinum respectively. By a later thermoelectric extrapolation Holborn and Henning (*Berlin Akad.*, 1905, 12, p. 311) found 1,535° C for the melting-point of palladium, and 1,710° C for that of platinum, values which were strikingly confirmed by J. A. Harker at the National Physical Laboratory, and by Waidner and Burgess at the Bureau of Standards, U S.A. Holborn and Valentiner employing an optical method (*Ann. Phys.*, 1907, 22, p. 1) found 1,582° C and 1,789° C for palladium and platinum respectively. There can be little doubt that the extrapolation of the parabolic formula for the thermocouple at these temperatures is quite untrustworthy and that the values given by the electrical resistance method, or by the laws of radiation, are more likely to be correct. Assuming that the total radiation varies as the fourth power of the absolute temperature, a radiation pyrometer can be calibrated by a single observation at a known temperature, such as the melting-point of gold, 1,063° C if a black body is employed as the source; and its indications will probably be accurate at higher temperatures under a similar restriction. If the pyrometer is sighted on the interior of a furnace through a small observation hole it will indicate the temperature of the furnace correctly, provided that the temperature is uniform. But it must be remembered that this condition does not generally exist in large furnaces. Suppose, for instance, that it is required to find the temperature of the molten metal on the hearth of a furnace viewed through a thick layer of furnace gases, which are probably at a much higher temperature. It is evident that the radiation from the intervening flame may be much greater than that from the metal, and may introduce serious errors. The same objection applies with greater force to optical pyrometers, as the luminous radiation from gases may be of a highly selective character If, on the other hand, it is required to observe the temperature of metal in a ladle before casting, the surface of the metal must be cleared of scum, and it is necessary to know the emissive power of the metal or oxide exposed.

For scientific measurements of temperature by the radiation method, the thermopile, or bolometer, or radiomicrometer, previously calibrated by exposure to a black body at a known temperature, is directly exposed at a known distance to a known area of the source of radiation The required result may then be deduced in terms of the area and the distance. The use of extraneous optical appliances is avoided as far as possible on account of selective absorption For practical purposes, in order to avoid troublesome calculations and measurements, an optical arrangement is employed, either lens or mirror, in order to form an image of the source on the receiving surface. In Féry's mirror pyrometer, a mirror which is focused by the pinion, forms an image of the source on a disk, supported by wires of constantan and copper forming a thermocouple, connected by the brass strips to terminals. An observation hole in the wall of the furnace is sighted through an eyepiece, and is made to overlap the disk slightly. The rise of temperature of the junction is assumed to be proportional to the intensity of radiation, and is indicated by the deflexion of a delicate galvanometer connected to the terminals A lens may be substituted for the mirror at high temperatures, but it is necessary to allow for the selective absorption of the lens, and to a less extent for that of the mirror, by a special calibration of the scale

Assuming Wien's laws for the distribution of energy in the spectrum (*see* HEAT), the temperature of a black body may also be measured by observing (1) the wave-length corresponding to maximum intensity in the normal spectrum, which varies inversely as the absolute temperature, or (2) the maximum intensity itself, which varies as the fifth power of the absolute temperature, or (3) the intensity of radiation corresponding to some particular radiation or colour which varies as an exponential function of T, as given by Wien's formula. Methods (1) and (2) require elaborate apparatus and are impracticable except for purposes of scientific research. The *exact* application of method (3) is almost equally difficult, and is less certain in its results, but for optical purposes this method may be realized with a fair degree of approximation by the use of coloured glasses, and forms the basis in theory of the most trustworthy optical pyrometers.

Optical or Photometric Pyrometers.—The change of colour of a heated body from red to white with rise of temperature, and the great increase of intrinsic brilliancy which accompanies the change, are among the most familiar methods of estimating high temperatures. For many processes eye estimation suffices, but a much greater degree of accuracy may be secured by the employment of suitable photometers. In Mesuré and Nouel's pyrometric telescope, the estimation of temperature depends on observing the rotation of a quartz polarimeter required to reduce the colour of the radiation to a standard tint. It has the advantage of requiring no auxiliary apparatus, but, owing to the lack of a standard of comparison, its indications are not very precise. In the majority of photometric pyrometers, a standard of comparison for the intensity of the light, either an amyl-acetate or gasoline lamp, or an electric glow-lamp, is employed. The optical pyrometer of H. L.

Le Chatelier (*Comptes Rendus*, 1892, 114, p. 214) was one of the earliest, and has served as a model for subsequent inventors The standard of comparison is an amyl-acetate lamp, the flame of which is adjusted in the usual manner and viewed in the same field as the image of the source. The two halves of the field are adjusted to equality of brightness by means of a cat's eye diaphragm and absorption glasses, and are viewed through a red glass, giving nearly monochromatic radiation in order to avoid the difficulty of comparing lights of different colours Assuming Wien's law, the logarithm of the intensity of monochromatic radiation for a black body is a linear function of the reciprocal of the absolute temperature, and the instrument can be graduated by observing two temperatures; but it is generally graduated at several points by comparison with temperatures observed by means of a thermocouple.

The Wanner Pyrometer (*Phys Zeits*, 1902, p 112) is a modification of Konig's spectrophotometer, in which the two halves of the field, corresponding to the source and the standard of comparison, are illuminated with monochromatic red light polarized in planes at right angles to each other

The Féry Absorption Pyrometer (*Journ Phys*, 1904, p 32) differs from Le Chatelier's only in minor details, such as the replacement of the cat's eye diaphragm by a pair of absorbing glass wedges The principles of its action and the method of calibration are the same The pyrometers of Morse, and of L F C Holborn and F Kurlbaum depend on the employment of a glow lamp filament as standard of comparison, the current through which is adjusted to make the intrinsic brilliancy of the filament equal to that of the source When this adjustment is made the filament becomes invisible against the image of the source as background, and the temperature of the source may be determined from an observation of the current required Each lamp requires a separate calibration, but the lamps remain fairly constant provided that they are not overheated. To avoid this, the source is screened by absorption glasses (which also require calibration) in observing high temperatures. Except at low temperatures the comparison is effected by placing a red glass before the eyepiece. At low temperatures a special advantage of the glow-lamp as a standard of comparison is that it matches the source in colour as well as in brightness, so that the instrument is very sensitive

International Temperature Scale.—The following specification has been abridged from the first announcement issued by the U.S A Bureau of Standards in Oct 1928. The numerical values assigned to the basic fixed points chosen in addition to 0° and 100° as the foundation of the scale are as follows·—

B P of Oxygen at $p=760$ mm $t=182{\cdot}97°$Int.

The variation with pressure between 680 and 780 mm is given by

$$t=-182\ 97+0{\cdot}0126\ (p-760)-0{\cdot}0000065\ (p-760)^2$$

Similarly for the B.P. of Sulphur between 680 and 780 mm pressure,

$$t=444{\cdot}60+0\ 0909(p-760)-0\ 000048(p-760)^2$$

F P. of silver (free from O_2) $t=960\ 5°$Int

F.P. of Gold $t=1063°$Int.

The instruments available for interpolation lead to a division of the scale into four parts.

(a) from 0° C to 660° the temperature t is deduced from the resistance R_t of a standard platinum resistance thermometer by the formula

$$R_t=R_o(1+At+Bt^2).$$

The constants R_o, A, and B are to be determined by calibration at the ice, steam, and sulphur points, respectively. The purity and physical state of the platinum should be such that R_t/R_o shall not be less than 1·390 for $t=100°$, and 2·645 for $t=444{\cdot}6°$. (*Note.* This agrees with equation (21) above, which would naturally be employed for thermometers adjusted to read direct in degrees of temperature on the platinum scale denoted by *pt.*)

(b) From −190° to 0° C, the temperature t is deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula

$$R_t=R_o(1-At-Bt^2-C[t-100]t^3)$$

The constants R_o, A, and B are to be determined as specified above, and the additional constant C is determined by calibration at the oxygen point

The standard thermometer for use below 0° C must, in addition have a ratio R_t/R_o less than 0 250 for $t=-183°$

(c) From 660° to the gold point, the temperature t is deduced from the electromotive force e of a standard platinum versus platinum-rhodium thermocouple, one junction of which is kept at a constant temperature of 0° C while the other is at the temperature t defined by the formula, $e=a+bt+ct^2$. The constants a, b, and c are to be determined by calibration at the freezing points of Antimony, Silver and Gold, that for antimony being determined with a standard platinum resistance thermometer, since it lies within the range 0° to 660°, being about 630 5° for pure antimony when protected from access of oxygen.

The platinum of the standard thermocouple should be of the same purity as specified for a resistance thermometer The alloy is to consist of 90% platinum with 10% Rh The couple should develop an electromotive force e not less than 10·2 international millivolts nor more than 10 4 at the gold point

(d) Above the gold point the temperature t is determined by means of the ratio of the intensity J_2 of monochromatic visible radiation of wave-length λ cm, to the intensity J_1 of radiation of the same wave-length emitted by a black body at the gold point, by means of the formula

$$\log_e(J_2/J_1)=(1\ 432/\lambda)\ \{1/1336-1/(t+273)\}.$$

This equation is valid if $\lambda\ (t+273)$ is less than 0 3 cm degrees, the constant 1 432 representing the value assigned to Wien's constant of radiation in the same units, and 1336 being the absolute temperature at the gold point

It is expected that international thermometric conferences will be called by the International Committee on Weights and Measures, for the revision of this scale as occasion requires

Secondary Fixed Points on the International Scale.

B P. of solid Co_2	−78 5	F.P of Tin	231 85	F P of Zinc	410.45
F.P. of Mercury	−38 38	B.P of $C_6H_5\ _2CO$	305 9	F P of Antimony	630 5
F.P of Na_2SO_4	32 38	F P. of Cadium	320 9	F.P of Copper	1083
B P of Napthlene	217 96	F P of Lead	327 3	F P of Palladium	1555

Bibliography.—Most of the principles and methods of thermometry are described in text-books on heat, of which Preston's *Theory of Heat* may be specially mentioned For recent advances in thermometry the reader should consult the original papers The greater part of the recent work on the subject will be found in the publications of the Bureau International des Poids et Mesures de Sèvres (Paris), of the Reichsanstalt (Berlin), of the Bureau of Standards, U S A (Washington), and of the National Physical Laboratory (London), *Methods of Measuring Temperature* by Ezer Griffiths is well up to date and gives very full references to original papers (H L C)

THERMOPYLAE, a Greek pass leading from Locris into Thessaly between Mount Oeta and the Maliac Gulf; chiefly famous for the heroic defence by the Spartan king, Leonidas, with 300 soldiers against the Persian army of Xerxes advancing upon Greece in 480 (*See* Leonidas) Two other battles here are famous In 279 B.C Brennus and the Gauls were checked for several months by a Greek army under the Athenian Calippus, and in 191 Antiochus of Syria vainly attempted to hold the pass against the Romans under M'. Acilius Glabrio. In the time of Leonidas the pass was a narrow track (probably about 14 yd wide) under the cliff In modern times the deposits of the Spercheius have widened it to a breadth of 1½ to 3 m broad. The hot springs from which the pass derived its name still exist close to the foot of the hill There is one large spring used as a bath and four smaller ones, and the water, which is of a bluish green colour and contains lime, salt, carbonic acid and sulphur, is said to produce good effects in scrofula, sciatica and rheumatism.

See G. B. Grundy, *Great Persian War*, pp. 277–291 (1901).

THERMOSTAT. A device to regulate automatically the temperature produced by a heating apparatus; in some cases to maintain the temperature at a definite degree. While thermostats differ greatly in detail, their principle is always the same; they take advantage of the expansion produced by heat to control the source of heat They can be applied to boilers or heating apparatus of all sorts, whether fired by solid or gaseous fuel, or by electricity.
Thermostats may be summarized under two principal headings. (1) those in which the expanding medium is volatile fluid and (2) those in which the sensitive part is metallic.

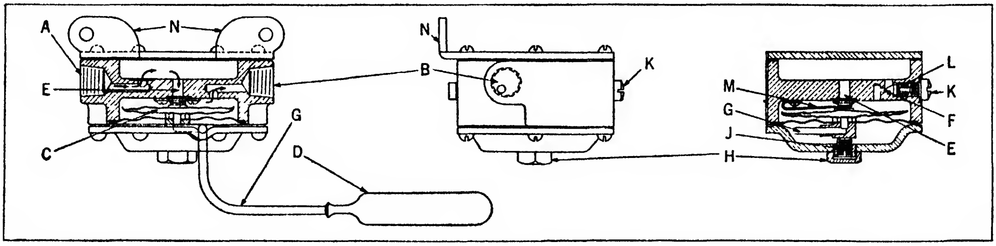


FIG. 1.—THERMOSTAT IN WHICH EXPANDING MEDIUM IS VOLATILE FLUID A FROM GAS SUPPLY LINE, B. GAS TO BURNER, C DIAPHRAGM, D. BULB, E MAIN VALVE, F BY-PASS VALVE (NEEDLE TYPE), G CAPILLARY, CONNECTING BULB TO DIAPHRAGM, H HEXAGONAL CAP SCREW, J ADJUSTING SCREW FOR LOWER OR HIGHER TEMPERATURE, K SEALING CAP SCREW, L. ADJUSTING SCREW FOR BY-PASS VALVE, M SPRING FOR OPENING MAIN VALVE; N. MOUNTING BRACKET

In either form, expansion or contraction with change of temperature affects fuel consumption and the production of heat.

In gas-fired hot water apparatus, in which a thermostat is commonly used, the regulators are worked by a capsule, containing volatile fluid, placed in close proximity to the water being heated; as the temperature rises the fluid expands and reduces the size of the passage through which the gas is conveyed to the burners. Figure 1 shows a section through such a thermostat In connection with this apparatus a small orifice or by-pass is provided, around the main gas passage, to maintain a small gas flame whatever condition prevails in the main passage. This prevents the gas from being entirely extinguished

The rod thermostat is another form of thermostat often used in gas apparatus. It is of very simple construction As the temperature rises the tube enclosing the rod lengthens, thereby drawing the rod outward and reducing the gas-way.

When either form of thermostat is used, the process is reversed when water is drawn off Upon cold water entering the apparatus the contraction of the thermostat allows more gas to pass, so that the temperature again rises. (*See* REGULATION, AUTOMATIC)

THÉROIGNE DE MÉRICOURT, ANNE JOSÈPHE (1762–1817), a Frenchwoman who was a striking figure in the Revolution, was born at Marcourt (from a corruption of which name she took her usual designation), Luxembourg, on Aug. 13, 1762. She was the daughter of a farmer, Peter Théroigne She was educated in the convent of Robermont. She was quick-witted, handsome, intensely passionate in temper, and had a vigorous eloquence, which she used with great effect upon the mobs of Paris during the few years of her life (1789–93) which are of historical interest She left her home on account of a quarrel with her stepmother. In her career as courtesan she visited London (1782), and Genoa as a singer (1788) In Paris on the outbreak of the Revolution, she was surrounded by a coterie of well-known men, chief of whom were Pétion and Desmoulins.

She was again in Paris in Jan 1792, where she often spoke in the clubs. Even in the National Assembly she would violently interrupt the expression of moderatist views. Known as "la belle Liégoise," she wore a riding habit, a plume in her hat, a pistol in her belt and a sword at her side, and excited the mob by violent harangues. Associated with the Girondists and the enemies of Robespierre, she became in fact the "Fury of the Gironde." She commanded in person the III corps of the so-called army of the faubourgs on June 20, 1792, and shares a heavy responsibility for the riots of Aug. 10. She took no part in the September massacres, and, moderating her conduct, became less popular from 1793. Towards the end of May the Jacobin women seized her, stripped her naked, and flogged her in the public garden of the Tuileries. The following year she became mad; she died at La Salpetrière on June 9, 1817

See E. and J de Goncourt, *Portraits intimes du XVIIIe siècle* (2 vols, 1857–58); M Pellet, *Étude historique et biographique sur Théroigne de Méricourt* (1886); L. Lacour, *Les Origines du féminisme contemporain Trois femmes de la Révolution* (1900), Vicomte de Reiset, *La Vraie Théroigne de Méricourt* (1903); and the play *Théroigne de Méricourt* of M Paul Hervieu, produced at the Théâtre Sarah Bernhardt in 1902.

THERSITES, the ugliest man in the Greek camp before Troy, a railing demagogue (*see* Homer, *Iliad* ii, 212), was a relative of Diomedes (*q v*)

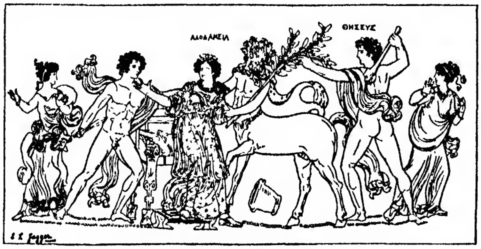
THESEUS was the great hero of Attic legends and the son of Aegeus, king of Athens, and Aethra, daughter of Pittheus, king of Troezen, or of Poseidon and Aethra The legend relates that Aegeus, being childless, went to Pittheus, who contrived that Aegeus should have intercourse with Aethra, who in due time brought forth Theseus On reaching manhood Theseus was sent by his mother to Athens He encountered many adventures on the way. First he met and slew Periphetes, surnamed Corynetes (Clubman). At the isthmus of Corinth dwelt Sinis, called the Pine-Bender, because he killed his victims by tearing them asunder between two pine-trees. Theseus hoisted the Pine-Bender on his own pine-tree. Next Theseus despatched the Crommyonian sow (or boar). Then over a cliff he flung the wicked Sciron, who used to kick his guests into the sea, while perforce they washed his feet. In Eleusis Theseus wrestled with Cercyon and killed him. Later he slew Procrustes, who fitted all comers to his only bed by lopping or racking them to the right length He found his father married to Medea, who had fled from Corinth Being a witch, she knew Theseus before his father did, and tried to persuade Aegeus to poison his son; but Aegeus recognized him Theseus was now declared heir to the throne, and the Pallantids[1], who had hoped to succeed the childless king, conspired against him, but he crushed the conspiracy He then attacked the fire-breathing bull of Marathon and brought it alive to Athens, where he sacrificed it to Apollo Delphinius. Next came the adventure of the Cretan Minotaur (q v.).

While Theseus was on his way to Crete, Minos, wishing to see whether Theseus was really the son of Poseidon, flung his ring into the sea. Theseus dived and brought it up, together with a golden crown, the gift of Amphitrite. He landed on the return voyage at Delos, and there he and his comrades danced the crane dance, whose complicated movements were meant to imitate the windings of the Labyrinth. In historical times, this dance was still danced by the Delians round the Altar of Horns. Theseus had promised Aegeus that, if he returned successful, the black sail with which the fatal ship always put to sea should be exchanged for a white one. But he forgot his promise; and when Aegeus, from the Acropolis at Athens, descried the black sail out at sea,

[1]The sons of Pallas, the brother of Aegeus. Aegeus and Poseidon are quite possibly one and the same.

he flung himself from the rock and died. Hence, at the festival which commemorated the return of Theseus there was always weeping and lamentation. Theseus now carried out the union of the various Attic communities into a single State. He extended the territory of Attica to the isthmus of Corinth.

He transformed the Isthmian ceremony in honour of Melicertes by adding games in honour of Poseidon. Alone, or with Heracles, he captured the Amazon princess Antiope. Thereafter



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM
THESEUS (ON RIGHT) AND PEIRITHOUS RESCUING LAODAMEIA (HIPPODAMEIA) FROM VIOLATION BY THE CENTAURS, FROM A GREEK VASE FOUND AT ANZI (BASILICATA) NOW IN THE BRITISH MUSEUM

the Amazons attacked Athens. Antiope fell fighting on the side of Theseus. By her he had a son, Hippolytus (q.v.). Theseus is also said to have taken part in the Argonautic expedition and the Calydonian boar-hunt. He compelled the Thebans to give up the unburied bodies of the Seven (*see* ANTIGONE).

The famous friendship between Theseus and Peirithous, king of the Lapiths, originated when Peirithous heard of the strength and courage of Theseus, and desired to put them to the test. Accordingly, he drove away from Marathon some cows which belonged to Theseus. The latter pursued, but when he came up with the robber the two heroes were so filled with admiration of each other that they swore brotherhood. At the marriage of Peirithous, a fight broke out between the Lapiths and Centaurs (q.v.). Theseus and Peirithous now carried off Helen (q.v.). He now descended to the lower world with Peirithous, to help his friend to carry off Persephone. But the two were caught and confined in Hades till Heracles came and released Theseus. When Theseus returned to Athens, he found that a sedition had been stirred up by Menestheus, a descendant of Erechtheus, one of the old kings of Athens. Failing to quell the outbreak, Theseus in despair sent his children to Euboea, and after solemnly cursing the Athenians sailed away to the island of Scyrus, where he had ancestral estates. But Lycomedes, king of Scyrus, took him up to a high place, and killed him by casting him into the sea. His ghost was said to have appeared in the Athenian ranks at Marathon. When the Persian war was over, the Delphic oracle bade the Athenians fetch the bones of Theseus from Scyrus and lay them in Attic earth. This was done, in 469, by Cimon. His chief festival, called Theseia, was on the 8th of the month Pyanepsion (Oct. 21), but the 8th day of every month was sacred to him.

The well-preserved Doric temple to the north of the Acropolis at Athens, commonly known as the Theseum, is certainly not his shrine. There were several (according to Philochorus, four) temples or shrines of Theseus at Athens.

See (a) of ancient works, especially Plutarch's *Theseus,* (b) of modern works, L. Preller, ed. C. Robert, *Gr. Mythologie,* ii. p. 676 ff. (4 vol., 1887–94); L. R. Farnell, *Hero-Cults,* p. 337 ff. (1921); Stending in Roscher's *Lexikon, s.v.* (good bibliography) also O. Gruppe, *Griechische Mythologie,* i. pp. 581–608 (Munich, 1898).

THESMOPHORIA. A very ancient festival, celebrated by women in many parts of the Greek world (as Attica, many places in the Peloponnesos, Boeotia, several islands, the coast of Asia Minor, Cyrene, Italy and Sicily, but not generally among the Dorians) in honour of Demeter *Thesmophoros,* which does not mean, as the ancients usually supposed, *legifera Ceres* (Virg., *Aen.,* iv. 57), since the festival can in no way be connected with the bringing or establishing of laws or customs (θεσμοί). It is possibly "bringer of treasure or wealth," an obsolete sense of θεσμός, of which a few traces remain; or perhaps better (Frazer, *Enc. Brit.* 9th ed., Nilsson, *Griech. Fest.*, p. 324), the name Thesmophoria is the primary one, from which the epithet of the goddess is derived, and it means "the carrying of things laid down," the radical meaning of θεσμός, referring to the curious fertility-charms described below.

As no men were admitted to the rites, and in any case they were largely secret (for the reasons *see* MYSTERY), we have nothing like a full description (but *see* H. J. Rose, *Primitive Culture in Greece,* 1925).

The celebrants were women who seem to have been at least generally married, and who must be free. They observed chastity for some days (nine, according to Ovid, a likely number enough considering its magical connotations), and also abstained from certain foods; thus, they must not eat pomegranate-seeds. The festival itself lasted three days, although in Attica it was lengthened by the addition of other celebrations of a similar character, the Stenia and the Halamusian Thesmophoria, making five days in all, Pyanopsion 10–14. But the original days were Pyanopsion 12–14 only, *i.e.*, about the beginning of October, and shortly after the Pyanopsia (*q.v.*). The days were called respectively *Anodos* (or *Kathodos*), *Nesteia*, *Kalligeneia*. *Anodos* (ascent) is often taken to mean the "going up" of the women to the Thesmophorion, or precinct of Demeter; but this does not explain why the day should also be called *Kathodos*, or descent. As the name of the second day, which signifies "fasting," describes what the celebrants then did, it is plausible to take the first day as having been called Ascent and Descent, and to connect it with the rite known to have been performed at some time in the festival. Pigs were thrown into an underground chamber, called a *megaron;* they were probably alive, but the text (Clement of Alexandria, *Protrept.*, p. 14 Pott.) is corrupt and uncertain. At all events they were left there until such parts of them as were not eaten by the guardian snakes of these underground sanctuaries had had time to rot. The remains were then brought up by certain women who had observed chastity for three days and were called ἀντλήριαι or drawers up—the verb ἀντλεῖν means to pump or draw off water, and it is strange that its cognate noun should be used in this way. These women also carried, or some of the celebrants did, certain well-known symbols of fertility, including pine-cones and "figures made of flour of wheat, in imitation of the shapes of serpents and of men." The remains of the pigs were laid on an altar, and if taken and mixed with seed were believed to ensure a good crop. Apparently the figures, like the pigs, were thrown into the chasms, but our authority here (a scholiast on Lucian, first published by Usener in *Rheinisches Museum*, xxv p. 548) is both confused and manifestly corrupt; he seems to be confusing the Thesmophoria with a quite different festival, the Arrhephoria. If, however, pigs, pine-cones, figures and all were thrown into the *megara* and "pumped" out again, it is very intelligible magic. These objects are all, in their nature, connected with fertility—a fertile beast, a seed-vessel, a preparation of grain shaped like a creature supposed to be full of earth-magic (the serpent) and like a man, perhaps a phallic figure. They are then put into a holy place, left there to acquire additional *mana* from the sacred surroundings and the touch of the sacred serpents, real or imaginary, who live there, and finally taken out again by pure agents, whose chastity has, so to speak, insulated them. Finally, they are laid on a holy altar, whence they are taken, heavily charged now with potency, and used to bring the blessing of fertility. To mix all manner of magical things with seeds to make them sprout better is a widespread savage custom, the Khonds, for instance, bury the flesh or ashes of a human victim (*meriah*) in their fields, or did so until the British Government stopped their horrible practices.

The ancients tried to explain all these matters as commemorations of the abduction of Kore; but it is rather the legends which have grown out of the ritual, now no longer understood. In modern times it has been found possible to conjecture a reason for them; but it is to be remembered that, owing to the fragmentary state of our knowledge, the above is offered as a conjecture only, especially as regards the date of the rite.

The *Nesteia* is easily enough explained; we know that the

women fasted, sitting upon the ground Fasting is a common piece of agricultural magic, and contact with the ground is also common; for a Greek parallel we may refer to the ancient Dodonaean priesthood of the *Selloi*, who slept on the earth (Homer, *Il.*, xvi 235). The third day, *Kalligeneia*, is "the fair birth." We need not take it as originally referring to anyone so definite as Kore; it rather indicates the happy issue of all this magic, and doubtless of much more which we do not know, in the fertility of the ground and doubtless of men and beasts as well It remains only to add that the Thesmophoria, or at least a great part of it, was carried out at night by torchlight, and that it was accompanied by ceremonial coarse abuse (αἰσχρολογία) between the women; again a common means of promoting fertility.

Bibliography.—A. Mommsen, *Feste der Stadt Athen* (1898); J. E. Harrison, *Prolegomena to the Study of Greek Religion* (1st ed. 1903); M P. Nilsson, *Griechische Feste von religiöser Bedeutung* (1906), L R Farnell, *Cults of the Greek States*, vol iii. (1907, relevant passages from ancient authors in full, p 326 f); Sir J G Frazer, *Golden Bough*, 3rd ed (*see* Index *s v.*). (H J R.)

THESPIAE, an ancient Greek city of Boeotia, on level ground commanded by the low eastward spurs of Mount Helicon The deity most worshipped at Thespiae was Eros, whose primitive image was an unwrought stone. The town contained many works of art, among them the Eros of Praxiteles, dedicated by Phryne in her native place, one of the most famous statues in the ancient world It was carried off to Rome by Caligula, restored by Claudius, and again carried off by Nero There was also a bronze statue of Eros by Lysippus The Thespians also worshipped the Muses, and celebrated a festival in their honour in the sacred grove on Mount Helicon Remains of the ancient citadel are still to be seen, solidly and regularly built. To E and S foundations bear witness to the extent of the ancient city The neighbouring village Eremokastro, on higher ground, was thought by Ulrichs to be probably the site of ancient Ceressus In 1882 there were discovered, about 1,200 yd east of Eremokastro, on the road to Arkopodi (Leuctra), the remains of a tomb of the 5th century B C., with a colossal stone lion, probably that of the Thespians who fell at Plataea

History.—Thespiae figures chiefly as an enemy of Thebes, whose centralizing policy it had all the more to fear because of the proximity of the towns During the Persian invasion of 480 B C it stood almost alone among Boeotian cities in serving the national cause. Seven hundred Thespians accompanied Leonidas to Thermopylae and of their own free will shared his fate The remaining inhabitants, though their city was burnt by Xerxes, furnished 1,800 men to the Greek army at Plataea In 424 B C. the Thespian contingent at Delium sustained heavy losses, and in the next year the Thebans took advantage of this to accuse Thespiae of friendship towards Athens and to dismantle its walls In 414 they interfered again to suppress a democratic rising In the Corinthian war Thespiae sided with Sparta, and between 379 and 372 repeatedly served the Spartans as a base against Thebes In the latter year they were reduced by the Thebans and compelled to send a contingent to Leuctra (371) It was probably shortly after this battle that the Thebans destroyed Thespiae and drove its people into exile Later the town was rebuilt and in 171 B C, true to its policy of opposing Thebes, sought the friendship of Rome.

Bibliography.—*See* Herodotus, v 79, vii 132–ix 30; Thucydides, iv. 93, 133, vi. 95, Xenophon, *Hellenica*, iv, vi; Pausanias, ix. 13, 8–14, 2, 26–27; Strabo, ix pp. 409–10

THESPIS, Greek poet, of Icaria, in Attica (6th cent. B.C.), generally considered the inventor of tragedy, flourished in the time of Peisistratidae. According to Diogenes Laërtius (iii. 56), he introduced for the first time in the old dithyrambic choruses a person distinct from the chorus, who conversed with the leader, and was hence called ὑποκριτής ("answerer") His claim to be regarded as the inventor of tragedy in the true sense of the term depends upon the extent to which this person was really an "actor." (*See* Drama) Suïdas gives the titles (of doubtful authenticity) of several of his plays (not confined to the legends of Dionysus, but embracing the whole body of heroic legends), but the fragments quoted in various writers as from Thespis (*see* Nauck [*Tragic Fragments*]), are probably forgeries by Heracleides of Pontus The statement of Horace (*Ars Poetica,* 276) that Thespis went round Attica with a cart, on which his plays were acted, is due to confusion between the origin of tragedy and comedy, and a reminiscence of the scurrilous jests which it was customary to utter from a waggon (σκώμματα ἐξ ἁμάξης) at certain religious festivals A. and M Croiset (*History of Greek Literature*, Eng. tr, 1904), who attach more importance to the part played by Thespis in the development of tragedy, accept the testimony of Horace. According to them, Thespis, actor and manager, transported his apparatus on a cart to the deme in which he intended to produce his drama, formed and trained a chorus, and gave a representation in public

See Drama; and W. Christ, *Griechische Litteraturgeschichte* (1898).

THESSALONIANS, EPISTLES TO THE, two books of the New Testament. These earliest extant letters of Paul mark the beginnings of Christian literature. Fortunately we can date them as written from Corinth early in A.D. 50, under the circumstances of the life of Paul (*q v.*) related in Acts xvii. The designation "Missionary Epistles" is sometimes applied to the pair because they stand apart from the "Major" four addressed to Galatia, Corinth, and Rome, being as yet unaffected by the Judaizing reaction. They thus afford a simpler view of the normal type of gospel preached by Paul in Gentile territory, with the reactions it encountered. The designation "Eschatological" would be more distinctive, because doctrinally they chiefly reflect the difficulties raised among Greek converts by the proclamation of "Christ and the resurrection" (Acts xvii. 22–32, *cf* I, i 9–10). The drama of a return of the glorified Jesus to judgment and renewal of the world, represented in such books of "Prophecy" as the Revelation of John (*q v*), was taken over by the primitive Church from contemporary Jewish Apocalypse, but in Paul's letters and in Greek Christianity generally is gradually modified and pruned of its crudities. We should not fail to note that in Acts xv. 32 Silas, or Silvanus, whom Paul here associates with himself as joint author, is specifically called a "prophet "

First Epistle.—Both Thessalonian epistles are replies to communications from that newly founded church, probably not in oral form alone I., i–iii. reviews Paul's whole relation to it by way of defence against insinuations from outsiders ascribing his missionary activities to selfish motives Paul reminds his converts that, when among them, he had not even called for the respect and support which were his due, but had depended for support on his own labour, supplemented by voluntary gifts from churches previously founded, showing toward them only the care and solicitude of a parent He had been driven out by the jealous hostility of the Jews, who here showed that bitter antagonism shown against the prophets of old, against Jesus, and the mother church in Jerusalem; but he still hopes to return If his prayers and hopes are frustrated it will be due only to the machinations of Satan, not any failure on his part A practical section follows in iv 1–12 urging increased efforts against sexual impurity (a besetting sin of the Greek churches), greater brotherly love, and a life of orderly industry forestalling possible charges from outsiders of idle fanaticism Practical advice leads over to doctrinal instruction Individuals have been disturbed in their faith by the death of some members of the brotherhood before the expected Coming Paul re-assures them by citing a "word of the Lord " This is not, as sometimes imagined, a transmitted report of some saying of the earthly Jesus, whose authentic teachings are of very different stamp, but a message from the glorified "Lord" in "the Spirit," that is, through the type of "prophecy" illustrated in the messages of Jesus "in the Spirit" to the churches of Asia (Rev. i 1 *ff.*). In I., iv. 13–18 Paul applies such parts of this primitive apocalypse as will serve to "comfort" those in danger of losing their Christian hope, and passes at once in v. 1–11 to further practical exhortation to watch and be sober as children of the light about to dawn, not overtaken like the sinful world by the Coming of the Lord to judgment. After direction to leaders and laity alike to co-operate toward a blameless and orderly communal life, with instructions that the letter be read in public assembly, Paul pronounces his apostolic benediction.

Second Epistle.—The second epistle continues the correspondence after an interval so brief that outward conditions appear unchanged, while leading features of the preceding letter are continued and accentuated In particular the unfamiliar Jewish eschatology is explained and developed. Chapter i. repeats with further detail the proclamation of the Coming of Christ to judgment of I, i 10, and justifies the doctrine of "wrath" against persecuting unbelievers in contrast with "rest" and "glory" for the saints. But in ch ii. a new factor appears. Before the hoped-for Advent the "mystery of lawlessness" now at work in the world must culminate in a counter-manifestation of Satan's power. An Antichrist (*q.v*) will appear "in the temple of God" claiming divine honours there after the manner of the desecration of Antiochus, self-styled "God-manifest," predicted in Daniel. The programme of redemption will begin by the slaying of Antichrist by the breath of the Lord's mouth at his Coming. Momentarily Satan is held in check by Roman power. The closing chapter (iii) resumes the admonitions of I., v. 12–28, re-enforcing disciplinary measures to be taken against the "disorderly"

Authenticity.—Objections once urged against the authenticity of I. have lapsed, but some still question II Slight changes of diction, usually toward more emphatic form in II., need not detain us Doubts aroused by the suspicions expressed in II, ii 2 and iii 17, are not warranted Actual circulation of spurious letters during the lifetime of the reputed author is indeed improbable But this is not implied Paul has heard of misrepresentations of his teaching and wishes to remove all conceivable excuse for it. The strong language of II, ii. 2 against an alleged Pauline doctrine of the Day of the Lord as "now present" no more presupposes actual utterance by "spirit" (*i e*, "prophecy"), or by "word" (of Jesus), or "by letter purporting to be from us" than the stronger language of Gal i 8 presupposes actual anti-Pauline preaching by "an angel from heaven" However, spurious epistles were common enough in Paul's time It is interesting to see how he already guards himself against this possibility by the device later exemplified in Gal vi 11–18 and illustrated by many actual documents among the Oxyrhynchus papyri, by attaching to the dictated letter an autographed farewell "in mine own hand"

Serious objections to the authenticity of II. are of two kinds, (1) from its similarity to I both in formal arrangement of material and in language, (2) from its unexpected attachment of the Antichrist doctrine to Paul's eschatology.

The similarity of material and structure is probably sufficient to prove dependence, possibly even literary dependence. But why not? Intrinsic probability as well as the known practice of the ancients suggests that a copy of I. would be available at Corinth for Paul's use in continuing the correspondence. There remains thus, as the only serious objection to the authenticity of II its belated supplement to Pauline eschatology The Antichrist doctrine, if not actually opposed to his teaching elsewhere, is almost unmentioned (but *cf* I Cor xv. 24–28 and "Belial" in II. Cor. vi 15) Did Paul forget to mention this preliminary crisis when seeking in I, v 1–11 to allay excitement at Thessalonica over the expected immediate Coming and to restore orderly industry? Was the working of the "mystery of iniquity" an afterthought?

For answer we must consider the occasion for his introducing the (apocalyptic) "word of the Lord" cited in I, iv. 15–17. It was to restore the hope of certain converts grieved by recent bereavement, and professedly contains but a part of the teaching. Paul purposely limited himself to the single lesson in I, v 1–11 of watchfulness in view of the uncertainty of the hour. But his readers, reminded of the revelation, seem now to feel that a little more definite information concerning the "times and seasons" would greatly help. If the Antichrist paragraph of II be read as in reply to an intimation of this kind, probably by letter, while the fact is kept in mind that in both letters the subject is repeatedly declared to be no new doctrine but something preached from the beginning by Paul and his fellow-missionaries, it will be easier to realize that it is not an afterthought with which we are here dealing, but rather something earlier and primitive, brought now to the surface by further development of the subject

Bibliography.—The most careful study of I. and II. Thess., with full bibliography will be found in the *International Critical Commentary* by J E Frame, 1912. Similar ground is taken by E von Dobschütz in Meyer's Commentary (1909) and by M Dibelius in Lietzmann's *Handbuch* (1911), also by Geo Milligan (1908) and J. Moffatt (in *Expositor's Gr. Test.*, 1910). Against the authenticity of II. *see* H J. Holtzmann (*Einl* 1892 and *Zeitschr. f. ntl Wiss.*, 1901), Pfleiderer, *Urchristenthum* (1902), and Wrede, *Echtheit des zweiten Thessalonicherbriefes* (1903). On the relation to Synoptic apocalypse *see* Bacon, *The Gospel of Mark* (1925) (B. W Ba)

THESSALY, a district of northern Greece, between Macedonia and the Hellenic countries towards the south, and between upland Epirus and the Aegean It forms an irregular square of about 60 m in each direction, for the most part level, but with well-marked boundaries, the Cambunian mountains on the north, Othrys on the south, the massive chain of Pindus, the backbone of this part of Greece, on the west, while at the north-eastern angle is Olympus, separated by the gorge of Tempe (*q v*) from the coast range of Ossa and Pelion, standing in a continuous line to the south-east Three peaks of Pindus are over 5,000 ft, and Olympus, Ossa and Pelion reach respectively 9,790, 6,398 and 5,350 feet The country within these limits is drained by numerous confluents, which pass into the sea through the gorge of Tempe

Through Thessaly, therefore, lie all land routes between peninsular Greece and the north An important pass from Petra in Pieria debouches west of Olympus on the plain north of Larissa By this Xerxes entered (Herodotus vii 173), and when the Greeks heard of this passage, they gave up their defence of Tempe. The main communication with Epirus passed over Mount Lacmon by the upper Peneius to Aeginium in the north-west angle By this route Julius Caesar arrived before the battle of Pharsalia Another pass, farther south by Gomphi, leads to the Ambracian gulf The great southern pass of Coela crosses Mount Othrys nearly north of Thermopylae

Though Thessaly is the most level district of Greece, it is composed of sections, divided by ranges of hills, Upper Thessaly, to the west and south-west, contains the higher course of the Peneius and all tributaries from the south—Enipeus, Apidanus, Onochonus and Pamisus Lower Thessaly, from the central ridge west of Larissa to the foot of Ossa and Pelion, is inundated by the Peneius, the flood-water forming the Lake Nessonis, and, when that is full, pouring into Lake Boebe The chief city of the lower Thessaly was Larissa, in the south at the pass of Coela is another plain, containing a small lake, formerly called Xynias, and low hills separate this from the town of Thaumaki, which overlooks the main upper plain "like a vast sea" (Livy xxxii 4) The Plain of Pharsalia, intersected by the Enipeus, lies north-east of this, and still farther another battlefield, Cynoscephalae The political divisions follow the physical, Pelasgiotis being the lower plain of the Peneius, Hestiaeotis and Thessaliotis respectively the north and the south portions of the upper, the fourth, Phthiotis, towards the south-east, was geographically separated by the watershed of Mt Othrys and its north-east spurs. The landlocked Pagasaeus Sinus (Gulf of Volo), extends from Pagasae at its head to Aphetae at its narrow outlet, where the chain of Pelion turns at right angles to south-west in broken ridges, while on the opposite side rise the heights of Othrys In the heroic age Phthiotis was the legendary birthplace of Greek navigation in the story of the Argonauts Hence Achilles came and, according to Thucydides (i. 3), it was the cradle of the Hellenes Iolcus, the centre of many legends, is near the modern Volo Near Iolcus, later, Demetrius Poliorcetes founded Demetrias, called by Philip V. of Macedon one of the "fetters of Greece," Chalcis and Corinth being the others.

The history of Thessaly is closely connected with its geography. From the earliest times Thessaly has had a separate history controlled by its situation. The fertility of the land offered a temptation to invaders, and was thus the primary cause of early migrations. Its first Neolithic culture combined Danubian characters with elements from the "Tripolje" culture of Ukraine; a second phase reinforces the latter elements, at Dimini near Volo. Then long decadence resulted from the spread, first of "Helladic," then of "Minyan" culture from the south. Finally, just as Mycenaean exploitation was beginning in the 12th century, fresh

northern invaders from Macedonia wrecked all At this point language and legend supplement archaeology. Thessalian Greek is of the Aeolic group, akin to Boeotian; but between lie the "West Greek" dialects of Phthiotis, Malis, and Doris, subsequently intruded Aeolic genealogies go back to the early part of the 14th century, whereas the Doric and West Greek expansion is referred to the 12th. Tradition brought both Thessalians and Boeotians from Arne in the north-west, imposing powerful aristocracies on the older inhabitants, who retained political coherence only among the marginal hills in Perrhaebia, Magnesia, and the like. The rich lowlands were the natural home of powerful families such as the Aleuadae of Larissa and the Scopadae of Crannon, and the absence of elevated positions was unfavourable to the foundation of cities, which might have fostered freedom and democracy The plains, also, were suited to the breeding of horses, and consequently the force in which the Thessalians were strong was cavalry, a kind of troops usually associated with oligarchy. The wealth and the semi-Hellenic character of the people (for, in race, as in geographical position, the Thessalians held an intermediate place between the Macedonians and the southern Greeks) held them aloof from national sentiment, and at the time of the Persian wars the Aleuadae joined the enemy United, as under Alexander and Jason, of Pherae, in the 4th century, the Thessalians were formidable, but they seldom combined for long, and consequently had little influence in Greece From the 4th to the 2nd century they were usually vassals of Macedon

For several centuries during the middle ages Rumanian immigrants formed so large a part of the population of Thessaly that that district was called by the Byzantine writers Great Wallachia (Μεγάλη Βλαχία); the Jewish traveller, Benjamin of Tudela, so describes it in the latter half of the 12th century Now, only a few Vlach (Ruman) colonies remain, principally on the west of Olympus and in some gorges of Pindus The Turkish conquerors settled in the larger towns and in great ranches The Greeks form so large a majority that, even while the country belonged to the Ottomans, Greek was the official language Thessaly was ceded to the Greek kingdom by the Porte in 1881 Since that time its prosperity has greatly increased The port of Volo, almost the only outlet of trade, has a steamer service to Athens Railways run· (1) from Volo by way of Velestino (ancient Pherae) to Larissa (*q v.*); (2) from Velestino to the west by Phersala (Pharsalos), Domokos (Thaumaki), Karditsa and Trikkala (Trika), to Kalabaka (Aeginium), in the upper valley of the Salambria (Peneius); (3) the main line from Athens to Salonika enters Thessaly by the Coela pass west of Othrys, reaches Larissa, and proceeds by the gorge of Tempe and the sea front of Olympus Thessaly is essentially an agricultural and pastoral district

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THETFORD, a market town and municipal borough of England, mostly in the south-west of Norfolk, but partly in Suffolk, 91 m N.N.E. from London by the L N E R Pop (1921) 4,700. In the time of Edward III. the town had twenty churches and eight monasteries There are now three churches principally of Perpendicular flint work, and a few monastic remains, the chief being two gate-houses. The most important relic of antiquity is the Castle Hill, a mound 1,000 ft. in circumference and 100 ft. in height. The grammar school was founded in 1610. In King Street is the mansion-house occupied as a hunting-lodge by Queen Elizabeth and James I. Brewing and tanning are carried on; and there are also manure and chemical works. The town is governed by a mayor, 4 aldermen, and 12 councillors. Area, 7,096 acres

Tradition tells that Uffa, who probably threw up the earthworks called the Castle Hill, established the capital of East Anglia here about 575. In 1290 its principal officers were a mayor and coroner, afterwards assisted by eight burgesses, whom Henry VIII. increased to ten. The town, never very prosperous since the Conquest, had then fallen into great decay, but the petitions of the burgesses for a charter were not heeded till 1573 when Elizabeth incorporated it under a mayor and common council. This charter, restored in 1692 after its surrender to Charles II, remained in force till 1835 when the borough was re-constituted.

See A L Hunt, *Capital of East Anglia* (1870); T. Martin, *History of Thetford* (1779).

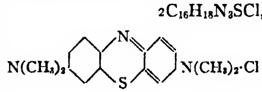
THETIS, in Greek mythology, daughter of Nereus, wife of Peleus and mother of Achilles The chief of the 50 Nereids, she dwelt in the depths of the sea with her father and sisters When Dionysus leaped into the sea to escape from the pursuit of Lycurgus, king of the Thracian Edones, and Hephaestus was flung out of heaven by Zeus, both were kindly received by Thetis. Again, when Hera, Athena, and Poseidon threatened to bind Zeus in chains, she sent the giant Aegaeon, who delivered him out of their hands She was married against her will to Peleus (*q v ; see* also ACHILLES). Thetis is used by Latin poets simply for the sea.

THEUNIS, GEORGES (1873–), Belgian statesman, was born at Montegnée, near Liége, on Feb. 28, 1873. In Jan 1916 he attended the Inter-Allied Relief Commission in London and in 1919 represented Belgium on the Reparations Commission In 1920 he became finance minister in Carton de Wiart's coalition ministry, the aims of which Government were first to settle the reparations question, with due regard to Belgium's prior claim and secondly to maintain the entente between the Allies Theunis represented Belgium at the Inter-Allied Conferences of San Remo 1920, London 1924 and Paris 1925, which resulted in the adoption of the Dawes Plan and a corresponding inter-Allied settlement His home policy was to place Belgian finance on a sound basis and to reconstruct the devastated regions His cabinet resigned in April 1925, after the elections in which the democratic parties triumphed In Aug 1925 Theunis was sent by his Government to Washington to discuss the question of the Belgian debt to U S A This mission resulted in an agreement which was submitted to the parliaments of the two countries Theunis presided over the World Economic Conference at Geneva in 1927, he was also chairman of the permanent consultative economic committee formed at the League of Nations to carry out and continue the work of the conference

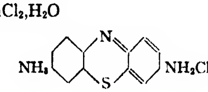
THEURIET, CLAUDE ADHÉMAR ANDRÉ (1833–1907), French poet and novelist, was born at Marly-le-Roi The best of his novels are *Le mariage de Gérard* (1875); *Raymonde* (1877); *Le fils Maugars* (1879); *La maison des deux Barbeaux* (1879); *Sauvageonne* (1880), *Reine des bois* (1890); *Villa tranquille* (1899); *Le manuscrit du chanoine* (1902). Theuriet died on the 23rd of April 1907

THIAZINES, in organic chemistry are compounds containing a ring system of one sulphur atom, one nitrogen atom and four carbon atoms. The most important thiazine is methylene-blue (formula I), a basic colouring matter employed in dyeing and printing on cotton mordanted with antimonyl tannate It is also used as a microscopic stain and as a reagent in bacteriological and histological researches. Methylene-blue was first discovered by H. Caro in 1876, who prepared it by oxidising *as*-dimethyl-*p*-phenylenediamine (obtained from *p*-nitrosodimethylaniline) with ferric chloride in presence of hydrogen sulphide The preparation was rationalised by A Bernthsen in 1887 who converted dimethyl-*p*-phenylenediamine into its thiosulphonic acid and oxidised this intermediate with chromic acid in the presence of a molecular proportion of dimethylaniline Methylene-blue is frequently sold in the form of its zincichloride,

$$2C_{16}H_{18}N_3SCl, ZnCl_2, H_2O$$



(I)



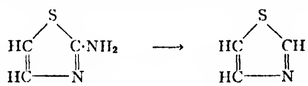
(II.)

A simpler member of the thiazine group is Lauth's violet (formula II), prepared from *p*-phenylenediamine by Caro's method of oxidation or from thiodiphenylamine by successive dinitration, reduction and oxidation (Bernthsen). The thiazine series of dyes also includes acidic colouring matters such as Brilliant Alizarin

Blue, prepared by condensing β-naphthaquinone-6-sulphonic acid with the thiosulphonic acid of a dialkyl-*p*-phenylenediamine For further information *see* the Colour Index of the Society of Dyers & Colourists (Edited by F. M Rowe, 1924).

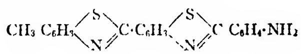
THIAZOLES, in organic chemistry, a series of compounds containing five-membered rings of one nitrogen, one sulphur and three carbon atoms The most prominent thiazole derivative is the dyestuff, primulin, discovered by A G Green in 1887, which dyes unmordanted cotton in yellow shades. The dyed fabric can be treated with nitrous acid, when the dye is diazotised (*see* DIAZO-COMPOUNDS) so that varying shades of red, brown and claret are produced on dipping the prepared material into solutions of developers (β-naphthol, resorcinol, α-naphthylamine, etc)

When thiourea and chloroacetaldehyde, or preferably dichloroether, $CH_2Cl\,CHCl\,O{\cdot}C_2H_5$, are condensed in aqueous solution, 2-aminothiazole (I) is formed and this pale yellow crystalline base (m p 90° C) on treatment with nitrous acid and alcohol

(I)  (II)

loses its amino-group for hydrogen giving rise to thiazole itself (II), which is a colourless liquid boiling at 117° C and smelling like pyridine (Traumann, 1888)

When *p*-toluidine and sulphur are heated at 200° C, a complex product known as "primulin base" is obtained which consists mainly of the following thiazole derivative



This product when sulphonated to render it soluble in water and converted into its sodium salt is primulin (*See* DYES, SYNTHETIC) (G T M)

THIBAUT (or THEOBALD) **IV.** (1201–1253), count of Champagne and Brie, and king of Navarre, French poet, was born at Troyes in 1201 His father, Thibaut III of Champagne died before his son's birth, and his mother, Blanche of Navarre was compelled to resign the guardianship of the young prince to Philip Augustus, king of France, but there is little doubt that the child was acquainted with Chrétien de Troyes and the other trouvères who found patronage at the court of Champagne Thibaut's verses belong to what is called "courteous" poetry, but they have a personal note that distinguishes them from mere exercises They are addressed to Blanche of Castille, the wife of Louis VIII, and Thibaut's relations with her have been the subject of much controversy The count took part with Louis in the crusade against the Albigenses, but in 1226, with no apparent reason, left the king and returned to Champagne Three months later Louis died under doubtful circumstances, and Thibaut was accused by his enemies of poisoning him

The real reason for Thibaut's desertion appears to have been a desire to consolidate his position as heir-apparent of Navarre by an alliance with the disaffected nobility of the south of France, but from this confederation Blanche was skilful enough to detach him The resentment of the league involved him in a war in which Champagne was laid waste, and his capital saved only by the royal intervention In 1234 he succeeded his uncle, Sancho VII, as king of Navarre, and from this period date his most fervent songs in praise of his lady The crusade turned Thibaut's thoughts to religion, and he announced his intention of singing henceforth only in honour of the Virgin Unfortunately his devotion took darker forms, for before sailing for the Holy Land he ordered and witnessed the burning of a hundred and eighty-three unfortunate men and women convicted of Manichaeism. The years 1239 and 1240 were spent in Palestine, and from the time of his return Thibaut devoted himself to efforts for the improvement of his dominions that won for him the title of *le Bon.* He died at Pampeluna on July 14, 1253

Thibaut was the most popular of all the 13th century song-writers, and his work is marked by a grace and sweetness which he owes perhaps in part to his association with the troubadours of the south. He is said to have set his own songs to music It seems doubtful whether the notes that have come down to us can with justice be attributed to him, but there is no contesting the musical quality of his verse His fame spread beyond the Alps, and Dante admired his poetry He was one of the most celebrated authors of *jeux-partis,* elaborate discussions between two interlocutors, usually on the subject of love

His works were edited in 1851 by P Tarbé in his *Chansonniers de Champagne.*

THIBAUT, ANTON FRIEDRICH JUSTUS (1774–1840), German jurist, was born at Hameln, in Hanover, on Jan 4, 1774, the son of an officer in the Hanoverian army He studied jurisprudence at Gottingen, Konigsberg and Kiel. Here in 1798 he was appointed extraordinary professor of civil law, and published his earlier works, including the important treatise (1799) *Theorie der logischen Auslegung des römischen Rechts* In 1802 Thibaut was called to Jena, where he wrote his chief work, *System des Pandektenrechts* (1803) This work is, in effect, a codification of the Roman law as it then obtained in Germany, modified by canon law and the practice of the courts into a comprehensive system of Pandect law In 1805 he went to Heidelberg, where he stayed till his death on March 29, 1840 His influence was great; and, except Gustav Hugo and Savigny, no civilian of his time was so well known. In 1814 appeared his *Civilistische Abhandlungen,* of which the principal was his famous essay advocating a national code for Germany This essay was inspired by the War of Liberation.

See Baumstark, *Thibaut, Blatter der Erinnerung* (1841), Karl Hagemann, *Aus dem Leben A F J Thibaut, mit Correspondenz,* in *die Preuss Jahrbucher* (1880), Teichmann, in *Holtzendorff's Rechtslexikon;* and E Landsberg, in *Allgemeine Deutsche Biographie,* vol 37.

THIBAW (now HSIPAW): *see* SHAN STATES

THIELMANN, JOHANN ADOLF, FREIHERR VON (1765–1824), Prussian cavalry soldier, was born at Dresden Entering the Saxon cavalry in 1782, he saw service against the French in the Revolutionary Wars and in the Jena campaign, and after Jena, at the siege of Danzig and at Friedland In 1809, as colonel of a Free-Corps, he opposed the advance of the Austrians into Saxony, and was promoted major-general, becoming lieutenant-general in 1810 As commander of the Saxon Heavy Cavalry Brigade he took part in the advance on Moscow (1812), and at Borodino attracted the attention of Napoleon, who took him into his own suite His own sovereign at the same time made him Freiherr In the war of Liberation Thielmann took a prominent part. When ordered to surrender the fortress of Torgan, of which he was governor, to the French, he resigned his command and joined the allies As a Russian general he reorganized the Saxon army after Leipzig, and in 1814 he commanded the Saxon corps operating in the Low Countries. Early in 1815 he became a lieutenant-general in the Prussian service, and in command of the 3rd army corps he took part in the Waterloo campaign, in which he fought the spirited action of Wavre (June 18–19) He was later a corps commander at Munster and at Coblenz, where he died in 1824

See von Petersdorf, *General Johann Adolf Freiherr von Thielmann* (Leipzig, 1894).

THIERRY, JACQUES NICOLAS AUGUSTIN (1795–1856), French historian, who was born at Blois on May 10, 1795 He was educated at the Blois Grammar School, and at the École normale supérieure. He embraced the ideas of the French Revolution with enthusiasm, and he became fired with Saint Simon's ideal society of the future. He became the secretary, and, as he would say himself, the "adopted son" of the famous visionary (1814–17); but, while most of Saint Simon's followers turned their attention to the affairs of life, devoting themselves to the problems, both theoretical and practical, of political economy, Thierry turned his to history. His imagination had been powerfully impressed by reading *Les Martyrs,* in which Châteaubriand had contrasted the two civilizations and the two races from which the modern world has sprung. His romantic ardour was later still further nourished by the works of

Sir Walter Scott, and though he did not himself actually write romances, his conception of history fully recognized the dramatic element. His main ideas on the Germanic invasions, the Norman Conquest, the formation of the communes, the gradual ascent of the nations towards free government and parliamentary institutions are already observable in the articles contributed by him to the *Censeur européen* (1817–20), and later in his *Lettres sur l'histoire de France* (1820). From Fauriel he learnt to use the original authorities, and by the aid of the Latin chronicles and the collection, as yet very ill understood, of the Anglo-Saxon laws, he composed his *Histoire de la Conquête de l'Angleterre par les Normands* (1825). This book, the preparation of which had required several years of hard work, cost Thierry his eyesight, in 1826 he was obliged to engage secretaries and in 1830 became quite blind Nevertheless he republished (1827) his *Lettres sur l'histoire de France,* with the addition of fifteen new ones, in which he described some of the more striking episodes in the history of the rise of the mediaeval communes

Thierry was ardent in his applause of the July Revolution and the triumph of liberal ideas He now re-edited, under the title of *Dix ans d'études historiques,* his first essays in the *Censeur européen* and the *Courrier français* (1834), and composed his *Récits des temps mérovingiens,* in which he reproduced in a vivid and dramatic form some of the most characteristic stories of Gregory of Tours These *Récits* appeared first in the *Revue des deux mondes;* when collected in volume form, they were preceded by long and interesting *Considérations sur l'histoire de France.* Thierry became a member of the Académie des Inscriptions et Belles Lettres, in 1841, on the motion of Villemain, the French Academy awarded him the first *Prix Gobert,* which became a kind of literary inheritance for him, being renewed in his favour fifteen years in succession. By the aid of zealous collaborators (including Bourquelot and Louandre) he compiled, in four volumes, a valuable *Recueil des monuments inédits de l'histoire du Tiers État* (1850–70), which, however, bear only on the northern part of France. He died in Paris on May 22, 1856

THIERS, LOUIS ADOLPHE (1797–1877), French statesman and historian, was born at Marseilles on April 16, 1797. He was educated, first at the lycée of Marseilles, and then in the faculty of law at Aix Here he began his lifelong friendship with Mignet, and was called to the bar. In 1821 Thiers went to Paris, and became a contributor to the *Constitutionnel.* Cotta, the well-known Stuttgart publisher, who was part-proprietor of the *Constitutionnel,* made over to Thiers a share of his dividends and he was thus relieved of any money anxiety.

Meanwhile Thiers became very well known in Liberal society, and he had begun the celebrated *Histoire de la révolution française* (10 vols, 1823–27), which founded his literary and helped his political fame. Coming as the book did just when the reaction against the revolution was about to turn into another reaction in its favour, it was assured of success In 1830 Thiers, with Armand Carrel, Mignet, and others started the *National,* a new opposition newspaper Thiers himself took a leading part in the actual revolution He ranked as one of the Radical supporters of the new dynasty At first Thiers, though elected deputy for Aix, obtained only subordinate places in the ministry of finance. After the overthrow of his patron Laffitte, he became much less radical, and, after the troubles of June 1832, was appointed to the ministry of the interior He repeatedly changed his portfolio, but remained in office for four years, became president of the council and in effect prime minister, and began his series of quarrels and jealousies with Guizot

At the time of his resignation in 1836 Thiers was foreign minister, and, as usual, wished for a spirited policy in Spain, which he could not carry out. He travelled in Italy for some time, and it was not till 1838 that he began a regular campaign of parliamentary opposition, which in March 1840 made him president of the council and foreign minister for the second time. But he held the position barely six months, and, being unable to force on the king an anti-English and anti-Turkish policy, resigned on Oct. 29 He now worked on his *Historie du Consulat et de l'Empire,* the first volume of which appeared in 1845. Though he was still a member of the chamber he spoke rarely, till after the beginning of 1846, when he was evidently bidding once more for power. When the revolution of February broke out he and Odilon Barrot were summoned by the king; but it was too late.

Under the republic he took up the position of conservative republican. The inconsistency of his conduct, especially in voting for Prince Louis Napoleon as president, was often and sharply criticized, one of the criticisms leading to a duel with a fellow-deputy, Bixio. He was arrested at the *coup d'état,* was sent to Mazas, and then escorted out of France. But in the following summer he was allowed to return. For the next decade his time was occupied for the most part on *The Consulate and the Empire.* It was not till 1863 that he re-entered political life, as deputy for a division of Paris. For the seven years following he was leader of the anti-Imperialists in the French chamber. While nominally protesting against its foreign enterprises, he perpetually harped on French loss of prestige, and so contributed more than any one to stir up the spirit which brought on the war of 1870

After the collapse of the empire Thiers visited in the autumn the different courts of Europe in the hope of obtaining some intervention, or at least some good offices. The mission failed; but the negotiator was immediately charged with another—that of obtaining, if possible, an armistice directly from Prince Bismarck Thiers was chosen deputy to the National Assembly by more than twenty constituencies (of which he preferred Paris), and was at once elected by the Assembly itself practically president, nominally *chef du pouvoir exécutif.* He lost no time in choosing a coalition cabinet, and then personally took up the hard task of negotiating peace. He succeeded in convincing the deputies that the peace was necessary, and it was (March 1, 1871) voted by more than five to one. Thiers held office for two years after the peace He had at first to meet and crush at once the Paris commune, and on Aug. 30 he became president of the republic.

His strong personal will and inflexible opinions had much to do with the resurrection of France, they also made it inevitable that he should excite violent opposition His talents and his temper made him utterly indisposed to maintain the attitude supposed to be incumbent on a republican president, and his tongue was never a carefully governed one. In January 1872 he formally tendered his resignation, and, though it was refused, almost all parties disliked him, while his chief supporters—men like Rémusat, Barthélemy Saint-Hilaire and Jules Simon—were men rather of the past than of the present In 1873 regulations were proposed, and on April 13, were carried, which were intended to restrict the executive and especially the parliamentary powers of the president The government was further weakened by a dissolution and reconstitution of the cabinet on May 19. Immediately afterwards the question was brought to a head by an interpellation moved by the duc de Broglie. The president declared that he should take this as a vote of want of confidence; a vote of this character (though on a different formal issue, and proposed by M. Ernoul) was carried by 16 votes in a house of 704. Thiers at once resigned (May 24). He died on Sept. 3, 1877.

His histories, in many different editions, and his speeches, as above, are easily accessible; his minor works and newspaper articles have not, we believe, been collected in any form Several years after his death appeared *Deux opuscules* (1891) and *Mélanges inédites* (1892), while *Notes et souvenirs,* 1870–73, were published in 1901 by "F. D.," his sister-in-law and constant companion, Mlle Félicie Dosne. Works on him, by M. Laya, M. de Mazade, his colleague and friend, M. Jules Simon, and others, are numerous. D Halévy, *Le Courrier de M. de Thiers* (1921), pp. 521; L. A. Thiers, *Thiers au pouvoir,* 1871–73 (1921), pp 357.

THIERS, a town of central France, capital of an arrondissement in the department of Puy-de-Dôme, 24 m. E.N.E. of Clermont-Ferrand, on the railway between that town and St. Étienne. Pop. (1926) 11,850. Thiers was sacked about 531 by the soldiers of Thierry, son of Clovis. About the same period Gregory of Tours speaks of a wooden chapel which may have occupied the site of the present church of Le Moutier. The streets rising in steep rows contain a number of 15th century houses. The church of St Genès was built in 575 by Avitus, bishop of Clermont, and rebuilt in the 12th century. It has some curious mosaic work of the Merovingian period and a fine tomb of the

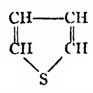
13th century. The church of Le Moutier, formerly part of a Benedictine monastery, dates chiefly from the 11th century. Thiers is the seat of a sub-prefect and has a tribunal of commerce, a chamber of commerce and a board of trade arbitrators Its special industry is the manufacture of cutlery.

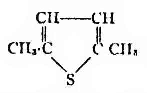
THIETMAR (DIETMAR or DITHMAR) OF MERSEBURG (975–1018), German chronicler, was a son of Siegfried, count of Walbeck, and was related to the family of the emperor Otto the Great. Born on July 25, 975, he was educated at Quedlinburg and at Magdeburg and became provost of Walbeck in 1002 and bishop of Merseburg seven years later. He took some part in the political events of the time, in 994 he was a hostage in the hands of the Northmen He died on Dec 1, 1018.

Thietmar wrote a *Chronicon* in eight books, which deals with the period between 908 and 1018. For the earlier part he used Widukind's *Res gestae Saxonicae*, the *Annales Quedlinburgenses* and other sources, the latter part is the result of personal knowledge. It has been edited by J M Lappenberg in Band III. of the *Monumenta Germaniae historica, Scriptores;* and by F. Kurze (Hanover, 1889); and has been translated into German by J. Laurent (new ed revised by W Wattenbach, Leipzig, 1892). *See* F Kurze, *Bischof Thietmar von Merseburg und seine Chronik* (Halle, 1890); and W. Wattenbach, *Deutschlands Geschichtsquellen*, Band II. (Berlin, 1904)

THIONVILLE, capital of the arrondissements of Thionville-Est and Thionville-Ouest in the department of Moselle, France, 22 m N from Metz by rail. Pop (1926), 11,974 Its German name is Diedenhofen It is an ancient Frank town (Theudonevilla, Totonisvilla), in which imperial diets were held in the 8th century, was captured by Condé in 1643 and fortified by Vauban, capitulated to the Prussians, after a severe bombardment, on Nov. 25, 1870, and was returned to France in 1918.

THIOPHEN, an organic sulphur compound present in small quantities in coal-tar benzene, from which it is separated only with considerable difficulty, owing to the close similarity of the physical and chemical properties of the two substances Thiophen is a colourless liquid with the odour of benzene, the former boils at 84° C, the latter at 80 5° C. Both readily undergo bromination, nitration and sulphonation Coal-tar toluene is similarly accompanied by small amounts of α- and β-methylthiophens (thiotolens) and the xylenes contain traces of dimethylthiophens (thioxens) In each case the sulphur compound simulates closely the boiling point and other properties of the hydrocarbon Hence in their relationship to the coal-tar hydrocarbons, thiophen and its homologues constitute a remarkable case of chemical "protective mimicry"

(I.) 

 (II.)

Thiophen (formula I) was first recognised in coal-tar benzene and isolated therefrom by V. Meyer (1883), who availed himself of the fact that thiophen is more readily sulphonated than benzene at the ordinary temperature Benzene containing thiophen was shaken with cold, concentrated sulphuric acid, the impure thiophensulphonic acid converted into lead salt and the latter distilled with ammonium chloride Impure thiophen was thus obtained and the process was repeated until the product after rectification was pure An alternative isolation due to O. Dimroth (1899) consists in boiling the benzene–thiophen mixture with mercuric acetate; a mercury derivative of thiophen which separates is decomposed by hydrochloric acid, regenerating pure thiophen

Thiophen is obtainable (1) by passing ethyl sulphide through a red hot tube, or (2) by heating succinic anhydride, succindialdehyde or metallic succinates with sulphides of phosphorus It is readily recognized by the intense blue coloration developed when a trace of thiophen or coal-tar benzene is added to isatin in concentrated sulphuric acid (the indophenin reaction).

The 1.4-diketones react in their dienolic forms on heating with phosphorus pentasulphide and yield homologues of thiophen 2:5-dimethylthiophen (formula II) is thus obtained from acetonylacetone, $CH_3{\cdot}C(OH){:}CH{\cdot}CH{:}C(OH){\cdot}CH_3$. *See* V. Meyer, *Der Thiophengruppe*, 1888.

THIRD DEGREE, originally an American slang or cant term, but now in common use in the United States and coming into such use in Great Britain, to designate the employment of brutal methods by police or prosecuting authorities to extort information or confessions from persons in custody. The phrase is believed to have been suggested by the third masonic degree, that of master mason, which is conferred with considerable ceremony

The phrase as often employed includes not only the use of physical violence, but also such forms of torture as depriving a prisoner of food, drink, sleep and toilet facilities and the prolonged and uninterrupted interrogation of him when exhausted, suffering and broken down by such deprivations. It is more commonly applied however to those forms of physical assault (such as beating with a rubber hose) which produce pain but leave no traces.

Since admissions and confessions of guilt have great probative weight when made voluntarily, it is obvious that unscrupulous officials interested in procuring convictions may be tempted to force unwilling confessions by improper means, and falsely to represent such confessions as voluntary In several of the United States, assertions that such methods are used to extort confessions or to elicit information have for some time been so common as seriously to disturb the courts Similar charges have in a few cases been made recently in the course of criminal trials in England

It is impossible to state to what extent the practices described prevail, as obviously there is no way in which the truth of an assertion that they have been employed can be determined with certainty since those charged with employing them invariably make denial and the facts are known only to the participants But those who are in close touch with the administration of the criminal law in many of the larger American cities do know that juries frequently render verdicts of acquittal in cases where alleged confessions, claimed by defendants to have been evoked by the use of force, have been received in evidence, which verdicts are explicable on no other theory than that the jury regarded the circumstances with suspicion and wholly rejected the alleged confession on that ground (C A P.)

THIRD (COMMUNIST) INTERNATIONAL: *see* INTERNATIONAL, THE

THIRD PARTY INSURANCE: *see* INSURANCE, MISCELLANEOUS

THIRD PARTY PROCEDURE: *see* PRACTICE AND PROCEDURE.

THIRLWALL, CONNOP (1797–1875), English bishop and historian, was born at Stepney, London, on Jan 11, 1797 He was educated at Charterhouse and at Trinity college, Cambridge In October 1818 he was elected to a fellowship, and went for a year's travel on the Continent On his return he settled down to study law, but without much zeal, and in 1827 he definitely abandoned law, and was ordained deacon At Rome in 1819 he had fallen in with Bunsen, and since that time had been interested in German literature He now joined with Hare in translating Niebuhr's *History of Rome* (1828) On Hare's departure from Cambridge in 1832, Thirlwall became assistant college tutor and was involved in the controversy upon the admission of Dissenters which arose in 1834 Thirlwall, in replying to objections by Thomas Turton, pointed out that no provision for theological instruction was in fact made by the colleges except compulsory attendance at chapel, and that this was mischievous After this outburst he had to resign his position as assistant-tutor Nevertheless he received from Lord Brougham the living of Kirby-under-Dale in Yorkshire Then he began his *History of Greece* (1835–44), which has remained a standard work

In 1840 Thirlwall was raised by Lord Melbourne to the see of St David's The great monument of his episcopate is the eleven famous charges in which he from time to time reviewed the position of the English Church with reference to pressing questions of the day—addresses at once judicial and statesmanlike, full of charitable wisdom and massive sense Thirlwall was one of the four prelates who refused to inhibit Bishop Colenso from preaching in their dioceses, and the only one who withheld his signature from the addresses calling upon Colenso to resign his see He took the liberal side in the questions of Maynooth,

of the admission of Jews to parliament, of the Gorham case, and of the educational conscience clause He was the only bishop who voted for the disestablishment of the Irish Church.

During his latter years Thirlwall took great interest in the revision of the Authorized Version of the Bible, and was chairman of the revisers of the Old Testament. He resigned his see in May 1874, and retired to Bath, where he died on July 27, 1875. He lies in Westminster Abbey in the same grave as Grote.

Thirlwall's *History of Greece* (new ed 1845–52) remains a standard book. *See* his *Remains, Literary and Theological,* ed J. J. S Perowne in three volumes (1877–80), two of which are occupied by his charges, *Letters, Literary and Theological,* with a connecting memoir, ed J J S Perowne and L Stokes (1881), and *Letters to a Friend* (Miss Johnes of Dolaucothy), ed Dean Stanley (1881). They were originally published by Dean Stanley, and there is a revised and corrected edition For a general view of Thirlwall's life and character, *see* the *Edinburgh Review,* vol cxlii.; for a picture of him in his diocese, *Temple Bar,* vol lxxvi.

THIRSK, a town and parish in the North Riding of Yorkshire, England, 22 m. N.W. by N. of York, on the L N.E. railway, on the Cod Beck, a tributary of the river Swale on the edge of the Vale of York The district is known as the Vale of Mowbray. Pop. (1921) 2,755 Thirsk is first mentioned as a borough in a charter granted by Roger de Mowbray to Newburgh priory in the reign of Henry II. The Perpendicular church of St Mary with its 80 ft tower, is one of the most beautiful churches in the Riding.

THIRST: *see* Hunger and Thirst

THIRTY YEARS' WAR (1618–1648), the general name of a series of wars in Germany which began formally with the claim of Frederick, the elector palatine, to the throne of Bohemia and ended with the treaty of Westphalia It was primarily a religious war and was waged with the bitterness characteristic of such wars, but at the same time political quarrels were interwoven with the religious question: with the consequence that the armies, considering themselves as their masters' retainers rather than champions of a cause, plundered and burned everywhere, military violence being in no way restrained by expediency.

Formation of the "Union" and the "League."—Fifty years before the outbreak of the war the Convention of Passau had compromised the burning questions of the Reformation, but had left other equally important points as to the secularization of church lands and the consecration of Protestant bishops to the future Each such case, then, came before the normal government machine—a Diet so constituted that even though at least half of the secular princes and nine-tenths of their subjects were Protestants, the voting majority was Catholic Moreover, the Jesuits had rallied and disciplined the forces of Catholicism, while Protestantism, however firm its hold on the peoples, had dissipated itself in doctrinal wrangles. The strongest side was that which represented conservatism, peace and Catholicism Realizing this from the preliminary mutterings of the storm, the Protestant princes formed a "Union," which was promptly answered by the Catholic League. This group was headed by the wise and able Maximilian of Bavaria and supported by his army, which he placed under a soldier of long experience and conspicuous ability, Count Tilly

The Bohemian Movement.—The war arose in Bohemia, where the Protestant magnates refused to elect Ferdinand of Austria to the vacant throne, offering it instead to Frederick, the elector palatine. But the aggrandizement of this elector's power was entirely unacceptable to most of the Protestant princes—to John George of Saxony above all. They declared themselves neutral, and Frederick found himself an isolated rebel against the Emperor Ferdinand.

Even thus early the struggle showed itself in the double aspect of a religious and a political war. Just as the Bohemians and their nominee found themselves looked upon askance by the other Protestants, so the emperor himself was unable to call upon Maximilian's Army of the League without promising to aggrandize Bavaria. Only the incoherence of the rebels saved Ferdinand. They ordered taxes and levies of soldiers, but the taxes were not collected, and the soldiers, unpaid and unfed, plundered the country-side The only coherent force was the mercenary corps of Ernst von Mansfeld, which, thrown out of employment by the termination of a war in Italy, had entered the service of Frederick. Nevertheless, the Bohemians were conspicuously successful at the outset: they won several engagements, and appeared before Vienna itself Moravia and Silesia supported the Bohemians, and the Austrian nobles attempted, in a stormy conference, to wrest from Ferdinand not only religious liberty but also political rights that would have made Austria and Bohemia a loose confederation of powerful nobles Ferdinand firmly refused, though the deputation threatened him to his face, and the tide ebbed as rapidly as it had flowed No sooner had Frederick accepted the crown than Maximilian let loose the Army of the League. Spanish aid arrived Spinola with 20,000 men from the Low Countries and Franche Comté invaded the Palatinate, and Tilly, with a combined army of Austrians and Bavarians crushed the Bohemians at the battle of the Weisser Berg near Prague (Nov 8–18, 1620) With this the Bohemian war ended Some of the nobles were executed, and Frederick, the "Winter King," was put to the ban of the empire. But the emperor's revenge alarmed the Union princes They were Protestants, and neither in religion nor in politics could they suffer an all-powerful Catholic emperor Moreover, the alternative to a powerful emperor was a powerful Bavaria, and this they liked almost as little

Predatory Armies.—There still remained for the army of Tilly the reduction of the smaller garrisons in Bohemia, which when finally expelled rallied under Mansfeld, the last general of a lost cause Then there began the wolf-strategy that was the distinguishing mark of the Thirty Years' War An army even of ruffians could be controlled, as Tilly controlled that of the League, if it were paid But Mansfeld, the servant of a shadow king, could not pay. Therefore "he must of necessity plunder where he was His movements would be governed neither by political nor by military considerations. As soon as his men had eaten up one part of the country they must go on to another." These movements were for preference made upon hostile territory, and Mansfeld was so far successful in them that the situation in 1621 became distinctly unfavourable to the emperor. Tilly and the League Army fought warily and did not risk a decision Thus even the proffered English mediation in the German war might have been accepted but for the fact that in the Lower Palatinate a corps of English volunteers, raised by Sir Horace Vere for the service of the English princess Elizabeth, the fair queen of Bohemia, found itself compelled, for want of pay and rations, to live, as Mansfeld lived, on the country along the Rhine. This brought about a fresh intervention of Spinola's Spaniards who had been destined to the interminable Dutch war Moreover Mansfeld, having thoroughly eaten up the Palatinate, decamped into Alsace, where he seized Hagenau and wintered in safety

The winter of 1621–22 passed in a series of negotiations which failed because too many interests, inside and outside Germany, were bound up with Protestantism to allow the Catholics to speak as conquerors, and because the cause of Protestantism was too much involved with the cause of the elector palatine to be taken in hand with energy by all Protestant princes. But Frederick and Mansfeld found two allies One was Christian of Brunswick, the gallant young knight-errant, titular bishop of Halberstadt, queen Elizabeth's champion, and withal, though he called himself *Gottes Freund, der Pfaffen Feind,* a plunderer of peasants as well as of priests The other was the margrave George Frederick of Baden-Durlach, reputed to be of all German princes the most skilful sequestrator of ecclesiastical lands In April 1622, while Vere garrisoned the central fortresses of the Palatinate, Mansfeld, Christian and George Frederick took the field against Tilly, who at once demanded assistance from Spinola. The latter, though engaged with the Dutch, sent a corps under his subordinate Cordova. Mansfeld and the margrave of Baden defeated Tilly at Wiesloch (April 17–27, 1622). But soon the allies had to separate to find food. Then Cordova came up, and Tilly and the Spaniards combined defeated George Frederick at Wimpfen on the Neckar (April 26–May 6). Cordova chased Mansfeld back into Alsace, while Tilly went north to oppose Christian of Brunswick on the

Main. On June 10–20 the latter's army was almost destroyed by the League Army at Höchst. Mansfeld, and with him Frederick, had already set out from Alsace to join Christian, but when that leader arrived with only a handful of beaten men, the war was practically at an end Frederick took Mansfeld and Christian back to Alsace, and after dismissing their troops, retired to Sedan. Henceforth he was a picturesque but powerless exile, and his lands and his electoral dignity, forfeited by the ban, went to the prudent Maximilian, who was created by the Emperor elector of Bavaria.

Mansfeld and Christian of Brunswick.—The next act in the drama, however, had already begun with the adventures of the outlaw army of Mansfeld and Christian. After Höchst, had it not been for them, the war might have ended in compromise. James I of England was busy as always with mediation schemes. Spain, being then in close connection with him, and the Protestant princes of North Germany being neutral, a diplomatic struggle over the fate of the Palatinate might have ended in a new convention of Passau that would have regulated the present troubles and left the future to settle its own problems. The struggle would only have been deferred, it is true, but meanwhile the North German Protestants remained powerless and inactive, while Tilly's army was kept in hand to deal with the adventurers.

These, after eating up Alsace, moved on to Lorraine, whereupon the French Government "warned them off." But ere long they found a new employment. The Dutch were losing ground before Spinola, who was besieging Bergen-op-Zoom, and the States-General invited Mansfeld to relieve it. The adventurers moved straight across Luxemburg and the Spanish Netherlands to the rescue Cordova barred the route at Fleurus near the Sambre, but the desperate invaders, held together by the sheer force of character of their leaders, thrust him out of their way (Aug. 19–29, 1622) and relieved Bergen-op-Zoom. But ere long, finding Dutch discipline intolerable, they marched off to the rich country of East Friesland

Their presence raised fresh anxieties for the neutral princes of North Germany In 1623 Mansfeld issued from his Frisian stronghold, and the threat of a visitation from his army induced many princes of the Lower Saxon Circle to join him Christian was himself a member of the Circle, and although he resigned his bishopric, he was taken, with many of his men, into the service of his brother, the duke of Brunswick-Wolfenbuttel Around the mercenary nucleus gathered many thousands of volunteers, for the towns and the nobles' castles alike were alarmed at the progress of the Catholics, who were reclaiming Protestant bishoprics But this movement was nipped in the bud by the misconduct of the mercenaries The authorities of the Circle ordered Christian to depart. He returned to Holland, therefore, but Tilly started in pursuit and caught him at Stadtlohn, where on July 28–Aug. 6, 1623 his army was almost destroyed Thereupon the Lower Saxon Circle, which, like the Bohemians, had ordered collectively taxes and levies of troops that the members individually furnished either not at all or unwillingly, disbanded their army to prevent brigandage. Mansfeld, too, having eaten up East Friesland, returned to Holland in 1624.

Foreign Intervention.—The only material factor was now Tilly's ever-victorious Army of the League, but for the present it was suspended inactive in the midst of a spider's web of European and German diplomacy. Spain and England had quarrelled. The latter became the ally of France, over whose policy Richelieu now ruled, and the United Provinces and (later) Denmark joined them. Thus the war was extended beyond the borders of the empire, and the way opened for ceaseless foreign interventions. From the battle of Stadtlohn to the pitiful end 20 years later, the decision of German quarrels lay in the hands of foreign powers. France was concerned chiefly with Spain, whose military possessions all along her frontier suggested that a new Austrasia, more powerful than Charles the Bold's, might arise James, in concert with France, re-equipped Mansfeld and allowed him to raise an army in England, but Richelieu was unwilling to allow Mansfeld's men to traverse France, and they ultimately went to the Low Countries, where, being raw pressed-men for the most part, and having neither pay (James having been afraid to summon parliament) nor experience in plundering, they perished in the winter of 1625 At the same time a Huguenot rising paralysed Richelieu's foreign policy. Holland after the collapse of Mansfeld's expedition was anxious for her own safety owing to the steady advance of Spinola. The only member of the alliance who intervened in Germany itself was Christian IV. of Denmark, who as duke of Holstein was a member of the Lower Saxon Circle, and as king of Denmark was anxious to extend his influence over the North sea ports. Gustavus Adolphus of Sweden, judging better than any the difficulties of affronting the empire and Spain, contented himself with carrying on a war with Poland

Intervention of Christian of Denmark.—Christian IV. raised an army in his own lands and in the Lower Saxon Circle in the spring of 1625. Tilly at once advanced to meet him. But he had only the Army of the League, the Emperor's troops being occupied in a war on Gabriel Bethlen of Transylvania. Then, like a *deus ex machina*, Wallenstein, duke of Friedland, came forward and offered to raise and maintain an army in the emperor's service. It was an army like Mansfeld's in that it lived on the country, but its exactions were systematic and the products economically used, so that it was possible to feed 50,000 men instead of 20,000. This method, the high wages which he paid, and his own princely habits and commanding personality gave it a cohesion that neither a free company nor an army of mere Lower Saxon contingents could ever hope to attain.

In 1625, Wallenstein kept his new army well away from the risks of battle until he could trust it to conquer It was fortunate for Ferdinand that he did so. Christian IV, who had been joined by Mansfeld and Christian of Brunswick, had, in 1626, 60,000 men. Wallenstein and Tilly together had only a very slight numerical superiority, and behind them was nothing Even the hereditary provinces of Austria were threatening revolt and Gabriel Bethlen was again giving trouble. But on the other side the English subsidies failed, and the Protestant armies soon began to suffer in consequence. Tilly opposed Christian IV, Wallenstein, Mansfeld The latter advanced upon Wallenstein, attacked him in an entrenched position at the Bridge of Dessau and was thoroughly defeated (April 15–25, 1626). He then wandered across Germany into Silesia and joined Bethlen. Wallenstein followed up, and by taking up strong positions, compelled Mansfeld and Bethlen to choose between attacking him and starving So, without a battle, he brought about a truce, whereby Bethlen was disarmed and Mansfeld was required to leave Hungary Mansfeld and Christian of Brunswick died soon afterwards, the one in Hungary, the other in Westphalia. King Christian, left alone and unable without English subsidies to carry on the war methodically, took the offensive, as Mansfeld had done, in order to live on the Thuringian countryside. But Tilly, with whom Wallenstein had left a part of his army, moved as quickly as the king, brought him to action at Lutter-am-Barenberge in Brunswick and totally defeated him (Aug 17–27)

With this, armed opposition to Tilly and Wallenstein in the field practically ceased, but their armies continued to live on the country. Christian of Denmark slowly gave up fortress after fortress to Tilly. Wallenstein, returning from the campaign against Gabriel Bethlen, drove Christian's army through Jutland and into the sea (1627). But Wallenstein, with his dreams of a united Germany free in conscience and absolutely obedient to the emperor, drifted farther and farther away from the League Ferdinand thought that he could fulfil the secular portion of Wallenstein's policy while giving satisfaction to the Catholics. The princes and bishops of the League continued to oppose any aggrandizement of the emperor's power at their expense and to insist upon the resumption of church lands. In this equilibrium the North German Protestant cities were strong enough to refuse to admit Wallenstein's garrisons. In 1628 Wallenstein, who had received the duchy of Mecklenburg on its rightful lord being put to the ban for his share in the Danish war, began to occupy his new towns, and also to spread along the coasts But the Hanse towns rejected his overtures, and Stralsund, second-rate seaport though it was, absolutely refused to admit a garrison of his wild soldiery The result was the famous siege of Stralsund (Feb. to Aug. 1628), in which the

citizens compelled the hitherto unconquered Wallenstein army to retire. The siege was, as the result proved, a turning-point in German history. The emperor's policy of restoring order had practically universal support. But the instrument of the restoration was a plundering army. Even this might have been borne had Wallenstein been able to give Germany, as he wished, not only peace but religious freedom. When the Edict of Restitution (1629) gave back 150 northern ecclesiastical foundations to the Catholics, men were convinced that one ruler meant one religion.

Gustavus Adolphus of Sweden.—Rather than endure this the North Germans called in Gustavus Adolphus of Sweden and, just as Gustavus landed, the resentment of the princes of the League against Wallenstein's policy and Wallenstein's soldiers came to a head, and the emperor was forced to dismiss him. His soldiers were taken over by Tilly, and for the moment he disappeared from the scene On Gustavus's side, a thoroughly trained army, recruited from good yeomen and stout soldiers of fortune, paid good wages, and led by a great captain, was a novelty in war that more than compensated for Tilly's numerical superiority. Gustavus, however, after landing at Peenemunde in June, spent the rest of the year in establishing himself firmly in Mecklenburg and Pomerania, in order to secure the active support of the more important Protestant princes, so as to appear as an auxiliary rather than a principal in the German conflict First the old duke Bogislav of Pomerania, then George William of Brandenburg joined him, very unwillingly He was soon afterwards allied with France, by the treaty of Bärwalde (Jan 1631) John George of Saxony, still attempting to stifle the war by a policy of neutrality, sent a last appeal to Vienna, praying for the revocation of the Edict of Restitution. Meanwhile Tilly had marched into north-eastern Germany, where his lieutenant Pappenheim was besieging Magdeburg. This city had twice defied Wallenstein's attempts to introduce a garrison, and it was now in arms against the League Gustavus, as yet without active allies, thought it impossible to go forward alone, and could only hope that his sudden and brilliant storm (April 3–13) of Frankfurt-on-Oder would distract Tilly from the siege.

Sack of Magdeburg.—But the hope was vain and when, realizing this, he moved directly to Magdeburg's relief, his passage through the territories of the Electors of Brandenburg and Saxony was delayed by the objections of the Protestant princes While he was negotiating with them in turn, Magdeburg, although the citizens fought desperately, was stormed, sacked and burned on the night of May 10, 1631, amidst horrors that neither of the imperialist generals was able to check. The Catholics rejoiced as though for another St. Bartholomew's day, the Protestants were paralysed, and Gustavus, accused on all hands of having allowed the Magdeburgers to perish, sorrowfully withdrew into Pomerania But Tilly, in spite of Pappenheim's remonstrances, turned westward against Hesse-Cassel and other minor principalities whose rulers had declared for Gustavus. The king of Sweden, thereupon, advanced to Werben (at the junction of the Elbe and the Havel), where his army entrenched itself, and, in spite of sickness and famine, stoically awaited the attack The desired result was achieved At the end of July Tilly, returning from the west, made his appearance and was twice repulsed (July 13–23 and 18–28), losing 6,000 men out of 22,000 Thereupon, turning away from Gustavus's entrenchments, Tilly invaded Saxony, being reinforced *en route* by 20,000 men from Italy The elector John George at once made an alliance with the Swedes.

Battle of Breitenfeld.—Then Gustavus advanced in earnest. He crossed the Elbe at Wittenberg. 16,000 Saxons joined his 26,000 Swedes at Duben, and some of the western Germans had already come in. Tilly had just captured Leipzig, and outside that place, carried away by Pappenheim's enthusiasm, he gave battle on Sept. 7–17 to the now superior allies. The first battle of Breitenfeld (*q.v.*) was a triumphant success for Gustavus and for the new Swedish system of war Though the raw Saxons were routed at the outset by Tilly's men, the Swedes on the other wing drove the veterans of the League off the field in disorder, leaving 6,000 dead. Tilly himself was thrice wounded and barely escaped

All Protestant Germany hailed Gustavus as the liberator. John George, the Swedish general Horn and the Swedish chancellor Oxenstierna united in advising Gustavus to march straight upon Vienna. Richelieu was of the same mind. But Gustavus deliberately chose to move into South Germany, there to organize the cities and the princes in a new and stronger Protestant Union, the *Corpus Evangelicorum*, and to place himself in a country full of resources whence he could strike out against the emperor, Tilly and the Rhine Spaniards in turn. The Swedish army pushed on to Mainz, where it wintered in luxury. The Palatinate was reorganized under Swedish officials and the reformed religion established again. In March 1632 the campaign was resumed. Nuremberg and Donauwörth welcomed Gustavus. Tilly's army, reorganized for the defence of Bavaria, stood to fight on the Lech, but the passage was forced (April 4–14) and Tilly himself was mortally wounded Augsburg, Munich and all the country south of the Danube were occupied without resistance. At the same time John George's Saxons, advancing into Bohemia, entered Prague without firing a shot.

Wallenstein Returns.—The emperor had now either to submit or to reinstate Wallenstein Wallenstein demanded as the price of his services the reversal of the Edict, and power to dethrone every prince who adhered to the Swedes His terms were accepted, and in April 1632 he took the field as the emperor's *alter ego* with a new army that his recruiters had gathered in a few weeks He soon expelled the Saxons from Bohemia and offered John George amnesty and the rescinding of the Edict as the basis of peace. The elector, bound by his alliance with Gustavus, informed the Swedish king of this offer, and a series of negotiations began between the three leaders But John George had too much in common with each to follow either Wallenstein or Gustavus unreservedly, and the war recommenced. The Swedish king had now to meet Wallenstein's new army of 60,000, composed of the men immortalized by Schiller's play, excellent in war and in plundering, destitute of all home and national ties, and owning allegiance to its general alone While Gustavus in Franconia was endeavouring with little success to consolidate his *Corpus Evangelicorum* Wallenstein came upon the scene Gustavus offered him battle But as in 1625 Wallenstein would risk no battle until his army had gained confidence. He entrenched himself near Furth, while Gustavus camped his army about Nuremberg and a contest of endurance ensued Wallenstein, aided by his superiority in irregular cavalry, was able to starve for three days longer than the king, and at last Gustavus furiously attacked the entrenchments (battle of the Alte Veste, Aug. 24–Sept. 3, 1632) and was repulsed with heavy losses Thereupon he retired, endeavouring in vain to tempt Wallenstein out of his stronghold by making his retreat openly and within striking distance of the imperialists. Wallenstein had other views than simple military success. Instead of following Gustavus he marched into Saxony, his army plundering and burning even more thoroughly than usual in order to force the Saxons into peace. Gustavus followed with the swiftness that was peculiar to the Swedish system, and concentrated at Erfurt when Wallenstein had scarcely mastered Leipzig But it was now late in the season, and Wallenstein hoped to spin out the few remaining weeks of the campaign in an entrenched position. Gustavus, without waiting for Arnim's Saxons to join him, suddenly moved forward, and on Nov. 6–16 the battle of Lutzen (*q v*) was fought, a battle as fierce even as Breitenfeld. Gustavus was slain, but Wallenstein's army was driven from the field.

The League of Heilbronn.—The fall of Gustavus practically determined the intervention of France, for Richelieu supported all electors, Catholic or Protestant, against the central power at Vienna as part of his anti-Spanish policy, and French assistance was now indispensable to the Protestants. For although Lützen was a victory and the Protestant circles formed the League of Heilbronn in April 1633, the emperor was really in the ascendant. John George of Saxony needed but little inducement to make peace. But the tragedy of Lützen was soon to be followed by the tragedy of Eger. Wallenstein, gradually forming the resolve of forcing peace on Germany with his army, relaxed his pressure on Saxony, and flung himself upon the Swedish garrisons in Silesia.

Winning a victory at Steinau (Oct. 11, 1633) and capturing one town after another, he penetrated almost to the Baltic. But he was recalled to the south-west before his operations had had any effect. The Swedish army, now under Bernhard of Saxe-Weimar, Horn and Banér, had returned to the South, and took Regensburg from Maximilian's army. But it was now late in the year and Wallenstein was intent upon peace. With this object he endeavoured to secure the higher officers of the army, but these were gradually won over by Spanish emissaries; the emperor, having decided to continue the war in alliance with Spain, dismissed his general for the second time. Wallenstein then openly attempted to unite the Swedish, Saxon and other Protestant armies with his own, so as to compel all parties to make peace. But his officers would not follow, the *coup d'état* failed, and Wallenstein was murdered at Eger by his own lieutenants, with the full sanction of the Emperor (Feb 15–25, 1634).

All idea of German unity died with him, and for the next 14 years Germany was simply the battle-ground of French, Spanish, Austrian and Swedish armies, which, having learned the impunity and advantages of plunder in the school of Mansfeld and Wallenstein, reduced the country to a state of misery that no historian has been able to describe, save by detailing the horrors of one or other village among the thousands that were ruined Germany remained for a century in the stillness of exhaustion

Battle of Nordlingen.—Success was for the present with the emperor and Spain Under the leadership nominally of the king of Hungary, Ferdinand's heir, but really of Gallas, the army recaptured Regensburg and Donauworth, and when the Spanish Cardinal Infante joined them with 15,000 men on his way from Italy to the Netherlands, they were invincible. Bernhard of Weimar and the Swedes attacked them in an entrenched position at Nordlingen (Aug 27/Sept. 6, 1634) and was beaten with absolutely ruinous loss. The model army of Gustavus perished there, and for the rest of the war a Swedish army, except for some advantages of organization and technical form, was intrinsically no better than another John George, having obtained from Ferdinand a compromise on the question of the Edict, agreed to the peace of Prague (May 20–30, 1635), wherein all that was Protestant in 1627 was to remain so, or if since resumed by the Roman Church to be returned to the Lutherans. A certain number of princes followed John George's example on the same terms. There was now no ideal, no objective, common even to two or three parties. Gustavus's *Corpus Evangelicorum* as a German institution was moribund since Nordlingen, and Richelieu and the Spaniards stepped forward as the protagonists

The Policy of Richelieu.—The centre of gravity was now the Rhine valley, the highroad between Spanish Italy and the Spanish Netherlands. Richelieu had, as the price of his assistance after Nördlingen, taken over the Alsatian fortresses held by the Swedes, and in May, just before the treaty of Prague was signed, he declared war on Spain. The French army numbered 130,000 men in 1635, and 200,000 in the year after. One army assembled in Upper Alsace for the attack of the Spaniards in Franche Comté; another occupied Lorraine, which had been conquered in 1633; a corps under Henri de Rohan was despatched from the same quarter across Switzerland, to expel the enemy from the Valtelline, Another force, co-operating with the duke of Savoy, was to attack the Milanese. Bernhard was to operate in the Rhine and Main country. Having thus arranged to isolate the Spanish Netherlands, Richelieu sent his main army, about 30,000 strong, thither to join Frederick Henry of Orange and so to crush the Cardinal Infante. This was strategy on a scale hitherto unknown in the war. Richelieu had unified France under the single authority of the king, and his strategy, like his policy, was masterful and clear. But the event proved that his scheme was too comprehensive. Richelieu proposed to strike at each of the two halves of his enemy's power at the same time as he separated them. His forces were not sufficient for these tasks and he was therefore compelled to eke them out, both in Italy and the Netherlands, by working with allies whose interests were not his. Popular outbreaks among the Brabanters and Flemings led Frederick Henry to withdraw to his own country, and in 1636 the French northern army had to face the whole of the Cardinal Infante's forces. In Italy the Franco-Piedmontese army achieved practically nothing In Alsace and Lorraine neither side was strong enough to prevail Bernhard waged a desultory campaign in Germany, and later, when supplies gave out he and his army were taken into the French service In eastern Germany the consequences of the peace of Prague were that Saxony, Brandenburg and other States, signatories to the treaty, were *ipso facto* the enemies of those who continued the war. Thus John George turned his arms against the Swedes in his neighbourhood But their commander Banér was as superior in generalship as he was inferior in numbers, and held the field until a truce between Sweden and Poland set free a fresh Swedish corps that had been held ready for eventualities in that country. This corps, under Torstensson, joined Banér in October, and on Nov. 1 they won an action at Domitz on the Elbe

Thus Richelieu's great scheme was only very partially executed The only important military events of the year took place outside Germany, within Germany men were chiefly occupied in considering whether to accept the terms of the peace of Prague But the land had no rest, for the armies were not disbanded. In 1636 the movements foreshadowed in 1635 were carried out with energy. John George, aided by an imperialist army, threatened to interpose between Banér and the Baltic. But Banér was too quick for them. Before the Brandenburg contingent could join John George, he brought on a general action at Wittstock (Sept 24–Oct 4, 1636) The elector had 30,000 men against 22,000 and sought to attack both in front and rear But while his entrenchments defied the frontal attack Banér threw most of his army upon the enveloping force and crushed it. The Swedes lost 5,000 killed and wounded, the combined army 11,000 killed and wounded and 8,000 prisoners The prestige of so brilliant a victory repaired even Nordlingen, and many North German princes who were about to make peace took fresh heart

Invasion of France.—In the west, though there were no such battles as Wittstock, the campaign of 1636 was one of the most remarkable of the whole war The Cardinal Infante was not only relieved by the retreat of the Dutch, but also reinforced by a fresh army[1] under a famous cavalry officer, Johann von Weert He prepared, therefore, to invade France from the north-west The French were too much scattered to offer an effective resistance, and the Cardinal Infante's generals took Corbie, passed the Somme and advanced on Compiègne For a moment Paris was terror-stricken, but the Cardinal Infante missed his opportunity. Louis XIII and Richelieu turned the Parisians from panic to enthusiasm The burghers armed and drilled, money, too, was willingly given, and some 12,000 volunteers went to Compiègne, where all levies and reinforcements were concentrated Thus the army at Compiègne was soon 50,000 strong. It was only half mobile owing to its rawness and its "trained-band" character, but the Spaniards and Bavarians retired unmolested to oppose Frederick Henry in the Low Countries

During the episode before Compiègne another storm burst on the eastern frontier of France. This was the inroad into Burgundy of Gallas with the main imperialist army He took a few small towns, but Dijon and the entrenchments of Bernhard's army there defied him, and his offensive dwindled down to an attempt, soon abandoned, to establish his army in winter quarters in Burgundy.

War in Italy.—In Italy the duke of Savoy with his own army and a French corps under Créqui advanced to the Ticino, and an action in which both sides lost several thousand men was fought at Tornavento, a few miles from the future battlefield of Magenta, to which in its details this affair bears a singular resemblance (June 22, 1636). But the victory of the French was nullified by the refusal of Victor Amadeus, for political reasons, to advance on Milan.

The campaign of 1637, on the French and Spanish side, was not productive of any marked advantage to either party. From Catalonia a Spanish army invaded Languedoc, but was brought to a standstill in front of the rocky fortress of Leucate and defeated with heavy losses by the French relieving army under Schom-

[1] Composed partly of Bavarians, partly of Cologne troops.

berg On the Low Countries frontier the cardinal de La Valette captured Câteau Cambrésis, Landrecies and Maubeuge.

War on the Rhine.—On the Rhine and in the adjacent countries Johann von Weert, returning from Belgium with his Bavarians, captured Ehrenbreitstein, the citadel of Coblenz, and expelled small French detachments from the electorate of Trier, whose ruler, the archbishop, had been put to the ban by the emperor. Then, passing into the Main valley, he took Hanau. The main imperialist army, still under Gallas, had departed from Alsace to the east in order to repair the disaster of Wittstock, and Charles of Lorraine was defeated by Bernhard on the Saône in June, after which Bernhard advanced vigorously against Piccolomini, the imperialist commander in Alsace. But soon Piccolomini was joined by Johann von Weert, and Bernhard retired again

In the north-east the effect of Wittstock proved but transient In 1638 Banér found himself the target of several opponents The Saxons did no more than defend their own country, but the imperialists and Bavarians uniting under Gen. Geleen manoeuvred Banér out of his strongholds on the Elbe He retreated on the Oder, but there found, not the expected assistance of Wrangel's Pomeranian army, but Gallas with the main imperial army which had hurried over from the west Banér escaped only by a stratagem Deluding Gallas with an appearance of retreat into Poland, he slipped northwards, joined Wrangel, and established himself for a time in Pomerania Gallas ruined his army by exposing it to an open winter in this desolate country, and at last retired to the Elbe

Fighting in the Netherlands and Alsace.—In 1638 the French operations in Italy, Belgium and Spain were in the main unsuccessful. In Italy the Spanish advanced to the Sesia and took Vercelli In the Low Countries Prince Thomas and Piccolomini repulsed in turn the Dutch and the French In the south the Prince of Condé led from Bayonne an invading army that was to dictate terms at Madrid, but failed ignominiously before the small frontier fortress of Fontarabia But the case was different in Alsace There Richelieu was more than ever determined to strike at the Spanish power, and there too was Bernhard, who hoped that Alsace was to be his future principality, with the survivors of Breitenfeld and Nordlingen, now in French pay under the name of the "Weimar Army" Bernhard had wintered about Basle, and began operations by taking a few towns in the Black Forest. Johann von Weert, however, fell upon him by surprise and drove him away (Feb 28). But Bernhard reassembled his adventurers and invited them to return and beat the imperialists at once The outcome was the battle of Rheinfelden, in which the redoubtable Weert, who had terrified Paris in 1636, was taken prisoner and his army dissipated (March 3) Bernhard later invested Breisach and received its surrender when the garrison had eaten the cats, dogs and rats in the place, on Dec. 17.

In the course of 1638 peace negotiations were carried on at Cologne and Hamburg, but the war still dragged on In the east, 1639 began with Banér's pursuit of the retreating Gallas Thanks to his skill the Swedish star was again in the ascendant Banér crossed the Elbe, inflicted a severe defeat on the imperialists at Chemnitz (April 14, 1638), and then after overrunning western Saxony advanced into Bohemia But he contented himself, after an unsuccessful attempt upon Prague, with thoroughly eating up the country and, as winter came on, he retired into the Saxon mountains.

France and Spain.—In 1639, as before, Richelieu's attacks on Spain, other than those directed upon Alsace and Baden, were unsuccessful In the north the French devoted this year, as they had devoted 1637 and 1638, to a methodical conquest of walled towns in view of a future *frontière de fer*. The two objectives selected, Hesdin and Thionville, were far apart, and Piccolomini, by a forced march from Liège and Huy through the Ardennes, flung himself upon the besiegers of Thionville before their "circumvallation" was completed, and being greatly superior in numbers he almost annihilated them (June 7, 1639). But on the Flemish flank Hesdin was driven to surrender On the side of the Pyrenees Condé as usual showed himself both unlucky and incapable In Italy Cardinal de La Valette died after allowing Prince Thomas to win over Savoy to the emperor's side and seeing almost every French post lost.

His successor was the duc d'Harcourt, called by his men "Cadet-la-Perle" on account of his earrings, but a bold and exceedingly competent soldier. Under him served Turenne, hitherto known only as a younger brother of the duke of Bouillon Harcourt successfully revictualled Casale, and beat the Savoyards and Imperialists in the Route de Quiers (Nov 29).

In Alsace Bernhard was carried off by a fever just as he was preparing to fight his way to a junction with Banér. Nevertheless he was fortunate in the opportunity of his death, for his dream of a duchy of Alsace had already brought him into conflict with Richelieu, and their conflict could only have ended in one way Another event of importance in this year was the episode of the Spanish fleet in the Downs. Now that the land route was imperilled the sea communications of Spain and Belgium were brought into use. A squadron sailed from Spain for the Netherlands, and, though it evaded the now powerful French navy, it was driven into English territorial waters by the Dutch. Charles I of England offered France free access to the victim if France would restore the Elector Palatine, offered Spain protection if she would furnish him with funds for his army. But the Dutch, contemptuous of his neutrality, sailed in and destroyed the fleet at anchor

In 1640 the French still kept up their four wars in Belgium, Germany, Italy and Spain But the Belgian and Spanish frontiers were no longer directly attacked The Catalans turned their arms against the old enemy Castile and Portugal declared herself independent under a king of the house of Braganza In the Low Countries Louis XIII himself presided over the siege of the important fortress of Arras, which surrendered on Aug 8

Casale and Turin.—In Italy, however, Cadet-la-Perle kept the moral ascendancy he had won in the brave action of the *Route de Quiers* In April with 10,000 men he advanced from Carignan against the 20,000 Spaniards who were besieging Casale and attacked their line of circumvallation boldly and openly on April 29. Half of Leganez's army was killed or captured After this, Harcourt promptly turned upon Prince Thomas, and then followed one of the most curious episodes in military history Thomas, himself defending Turin, was besieging the French who still held the citadel, while Harcourt, at once besieging the town and attempting to relieve the citadel, had, externally, to protect himself against Leganez's army which was reorganized and reinforced from Naples and the Papal States. Harcourt's courage and the disunion of his opponents settled the problem Their general attack of July 11 on the French lines was made not simultaneously but successively, and Harcourt repulsed each in turn with heavy losses Soon afterwards the French received fresh troops· the citadel was relieved and the town surrendered Leganez retired to Milan.

In Germany Banér's course was temporarily checked and when at last Bernhard's old army, under the duc de Longueville, crossed the Rhine and joined Banér in Thuringia, the country could not support the combined army The Weimar army retired to the Rhine valley and Banér to Waldeck. A fresh opportunity came to Banér in the winter months of 1640–41. Negotiations for peace were constantly in progress, but no result seemed to come out of them. The Diet was assembled at Regensburg. Banér suddenly moved south to surprise the Diet, for the defence of which all available troops were hurried up by the emperor The Weimar army under Guébriant joined the Swedes *en route*, and the combined army reached the objective. But a thaw hindered them and gave the emperor time to concentrate his forces, and the raid failed. On May 20 Banér, worn out by fatigue, died, and Torstensson succeeded to the command The war had now receded far from Alsace, which was firmly held by France, but Harcourt's continued success in Piedmont and the trouble to Spain caused by the Catalan and Portuguese insurrection was partly balanced by France's own difficulties in the abortive conspiracy against Richelieu.

In Dec 1641 there began at Münster and Osnabrück in Westphalia the peace negotiations which, after eight more years of spasmodic fighting, were to close this ruinous war. In 1642 Tors-

tensson crossed the Elbe and besieged Leipzig. The imperialist army, which was joined by the Saxons when their country was again the theatre of war, marched to the rescue. But Torstensson defeated them with enormous loss in the second battle of Breitenfeld (Nov. 2, 1642) But, although the Austrians feared an advance on Vienna itself, the victors waited for the fall of Leipzig and then took up winter quarters The Bavarians had advanced into the lower Rhine region in order to support, in concert with the Belgian army of Spain, a fresh outbreak in France (Cinq-Mars' conspiracy). But the Spanish were attacked and defeated before the Bavarians came up, at Hulst (Jan. 17), whereupon the Bavarians took shelter under the guns of the fortress of Jülich.

On the northern frontier of France, Harcourt, the brilliant commander of the Italian army, failed to prevent the Spaniards from capturing Lens and La Bassée, and another army was defeated and routed at Honnecourt (May 26) The Spaniards in the Milanese lost fresh ground. Louis XIII. himself conquered Roussillon Richelieu crushed the conspiracy of Cinq-Mars by executing its leaders, and Marshal de la Motte-Houdencourt held Catalonia and defeated Leganez at Lerida (Oct 7th).

The Duc d'Enghien.—Before the next campaign opened, Louis and Richelieu were dead One of the last acts of the king was to designate the young duc d'Enghien, son of the incapable Condé, general of his northern army It was no small matter to put in command a youth of 21, who might prove not merely inexperienced but also incompetent. But Enghien's victory was destined to be the beginning for the French army of a long hegemony of military Europe Melo, the Spanish general, had selected the Meuse route for his advance on Paris On it he would meet only the places of Rocroi and Rethel The young duke learned at the same moment that Louis XIII was dead and that the Spaniards had invested Rocroi With the resolution and swiftness which was to mark his whole career, he marched at once to offer them battle, though all the generals of the old school were for delay The battle took place on May 19, 1643, in a plain before Rocroi Melo's cavalry was routed, and nearly all the infantry, the best regiments in the Spanish army, stood their ground and were annihilated

But even Rocroi, under the existing conditions of warfare, was decisive only in so far as by the destruction of Spain's superiority in Belgium, it saved France from further danger from the north. The thorough establishment of the French on the Rhine and the need of co-operating with the Swedes were considered by the young general to be more important than fighting Melo in front of Brussels, and in spite of the protests of the Regent and Mazarin, he decided to attack Thionville Taking a leaf out of Melo's book, he threatened Brussels in order to draw all the defenders thither, and then suddenly turned eastward Enghien arrived on June 18, and on Aug 8, Thionville surrendered

Beyond the Rhine Guébriant was mortally wounded in the siege of Rottweil, and Rantzau, taking over the command, allowed himself to be surprised in the act of dispersing into winter-quarters, and was defeated at Tuttlingen on the headwaters of the Danube (Nov. 24).

In the East the campaign had as usual turned more upon subsistence than upon military operations. Torstensson swept through Bohemia and Moravia, his steps dogged through the devastated country by Gallas, until he reached Brünn. Thence, however, he suddenly retreated to the shores of the Baltic. For Christian of Denmark had declared war on Sweden, and threatened to isolate the Swedish forces in Germany Torstensson, therefore, wintered in Holstein. In Italy and Spain there was no event of any importance

In 1644 Gaston of Orleans began the conquest of the Dunkirk region in July, and Melo, having no army to oppose him, remained inactive. In Italy there happened nothing serious, while in Spain La Motte-Houdencourt lost Lerida, and was imprisoned by Mazarin in consequence. But the Rhine campaign is memorable for the first appearance of Turenne at the head of an army and for the terrible battle of Freiburg

Freiburg.—In Suabia Mercy's Bavarians were left to oppose Turenne, who spent the first months of the year in restoring discipline and confidence in the shaken Weimar army. But Mercy was still considerably superior in strength, and, repulsing Turenne's first inroad into the Black Forest, besieged Freiburg Turenne made one cautious attempt at relief, then waited for reinforcements These came in the shape of Enghien's army, and Enghien as a prince of the blood took over the supreme command But both armies together numbered hardly 17,000 men when Enghien and Turenne united at Breisach on Aug. 2. On the 3rd they crossed the Rhine and attacked Mercy's position, which was of great natural and artificial strength, in front and flank Three separate battles, which cost the Bavarians one-third of their force and the French no less than half of theirs, ended in Mercy's retreat (*see* FREIBURG) on Aug. 10 Enghien did not follow him into the mountains, but proceeded to the methodical conquest of the middle Rhine fortresses, leaving Turenne and the Weimar army at Spire

In the east, or rather in the north, a desultory campaign was carried on during 1644 between Torstensson and the younger Wrangel, on the one side, the Danes and Gallas on the other, and in the end Gallas retreated to Austrian territory, so completely demoralized that his army dwindled on the way from 20,000 men to 2,000. Torstensson followed him, having little to fear from the Danes. Meanwhile the prince of Transylvania, George Rakóczy, playing the part of Gabriel Bethlen his predecessor, made war upon the emperor, who not being able on that account to send fresh troops against Torstensson called for help to Maximilian of Bavaria. The Elector sent most of his own troops under Weert on the same errand—hence Mercy's defeat at Freiburg But Torstensson pressed on towards Vienna, and on Feb 24–March 6, 1645 he inflicted a crushing defeat on the Bavarians and Imperialists at Jankau near Tabor In his extremity Ferdinand offered part of Bohemia and Silesia to Maximilian in return for soldiers. But the Bavarian ruler had no more soldiers to give, for Turenne was advancing again from the Rhine

At the end of March the Weimar army marched to Heilbronn, and Rothenburg-on-Tauber, when Turenne resolved to go northward in search of supplies and recruits in the territories of his ally and cousin the landgravine of Hesse-Cassel But at this point the army, headed by Bernhard's old colonels, demanded to be put into rest-quarters, and Turenne allowing them to disperse as they wished, was surprised by Mercy and Weert—who brought his courage, if nothing else, back from the field of Jankau—and lost two-thirds of his forces. But Turenne, instead of retreating to the Rhine, installed himself in the landgravine's country, while Enghien hurried up from the Moselle to his aid The "Army of Weimar" and the "Army of France" joined forces, as in 1644, almost under the eyes of the enemy Enghien at once pushed forward from Ladenburg, by Heidelberg and Dinkelsbuhl, and found the Austro-Bavarians under Mercy entrenched in a strong position at Allerheim near Nordlingen, directly barring the way to the Danube The second battle of Nördlingen (Aug 3, 1645) was as desperately fought as the first, and had not Mercy been killed at the crisis of the day Enghien would probably have been disastrously defeated As it was, the young duke was victorious, but he had only 1,500 infantry left in rank and file out of 7,000 at the end. Soon afterwards Enghien fell ill, and his army returned to France. Turenne, left with a few thousand men, attempted in vain to hold his ground in Germany and had to make a hasty retreat to Philippsburg on the Rhine, almost the only remaining conquest of these two brilliant but costly campaigns In Flanders Gaston of Orleans conquered a number of fortresses, and his army united with that of the Dutch But the allies separated again almost at once, each to undertake the sieges which suited its own purposes best.

From Silesia Wrangel, who had succeeded Torstensson, passed into Bohemia, where he remained until the forces employed against Rakóczy and Turenne could send help to the imperialists opposed to him. He then drew away into Hesse, the Archduke Leopold and the Bavarians following suit

Turenne's Strategy.—The campaign of 1646 in Hesse up to August was as usual uneventful, each army being chiefly concerned

with its food. But at last the archduke retired a little, leaving Turenne and Wrangel free to join their forces. Turenne had no intention of repeating the experiences of Freiburg and Nordlingen. It was more profitable to attain the small objects that were sought by manoeuvre than by battle, and the choice of means practically lay between manoeuvring the enemy's army into poor districts and so breaking it up by starvation, and pushing one's own army into rich districts regardless of the enemy's army. The usual practice was the first method. Turenne chose the second.

Delayed at the opening of the year by orders from Mazarin—Turenne found it impossible to reach Hesse by the short and direct route, and he therefore made a rapid and secret march down the Rhine as far as Wesel, whence, crossing unopposed, he joined Wrangel on the upper Lahn (Aug 10) The united armies were only 19,000 strong But the imperialists, fearing to be hemmed in and starved between Turenne and the Rhine, fell back to Fulda, leaving the Munich road clear The interior of Bavaria had not been fought over for 11 years, and was thus almost the only prosperous land in desolated Germany. Turenne and Wrangel marched straight forward on a broad front, and for the rest of the year they devastated the country about Munich in order to force Maximilian to make terms An armistice was concluded in the winter, Maximilian having been finally brought to consent by an ill-judged attempt of the emperor to seduce his army. The French and Swedes wintered in southern Württemberg

In Flanders, Gaston of Orleans and Enghien took Dunkirk and other fortresses In Italy, where the Tuscan fortresses were attacked, the French were completely checked at first, until Mazarin sent a fresh corps thither and restored the balance In Catalonia Harcourt underwent a serious reverse in front of Lerida at the hands of his old opponent Leganez, and Mazarin sent Enghien, now prince of Condé, to replace him

1647 was a barren year In the Low Countries the war dissipated itself in sieges. In Italy Plessis-Praslin won an unprofitable victory over the viceroy of the Milanese on the Oglio (July 4). In Spain Condé, resuming the siege of Lerida, was repulsed and had to retire. In Germany Turenne and Wrangel parted company The latter returned to Hesse, whence he raided into Bohemia, but was driven back by the imperialists As the few obtainable supply areas gave out one by one, the Swedes gradually retired almost to the coast, but the imperialists did not follow, swerving into Hesse instead. Turenne meanwhile had had to send all his French troops to Luxemburg to help in the defence of northern France against the Spaniards The Weimar army had refused to follow him to the Meuse, and mutinied for its arrears of pay. Turenne, however, promptly seized the ringleaders and after a sharp fight disarmed the rest. Thus ignominiously Bernhard's old army vanished from the scene.

In the autumn the elector of Bavaria was reconciled to the emperor and his army re-entered the field. Turenne was therefore sent back to Germany to assist the Swedes. But winter came on before any further inroads could be made into south Germany.

The campaign of 1648 brought the decision at last. Turenne and Wrangel, having refitted their forces and united in Hesse as in 1646, steadily drove back the imperialists and Bavarians, whose 30,000 combatants were accompanied by a horde of nearly 130,000 hangers-on—men, women and children—to the Danube At Zusmarshausen (May 17) catching the enemy in the act of manoeuvring, they destroyed his rear-guard The victors advanced as far as the Inn, but Piccolomini, reorganizing the débris of the Austro-Bavarian army, checked their further progress and even drove them back to the line of the Isar. Meantime, however, the Swedish general Königsmarck, had entered Bohemia and was besieging Prague. This caused the recall of Piccolomini's army, and Turenne and Wrangel invested Munich But Mazarin ordered the French to retire into Suabia so as not to compromise the peace negotiations at the critical moment, and Wrangel followed suit. Before Königsmarck was in a position to assault Prague news came of peace Meanwhile in Artois Condé had repulsed the Spanish invasion by his brilliant victory of Lens (Aug. 5), which was a second Rocroi After the thanksgiving service for the victory at Nôtre Dame, Mazarin arrested the leaders of the *parlement* of Paris, and in a few hours the streets were barricaded and a civil war was in progress. This was the Fronde (*q.v.*), which went on for another 11 years.

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THISTLE, a name, as generally employed, of vague application, being given to almost any herbaceous plant that is of a spiny character. More strictly, it is applied to the species of *Carduus,* herbs belonging to the family Compositae, with very spiny leaves, and similar bracts surrounding a head of purplish-white, tubular, five-parted flowers seated on a pitted and hairy receptacle. The fruit is surmounted by a tuft of silky-white hairs. The species, chiefly natives of Europe and western Asia, are numerous, and some are of great beauty, though, not unnaturally, looked on with disfavour by the farmer The blessed thistle is *Carduus benedictus;* lady's thistle, the leaves of which are spotted with white, is *C marianus.* The common *C lanceolatus* seems to be the most suitable prototype for the Scots thistle, though that honour is also conferred on an allied plant *Onopordon Acanthium,* the cotton thistle, remarkable for its covering of white down, a doubtful native of Great Britain, and on other species The carline thistle is *Carlina vulgaris,* a member of the same family as is also the sowthistle, *Sonchus oleraceus* The great objection to thistles from an agricultural point of view resides in the freedom with which they produce seed, and in the vigour of their underground growth, which makes their uprooting a matter of difficulty. The artichoke (*q v*) and cardoon (*q v*) are very near allies of the thistles. The safflower, *Carthamus,* another thistle, yields a serviceable dye, the burdock, *Arctium lappa,* a member of the same family, has an edible root, and numerous allied species have medicinal properties. (*See* Canada Thistle)

THISTLEWOOD, ARTHUR (1770–1820), the principal instigator of the Cato Street conspiracy, a plot formed to murder the British cabinet in 1820. A son of William Thistlewood, and born at Tupholme in Lincolnshire, young Thistlewood became a soldier and visited France and America He developed republican sympathies and on taking up his residence in London joined the Spencean Society, a revolutionary body, associated himself with James Watson (d. 1838) and other agitators, and in December 1816 helped to arrange a meeting in Spa Fields, London, which was to be followed by the seizure of the Tower of London and the Bank of England, and by a general revolution. The proposed rising failed, but the Habeas Corpus Act was suspended and Thistlewood and Watson were tried but acquitted. Thistlewood continued his intrigues and was sentenced to a year's imprisonment for challenging the home secretary, Lord Sidmouth, to a duel. After his release in May 1819, having broken away from Henry Hunt and the more moderate reformers, he prepared a new and comprehensive plot. On Feb. 23, 1820, at a time of great distress and during the unrest caused by the death of George III, the cabinet ministers had arranged to dine at the earl of Harrowby's house in Grosvenor Square. With some associates Thistlewood hired a room in the neighbouring Cato Street, collected arms and made ready to fall upon Harrowby's guests. The authorities had been informed of the plot, probably by one of the conspirators named George Edwards; officers appeared upon the scene and arrested some of the conspirators; and although Thistlewood escaped in the confusion he was seized on the following day. Tried for high treason, Thistlewood and four others were sentenced to death, and were hanged on May 1, 1820

See Sir S. Walpole, *History of England* (1890), vol. i.

THÖKÖLY, IMRE (Emerich), Prince (1657–1705), Hungarian statesman, was born at Késmark on the 25th of September 1657. He lost both parents while still a child. In 1670, fleeing from the dangers of Upper Hungary, where the Protestants and Imperialists were constantly in arms against each other, he took

refuge with his kinsman Michael Teleki, the chief minister of Michael Apafy, prince of Transylvania. Here he came into contact with the Magyar refugees, who had great hopes of the high-born, high-gifted youth who was also a fellow sufferer, a large portion of his immense estates having been confiscated by the emperor. The discontent reached its height when Leopold (Feb. 27, 1673) suspended the Hungarian constitution, appointed Johan Gaspar Ampringen dictator, deprived 450 Protestant clergy of their livings and condemned 67 more to the galleys. Encouraged by promises of help from Louis XIV, the Magyars now rose *pro libertate et justitia,* and chose the youthful Thököly as their leader The war began in 1679. Upper Hungary and the mining towns were soon in Thököly's possession In 1681, reinforced by 10,000 Transylvanians and a Turkish army under the pasha of Nagy-várad, he compelled the emperor to grant an armistice. Thököly's distrust of the emperor induced him to turn for help to the sultan. In the same year Thököly captured fortress after fortress from the emperor and extended his dominions to the Waag He refused the title of king offered to him by the Turks. He was buried at Nicomedia but in 1906 his relics were transferred to Hungary

See *Correspondence of Thököly* (Hung), ed by Kálmán Thaly (Budapest, 1896); V. Fraknói, *Papst Innocenz XI und Ungarn's Befreiung von der Turkenherrschaft* (Freiburg, 1902); *Memoirs of Emeric Count Teckely* (London, 1693), *Correspondence of Michael Teleki* (Hung), ed. by S Gergely (Budapest, 1905–06).

THOLOS, in Greek architecture, a circular building, with or without a peristyle, the earliest examples are the beehive tombs at Mycenae and in other parts of Greece, which were covered by domes built in horizontal courses of masonry. The Tholos at Epidaurus, built by Polycleitus (*c.* 400 B.C.), and the Tholos at Olympia, known as the Philippeion, are the most remarkable examples, and in both cases were covered with a sloping roof and not with a dome.

THOLUCK, FRIEDRICH AUGUST GOTTREU (1799–1877), German Protestant divine, was born at Breslau, on March 30, 1799 He studied at Breslau and at Berlin, where he was received into the house of the Orientalist Heinrich Friedrich von Diez (1750–1817) He came under the influence of the pietist Baron Ernst von Kottwitz (1757–1843), who became his "spiritual father," and of the historian Neander. In 1821 he was *Privatdozent* and in 1823 became professor extraordinarius of theology in Berlin. *Die wahre Weihe des Zweiflers* (1823; 9th ed, with the title *Die Lehre von der Sunde und dem Versohner,* 1870), the outcome of his own religious history, secured his commanding position as the Pietistic apologist of Evangelical Christianity In 1825, with the aid of the Prussian government, he visited the libraries of England and Holland, and on his return was appointed (in 1826) professor ordinarius of theology at Halle, the centre of German rationalism, where he afterwards became preacher and member of the supreme consistorial council. Here he sought to combine in a higher unity the learning and to some extent the rationalism of J. S Semler with the devout and active pietism of A. H. Francke, and, in spite of the opposition of the theological faculty of the university, he succeeded in changing the character of its theology. Tholuck was also one of the prominent members of the Evangelical Alliance, and few men were more widely known or more beloved throughout the Protestant world than he. As a preacher he ranked among the foremost of his time. He died at Halle on June 10, 1877.

After his commentaries (on Romans, the Gospel of John, the Sermon on the Mount and the Epistle to the Hebrews) and several volumes of sermons, his best-known books are *Stunden christlicher Andacht* (1839; 8th ed, 1870), intended to take the place of J H. D. Zschokke's standard rationalistic work with the same title, and his reply to David Strauss's *Life of Jesus* (*Glaubwurdigkeit der evangelischen Geschichte,* 1837). He published at various times valuable contributions towards a history of rationalism—*Vorgeschichte des Rationalismus* (1853–62), *Geschichte des Rationalismus* (1865), i. and a number of essays connected with the history of theology and especially of apologetics. His views on inspiration were indicated in his work *Die Propheten und ihre Weissagungen* (1860), in his essay on the "Alte Inspirationslehre," in *Deutsche Zeitschrift für christliche Wissenschaft* (1850), and in his *Gespräche über die vornehmsten Glaubensfragen der Zeit* (1846; 2nd ed., 1867).

See *Das Leben Tholucks,* by L. Witte (2 vols, 1884–86).

THOMAR, now Tomar, on the river Nabão, a tributary of the Zezere, 4 m from Paialvo railway station, which is 80 m N.E. of Lisbon by the main line to Oporto Pop (1911), 8,054. Thomar contains examples of the best Portuguese architecture from the 12th century to the 17th The ruined castle of the Knights Templar, given to that order in 1159, is said to occupy the site of the ancient Nabantia On the suppression of the Templars, King Dinis of Portugal founded the Order of Christ in 1314 The convent palace of the Knights of Christ includes a church and cloister dating from the 12th century, two cloisters and a chapter-house added in the 15th century by Prince Henry the Navigator and a very fine 16th century church built in the Manueline style by João de Castilho Other interesting buildings are the churches of Santa Maria do Olival, rebuilt in the Gothic style in 1450 on the site of an older Templar foundation; São João Baptista, also Gothic, built in 1490, but with Manueline additions; Nossa Senhora da Conceição, Renaissance of 1579; and the ruined palace of Prince Henry the Navigator, restored in the 16th century by Queen Catherine, widow of John III.

THOMAS, ST., one of the twelve apostles The name means "twin" in Aramaic, as is recognised in John xi 16 ("called Didymus"). Eusebius (*H E.* iii 1, 1) says Thomas was the evangelist of "Parthia," probably because Edessa (*q v*), where some of his bones were preserved, is sometimes called "Edessa of the Parthians" These bones were reputed to have been brought to Edessa from India, and a work known as the *Acts of Thomas* relates his missionary labours and martyrdom there. This work was originally composed in Syriac; it is indeed one of the oldest and most idiomatic monuments of Syriac literature, though it is very doubtful whether it is based on any historical facts In the 4th century it was translated into Greek, and thence into Latin, almost certainly as part of the Manichaean propaganda. The Manichaean taint was soon recognised (*e g*, by Augustine) and the *Acta Thomae* in their original form branded as heretical The view taken was that the framework, recounting the journeyings of the apostle, was historical, while the speeches and sermons contained the heresy In consequence most mss, both Greek and Latin, contain very little of the speeches while retaining the framework Even Wright's Syriac ms has been occasionally conventionalized, and the original form is only to be found in the ancient (4th or 5th century) palimpsest fragments at Sinai

The *Acts of Thomas* is a leading authority for the earliest Christianity in the countries east of the Euphrates: it was ascetic, marriage being discountenanced and all preoccupation with the things of this world discouraged In the Acts Eucharistic prayers are given, but (according to the Sinai fragments and the best Greek) only bread and water were used The Lord's Prayer is quoted in full A curious feature is that the name of the apostle is given as Judas Thomas, and it is expressly set forth that he was the twin of Jesus Christ As a tale the *Acts of Thomas* is remarkable for the real religious emotion that pervades it and for careful delineation of character. but above all for the hymn chanted by the apostle when in prison This, commonly known as the "Hymn of the Soul" (Wright, pp 238–245), is a metrical Syriac poem describing, under the parabolic form of the journey of a prince from his Eastern home to Egypt, the descent to earth and the return to its heavenly home of the soul It is often supposed to be an independent composition inserted into the *Acts,* but for this there is no real evidence In any case it is the great gem of Syriac literature

"Christians of St. Thomas" is a name often applied to the ancient Christian churches of southern India; the view taken of their history is so intimately connected with the historicity of the *Acts of Thomas* that it is convenient to treat of them here According to the tradition, St. Thomas founded the Christian churches in Malabar (south-west coast), and then crossed to Mylapur, now a suburb of Madras, where the shrine of his martyrdom, rebuilt by the Portuguese in 1547, still stands on Mt. St. Thomas, where a cross is shown with a Pahlavi inscription which may be as old as the 7th century. We know from Cosmas Indicopleustes that there were Christians of Persian (East Syrian) origin, and doubtless of Nestorian creed, in Ceylon, in Malabar,

and at Caliana (north of Bombay) before 550 In 1400 they sent to the Nestorian patriarch Simeon, who gave them fresh bishops (Assemani, *Bib Or* iii 1,590-f, *J. Theol. Stud.* xxix 155) Hard pressed by the Muslims they welcomed the Portuguese and, after much controversy, a formal union with Rome was carried through in the Synod of Diamper (1599) Syriac was to remain the ecclesiastical language, but the service books were "purified from error."

Dom R H Connolly proved in 1914 that this revision was slight in extent, and that the Malabar liturgy remained essentially a form of the Nestorian rite After a century and a half of Jesuit rule a great schism took place in 1653, those who thus became independent of Rome organizing themselves under Jacobite (Monophysite) influence (The ms of the whole Syriac Bible and the Clementine literature [12th century] then sent to Malabar from Mesopotamia was brought to Europe by Claudius Buchanan [1811] and is now in the Cambridge university library) Both this Church and the Roman obedience still flourish in Malabar.

From what has been said, the ancient Christian communities of southern India would be naturally regarded as a surviving branch of the extensive Nestorian missions, parallel to those which once flourished in Turkestan and China. But the Christians in India have come to regard St. Thomas as their founder and appeal to the *Acts of Thomas*, or documents derived from that work, in support It may be remarked that their whole knowledge of this work seems to be derived from the Latin form of the *Acta Thomae* It is claimed that the *Acta* are historical, and further, that the scene of the *Acts* is laid in southern India. Unfortunately for this view, the details in the *Acts* which point to any acquaintance with India at all are connected with the northwest and the country between India and Mesopotamia. The Indian King Gundaphar of the *Acts* is certainly meant for the historical Gondophares, whose dynasty was Parthian, though his realm included regions loosely reckoned to India. But the use of such names does not prove historicity; the name Ahasuerus does not establish the historicity of the book of Esther Moreover the greater part of the names in the *Acts of Thomas* are Mesopotamian, *e g*, the heroine, Mygdonia, is named after the river on which Nisibis stands In any case there is nothing in these Acts about caste or other prominent features of Indian life. The real value of the *Acts of Thomas*, as indicated above, is to illustrate the ideas and aspirations of the Christianity, not of India but of upper Mesopotamia, in the 3rd century A D

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THOMAS, surnamed MAGISTER (*i e.*, officiorum)[1], also known as a monk by the name Theodulos Monachos, a native of Thessalonica, Byzantine scholar and grammarian and confidential adviser of Andronicus II (1282–1328) His chief work, Ἐκλογὴ Ὀνομάτων καὶ Ῥημάτων Ἀττικῶν, is a collection of selected Attic words and phrases, partly arranged in alphabetical order, compiled as a help to Greek composition from the works of Phrynichus, Ammonius, Herodian and Moeris. He also wrote scholia on Aeschylus, Sophocles, Euripides (with life), and three of the comedies of Aristophanes, the scholia on Pindar, attributed to him in two mss, are now assigned to Demetrius Triclinius. His speeches and letters deal with contemporary events.

Editions of the Ἐκλογή by F. Ritschl (1832), C. Jacobitz (1833) and C. D. Beck (1836); other works in J P Migne, *Patrologia graeca*, cxlv., *see* also C. Krumbacher, *Geschichte der byzantinischen Literatur* (1897).

[1]For the duties of this important office, *see* J. B. Bury (*Later Roman Empire*) (1889), i. 45.

THOMAS (d. 1100), archbishop of York, a native of Bayeux, is usually called Thomas of Bayeux. His father was a priest named Osbert, and Samson, bishop of Worcester (1086–1112), was his brother Owing largely to the generosity of Odo, bishop of Bayeux, Thomas studied in France, Germany and Spain and then became one of Bishop Odo's officials and after 1066 one of William the Conqueror's chaplains, or secretaries. In 1070 he succeeded Aldred as archbishop of York, but declining to promise obedience to the archbishop of Canterbury, Lanfranc refused to consecrate him King William, however, induced him to submit and he was consecrated, but his profession of obedience was to Lanfranc personally and not to the archbishops of Canterbury.

In 1071 both archbishops travelled to Rome for their palls and while there Thomas wished Pope Alexander II. to decree the equality of the sees of Canterbury and York. The pope, however, referred the dispute to a council of English prelates which met at Windsor at Whitsuntide in 1072 It was then decided that the archbishop of Canterbury was the superior of the archbishop of York, who had no rights south of Humber, but whose province included Scotland This decision did not end the dispute which broke out again in 1092 and 1093 when Thomas protested against what he thought infringements of his archiepiscopal rights The first of these occasions was over the dedication of the cathedral built by Remigius at Lincoln and the second was over the consecration of St Anselm to the archbishopric of Canterbury. He died at York on Nov. 18, 1100.

THOMAS, ALBERT (1878–), French statesman, was born on June 16, 1878, at Champigny-sur-Marne, near Paris His father was a baker who by great sacrifices enabled his son to receive a college and university education Scholarships enabled him to travel in Russia and Germany A sequel to this was his book *Le syndicalisme allemand* (1903) in which his socialist faith was propounded for the first time.

When, in 1904, Jean Jaurès launched *l'Humanité* he appointed Thomas assistant editor Thomas played an important part as a right-wing leader in the General Confederation of Labour (C G.T) He published in 1908 a volume on the Second Empire in Jaurès' great *Histoire socialiste*

He was elected to the Chamber for his native city in May 1910 and again in 1914, becoming one of the most active and prominent Socialist members

He joined his regiment in 1914 After he had seen a few weeks of war service, the Government summoned Thomas and two other Socialists, Jules Guesde and Marcel Sembat, to organize the production of munitions In May 1915 he entered the cabinet as under-secretary for armaments and also joined the Briand Ministry which followed at the end of the year Towards the end of 1916 he became minister of munitions, retaining this post in the Ribot Ministry which followed. In April 1917 he was sent to Russia, where he remained for several months and succeeded in persuading Kerensky to undertake the ineffectual "great offensive" against the Central Powers

Meanwhile in France the struggle was becoming very bitter between the majority (pro-war) and the minority (internationalist) sections of the French Socialist party, culminating in the Stockholm Conference Leader, with Renaudel and Sembat, of the majority party, Albert Thomas was also a strong advocate of the independence of Czechoslovakia and Poland and the creation of a "Great Serbia" and a "Great Rumania." Since this "majority wing" policy was opposed by many Socialists, particularly in the Paris district, Thomas decided not to stand again in the Paris suburbs and resigned the mayoralty of Champigny. At the elections of Nov. 16, 1919, he was returned as a Socialist in the Tarn, Jaurès' former constituency.

During the first session of the International Labour Conference, held at Washington at the end of the year, Thomas was provisionally appointed director of the International Labour Office (League of Nations) by its governing body; the appointment was confirmed at the governing body's second meeting held in Paris in Jan. 1920. Apart from the organization and conduct

of the administration and scientific work of the Office, he has been indefatigable in his personal efforts to secure national ratifications of conventions adopted by the International Labour Conference In 1921 the claims of his work at Geneva led him to resign his seat in the Chamber of Deputies, but he has remained a member of the "right" section of the French Socialist party. As director of the International Labour Office he has played a pre-eminent part in the advance and maintenance of labour standards throughout the world To the present edition of the *Encyclopædia Britannica*, M Thomas contributes articles on CO-OPERATION and JAURÈS, JEAN.

THOMAS, ARTHUR GORING (1850–1892), English composer, was born at Ratton Park, Sussex, on Nov. 20, 1850, and educated at Haileybury College He studied music in Paris under Durand and at the Royal Academy of Music under Ebenezer Prout and Arthur Sullivan while at a later period he received some instruction in orchestration from Max Bruch The performance at the Royal Academy of a selection from *The Light of the Harem* (libretto by Clifford Harrison), induced Carl Rosa to commission him to write *Esmeralda* (libretto by T. Marzials and A Randegger), which was successfully produced at Drury Lane on March 26, 1883 Two years later it was given in German at Cologne and Hamburg, and in 1890 (in French) at Covent Garden On April 16, 1885 Rosa produced at Drury Lane Thomas's fourth and best opera, *Nadeshda* (libretto by Julian Sturgis), a German version of which was given at Breslau in 1890 Besides his dramatic works Thomas's chief compositions were a psalm, "Out of the Deep," for soprano solo and chorus (London, 1878), a choral ode. "The Sun Worshippers" (Norwich, 1881), and a suite de ballet for orchestra (Cambridge, 1887) Goring Thomas occupies a distinct place among English composers of the 19th century His music, which shows traces of his early French training, reveals a great talent for dramatic composition and a real gift of refined and beautiful melody He died on March 20, 1892

THOMAS, AUGUSTUS (1857–), American playwright, was born in St Louis (Mo), Jan 8, 1857 He was educated in the public schools, served as a page boy in the Missouri Legislature and in Congress, for several years worked in railway freight offices, and, after serving as writer and illustrator for various newspapers, became in 1886 part editor and proprietor of the Kansas City (Mo) *Mirror*

The success in New York and on the road of *The Burglar* (1889), an elaboration of the earlier one-act piece, and of *A Man of the World* (1883) used by Maurice Barrymore, induced A M Palmer of the Madison Square Theatre to offer the young playwright the post left vacant by the retirement of Dion Boucicault, and under Palmer's management *Alabama* (1891) was produced, a play which contributed to the removal of sectional prejudice resulting from the Civil War Thenceforth Thomas was one of the most prolific and successful of American playwrights. Other dramatic successes by him which made use of native materials were *In Mizzoura* (1893), *The Hoosier Doctor* (1898), *Arizona* (1898), and *The Copperhead* (1917). Other outstanding plays, chiefly in the vein of light comedy or romance, were *Oliver Goldsmith* (1900), *The Earl of Pawtucket* (1903), *Mrs Leffingwell's Boots* (1905) and *The Witching Hour* (1907). An autobiographical volume *The Print of My Remembrance* appeared in 1922

THOMAS, GEORGE (*c* 1756–1802), British military adventurer in India Thomas was born of poor parentage in Ireland in 1756, deserted from the British Navy in Madras, and made his way north to Delhi, where he took service under the begum Samru of Sardhana He then served Appa Rao, a Mahratta chieftain, and subsequently set up an independent kingdom of his own in Hariana with his capital at Hansi. He dreamed of conquering the Punjab, and fought one of his best campaigns against the Sikh chiefs; but he was finally defeated and captured by Sindhia's army under General Perron (*q v.*). He died on his way down the Ganges on Aug 22, 1802.

See Francklin, *Military Memoirs of Mr. George Thomas* (1803), Compton, *Military Adventurers of Hindustan* (1892).

THOMAS, GEORGE HENRY (1816–1870), American general, was born in Southampton county (Va), on July 31, 1816. He graduated at West Point in 1840, served as an artillery subaltern in the war against the Seminole Indians in Florida (1841), and in the Mexican War at the battles of Fort Brown, Resaca de la Palma, Monterey and Buena Vista, receiving three brevets for distinguished gallantry in action From 1851 to 1854 he was an instructor at West Point In 1855 he was appointed by Jefferson Davis, then secretary of war, a major of the 2nd cavalry. His regimental superiors were A S Johnston, R E Lee and Hardee All three resigned at the outbreak of the Civil War Thomas finally decided to adhere to the United States. He was promoted in rapid succession to be lieutenant colonel, colonel in the regular army, and brigadier general of volunteers

In command of an independent force in eastern Kentucky, on January 19, 1862, he attacked the Confederate Gen Zollicoffer at Mill Springs, and gained the first important Union victory in the west. He served under Buell and was offered, but refused, the chief command in the anxious days before the battle of Perryville Under Rosecrans he was engaged at Stone River and was in charge of the most important part of the manoeuvring from Decherd to Chattanooga At the battle of Chickamauga (*q v*) Sept 19, 1863, he gained the name of "The Rock of Chickamauga," because of his firmness He succeeded Rosecrans in command of the Army of the Cumberland shortly before the great victory of Chattanooga (*q v*), in which Thomas and his army played a most conspicuous part, his divisions under Sheridan, Wood and Baird carrying Missionary Ridge in superb style When J B Hood broke away from Atlanta in the autumn of 1864, menaced Sherman's long line of communications and endeavoured to force Sherman to follow him, Sherman left to Thomas the difficult task of dealing with Hood At the battle of Franklin, Nov 30, 1864, Thomas's force, under Gen Schofield, checked Hood long enough to cover the concentration at Nashville (*q v*) Thomas attacked (Dec 15–16, 1864) and inflicted on Hood the worst defeat sustained in the open field by any army on either side during the war For this Thomas was made a major-general in the regular army and received the thanks of Congress. After the Civil War he commanded military departments in Kentucky and Tennessee until 1869, when he was placed over the division of the Pacific with headquarters at San Francisco He died there on March 28, 1870

See George H Thomas, "Union Portraits," *Atlantic Monthly*, 1914, *Sketch of General G H Thomas*, R. W Johnson, *Memoir of Major-General George H Thomas*, Van Horne, *The Life of Major-General George H Thomas.*

THOMAS, ISAIAH (1749–1831), American printer, was born in Boston, Mass , on Jan 19, 1749 He was apprenticed in 1756 to Zechariah Fowle, a Boston printer, with whom, after working as a printer in Halifax, N S, Portsmouth, N H, and Charleston, S.C., he formed a partnership in 1770 He issued in Boston the *Massachusetts Spy* three times each week, then (under his sole ownership) as a semi-weekly, and beginning in 1771, as a weekly which soon espoused the Whig cause and which the government tried to suppress On April 16, 1775 (three days before the battle of Concord, in which he took part) he took his presses and types from Boston and set them up at Worcester, where he was postmaster for a time, here he published and sold books and built a paper-mill and bindery, and continued the paper until about 1802 except in 1776–78 and in 1786–88 The *Spy* supported Washington and the Federalist party In Boston Thomas published, in 1774, the *Royal American Magazine*, which was continued for a short time by Joseph Greenleaf, and which contained many engravings by Paul Revere, and in 1775–1803 the *New England Almanac*, continued until 1819 by his son He set up printing houses and book stores in various parts of the country, and in Boston, with Ebenezer T Andrews, published the *Massachusetts Magazine*, a monthly, from 1789 to 1793 At Walpole, N.H , he published the *Farmer's Museum* About 1802 he gave over to his son, Isaiah Thomas, Jr , his business at Worcester including the control of the *Spy* Thomas founded in 1812 the American Antiquarian Society He died in Worcester on April 4, 1831

His *History of Printing in America, with a Biography of Printers,*

and an Account of Newspapers (1810; 2nd ed, 1874, with a memoir by his grandson B. F. Thomas) is an important work, accurate and thorough *See* also "Diary of Isaiah Thomas, 1805–28" in *Transactions of the American Antiquarian Society*, vol ix. and x. (1909), and C L Nichols, "Isaiah Thomas and his Worcester Imprints" in *Proceedings of the American Antiquarian Society*, New Series, vol. xiii. (1900).

THOMAS, JAMES HENRY (1878–), British Labour leader, was born at Newport, Mon, on Oct 3, 1878 He started work as an errand boy at the age of 9 and was later employed by the Great Western railway as an engine cleaner; he rose rapidly and soon became a power in Swindon (the G.W.R. headquarters) both as a trade unionist and in local government. By 1910 he had become president of the Amalgamated Society of Railway Servants and played a leading part in its reorganization as the National Union of Railwaymen of which he was appointed general secretary after the great railway strike of 1911 Under him the N U R became the leader in the policy of "industrial" or "all grades" as against "craft" trade unionism

Thomas early took the view that larger labour aspiration could be realized only through political action, and was an opponent both of syndicalism and of communism. He was elected member for Derby in 1910 and appointed to the privy council in 1917 He refused to enter the Coalition government. He was secretary for the colonies in the Labour Government of 1924. From the first Thomas was closely associated with the management of the British Empire exhibition at Wembley Thomas was president and chairman of the parliamentary committee of the Trades Union Congress (1920–21) and president of the International Federation of Trade Unions (1920–24).

In the MacDonald cabinet of 1929 he became lord privy seal. This office, to which no departmental duties were attached, was chosen so that he might act as deputy leader for his chief in the House of Commons and preside over the prime minister's special cabinet committee on unemployment

THOMAS, PHILIP EDWARD (1878–1917), British author and poet, was born on March 3, 1878, and educated at St. Paul's School and at Lincoln college, Oxford His first book was a volume of nature studies, *The Woodland Life* (1897), followed by *Horae Solitariae* (1902), and numerous other works. Among a good many miscellaneous works should be noted his critical studies of *George Borrow* (1912); *Swinburne* (1912); and *Walter Pater* (1913), and a volume of stories, *Four-and-Twenty Blackbirds* (1915) But his prose work, though its quality is undoubted, was done to order, and shows signs of constraint as to subject and time. A collection of his prose fragments appeared in 1928, under the title of *The Last Sheaf;* some of these were written under less exacting conditions, and allow more scope to his leisurely and precise genius. It was not till middle age that, under the influence of Robert Frost, the American poet, Thomas discovered himself as a poet, and soon after came the War. Thomas enlisted in 1915, and with freedom from routine literary work became extremely fluent. His verse was first written under the name of "Edward Eastaway" and a volume of *Poems* under his own name appeared in 1917. He was killed in France on April 9, 1917 His poetry is not sharply distinguished from his prose; the rhythms are quiet and unstressed Pre-eminently a poet of the country, when he was killed, as De la Mare has said "there was shattered a mirror of England."

THOMAS, SIDNEY GILCHRIST (1850–1885), British inventor, was born on April 16, 1850, at Canonbury, London. As a police court clerk he found time to study chemistry at the Birkbeck Institute He set himself to solve the problem of separating phosphorus from iron in the Bessemer converter, and by the end of 1875 he was convinced that he had discovered a method The method was tested by his cousin, P. C. Gilchrist, at the Blaenavon works, and found effective In March 1878 the first public announcement of the discovery was made at the meeting of the Iron and Steel Institute; and a paper was written by Thomas and Gilchrist on the "Elimination of Phosphorus in the Bessemer Converter" for the autumn meeting of this institute, but was not read till May 1879 Thomas, however, interested E. W Richards, the manager of Bolckow, Vaughan & Co's works at Cleveland, Yorkshire, whom he interested in the process, and from this time the success of the invention was assured and domestic and foreign patents were taken out. The "basic process" invented by Thomas was especially valuable on the continent of Europe, where the proportion of phosphoric iron is much larger than in England, and both in Belgium and in Germany the name of the inventor became more widely known than in his own country Thomas died in Paris on Feb. 1, 1885.

See *Memoirs and Letters of Sidney Gilchrist Thomas* (1891), ed. by R. W. Burnie.

THOMAS, THEODORE (1835–1905), American musician, was born in Essen, Germany, on Oct 11, 1835. His first public appearance as a violinist was made at the age of five He was taken to America by his parents in 1845, and became first violin in the orchestra that accompanied Jenny Lind (1850), Sontag (1852) and Grisi and Mario (1854) In 1862 he began to organize his own orchestra, and in 1864 he inaugurated the series of Irving Hall symphony concerts, which for 14 years were regarded as one of the great musical institutions of New York city To Theodore Thomas is largely due the popularization of Wagner's works in America, and it was he who founded the Wagner Union in 1872 In 1888, Thomas organized the Chicago Symphony orchestra which has continued to be one of the foremost organizations of its class in the world. In 1928 this orchestra possessed a liberal endowment and its own symphony hall He died Jan 4, 1905, in Chicago.

See biography by George P. Upton

THOMAS À KEMPIS (*c.* 1380–1471), the name by which the Augustinian canon and writer Thomas Hammerken (Hammerchen, Malleolus) is commonly known. He was born in 1379 or 1380 in the town of Kempen, near Dusseldorf, in one of the many patches of territory between the Meuse and the Rhine belonging to the archiepiscopal principality of Cologne "Ego Thomas Kempis," he says in his chronicle of the monastery of Mount St Agnes, "scholaris Daventriensis, ex diocesi Coloniensi natus." His father was a poor hard-worked peasant, his mother "ad custodiam rei domesticae attenta, in opere alacris, in victu sobria, in potu abstemia, in verbo pauca, in factis pudica," as her son fondly says, kept a dame's school for the younger children of the town John and Gertrude Hammerken had two sons, John and Thomas, both of whom found their way to Deventer, and thence to Zwolle and to the convent of Mount St. Agnes. Thomas reached Deventer when he was barely twelve years old, was taught by a dame the beginnings of his learning, and in a few months to his great joy entered the classes of Florentius Radewyn After the fashion of the time he was called Thomas from Kempen, and the school title, as was often the case then, pushed aside the family name Thomas Hammerken was forgotten; Thomas à Kempis has become known to the whole Christian world.

The school at Deventer had become famous long before Thomas à Kempis was admitted to its classes. It had been founded by Gerhard Groot (*q v*), a wealthy burgher who had been won to pious living mainly through the influence of Ruysbroeck, the Flemish mystic. At Deventer, in the midst of this mystical theology and hearty practical benevolence, Thomas à Kempis was trained. Gerhard Groot was his saintly ideal. Florentius Radewyn and Gerhard's other early disciples were his heroes; their presence was his atmosphere, the measure of their lives his horizon. But he was not like them, he was not an educational reformer like Radewyn, nor a man of affairs like Gerhard. He liked books and quiet corners all his days, he says; and so, when conviction of sin and visions of God's grace came to him in the mediaeval fashion of a dream of the anger and forgiveness of the Virgin, Florentius told him that a monk's life would suit him best, advised him to join the Augustinian order, and sent him to Zwolle to the new convent of Mount St. Agnes, where his brother John was prior. Thomas was received there in 1399, professed the vows in 1407, received priest's orders in 1413, became sub-prior in 1425 and died on Aug. 8, 1471, at the age of ninety-one.

Works.—The convent of Mount St. Agnes was poor, and most of the monks had to earn money to support their household by copying MSS. Thomas was a most laborious copyist; missals, books of devotion and a famous MS. Bible were written by him.

He also wrote a large number of original writings, most of them relating to the convent life, which was the only life he knew. He wrote a chronicle of the monastery and several biographies—the life of Gerhard Groot, of Florentius Radewyn, of a Flemish lady St. Louise, of Groot's original disciples; a number of tracts on the monastic life—*The Monk's Alphabet, The Discipline of Cloisters, A Dialogue of Novices, The Life of the Good Monk, The Monk's Epitaph, Sermons to Novices, Sermons to Monks, The Solitary Life, On Silence, On Poverty, Humility and Patience;* two tracts for young people—*A Manual of Doctrine for the Young,* and *A Manual for Children;* and books for edification—*On True Compunction, The Garden of Roses, The Valley of Lilies, The Consolation of the Poor and the Sick, The Faithful Dispenser, The Soul's Soliloquy, The Hospital of the Poor* He also left behind him three collections of sermons, a number of letters, some hymns and the famous *Imitatio Christi* (though his authorship of this has been disputed).

Character.—These writings help us to see the man and his surroundings, and contemporary pious records make him something more than a shadow We see a real man, but a man helpless anywhere save in the study or in the convent—a little fresh-coloured man, with soft brown eyes, who had a habit of stealing away to his cubiculum whenever the conversation became too lively; somewhat bent, for it is on record that he stood upright when the psalms were chanted, and even rose on his tiptoes with his face turned upwards, genial, if shy, and occasionally given to punning, as when he said that he preferred Psalmi to Salmones; a man who perhaps led the most placid uneventful life of all men who ever wrote a book or scribbled letters His brethren made him oeconomiae prefectus, but he was too "simple in worldly affairs" and too absent-minded for the post, and so they deposed him and made him sub-prior once more. And yet it is this placid kindly fresh-coloured old man who has come down to us as the author of that book the *Imitation of Christ,* which has been translated into more languages than any other book save the Bible, and which has moved the hearts of so many men

On the controversy as to the author of the *Imitatio, see* the article IMITATION OF CHRIST *See* also James Williams, *Thomas of Kempen* (1910). The classical edition of the works of Thomas à Kempis by Sommalius—*Thomas Malleoli à Kempis opera omnia* (3 vols in 1, 1607)—has been many times reprinted A critical edition in 8 vols by M J Pohl has also been undertaken. The best accounts in English of Thomas à Kempis are those by S. Kettlewell (1882) and F R Cruise (1887), written from the Protestant and the Catholic standpoints respectively. A penny tract by F. R. Cruise, entitled *Outline of the Life of Thomas à Kempis* (1904), contains substantially all that is known concerning him (T M Li)

THOMASIUS, CHRISTIAN (1655–1728), German jurist and publicist, was born at Leipzig on Jan. 1, 1655, and was educated by his father, Jakob Thomasius (1622–1684), at that time head master of the Thomasschule. Through his father's lectures Christian came under the influence of the political philosophy of Hugo Grotius and Samuel Pufendorf, and continued the study of law at Frankfort-on-Oder. In 1684 he commenced the career of professor of natural law at Leipzig, and soon attracted attention by his abilities, but particularly by his daring attack upon traditional prejudices, in theology and jurisprudence In 1687 he made the daring innovation of lecturing in German instead of Latin, and in the following year published a monthly periodical (*Scherzhafte und ernsthafte, vernünftige und einfältige Gedanken uber allerhand lustige und nutzliche Bucher und Fragen*) taking the side of the Pietists in their controversy with the orthodox, and defending mixed marriages of Lutherans and Calvinists In consequence of these and other views, he was denounced from the pulpits, forbidden to lecture or to write (May 10, 1690), and his arrest was ordered The latter he escaped by flight to Berlin, and the elector Frederick III. offered him a refuge in Halle, with a salary of 500 talers and the permission to lecture. He took part in founding the university of Halle (1694), where he became second and then first professor of law and rector of the university. He died on Sept. 23, 1728. In theology Thomasius was a believer in the necessity of revealed religion for salvation.

Thomasius's most popular and influential German publications were his periodical already referred to (1688–89); *Einleitung zur Vernunftlehre* (1691, 5th ed 1719); *Vernunftige Gedanken uber allerhand auserlesene und juristische Handel* (1720–21); *Historie der Weisheit und Torheit* (3 vols, 1693), *Kurze Lehrsatze von dem Laster der Zauberei mit dem Hexenprozess* (1704), *Weitere Erlauterungen der neueren Wissenschaft anderer Gedanken kennen zu lernen* (1711)

See Luden, *Christian Thomasius nach seinen Schicksalen und Schriften* (1805); H. Dernburg, *Thomasius und die Stiftung der Universitat Halle* (1865); B. A. Wagner, *Thomasius, ein Beitrag ur Wurdigung seiner Verdienste* (1872); Nicoladoni, *Christian Thomasius. Ein Beitrag zur Geschichte der Aufklarung* (Berlin, 1888); and E. Landsberg, *Zur Biographie von Christian Thomasius* (1894).

THOMAS OF CELANO, Franciscan friar and disciple and biographer of St. Francis of Assisi. Born at Celano in the Abruzzi, he joined St Francis probably about 1214, and he appears to have been one of the first band of friars who went into Germany He was commissioned by Gregory IX to write the Life of St. Francis, and in 1229 he completed the *First Legend;* in 1247 at the command of the minister general he composed the *Second Legend,* and a few years later the *Tract on the Miracles of St. Francis.* He also composed in 1255 the *Legend of St Clare;* and he is one of those to whom the sequence *Dies irae* is attributed.

Thomas of Celano's writings on St Francis have been critically edited by E d'Alençon in 1906. An English translation (*The Lives of S. Francis of Assisi by Brother Thomas of Celano*) by A G. Ferrers Howell appeared in 1908. *See* FRANCIS OF ASSISI (E. C. B)

THOMAS OF ERCELDOUNE, called also THE RHYMER, and sometimes given the surname of LEARMONT (*fl.* ? 1220–? 1297), poet and prophet in the legendary literature of Scotland The historical person of that name figures in two charters of the 13th century, and from these it appears that he owned lands in Erceldoune (now Earlstoun), in Berwickshire, which were made over by his son and heir on Nov. 2, 1294, to the foundation of the Holy Trinity at Soltra (or Soutra) on the borders of the same county This would imply that Thomas the Rhymer was already dead, but J A H Murray, who edited *The Romance and Prophecies* (E E T S, 1875), thinks that he was living three years later in a Cluniac priory in Ayrshire. He figures in the works of Barbour and Harry the Minstrel as the sympathizing contemporary of their heroes, and Walter Bower, who continued the *Scotichronicon* of Fordun, tells how he prophesied the death of Alexander III in 1285

In the folk-lore of Scotland his name is associated with numerous fragments of verse of a gnomic and prophetic character. The romance of Thomas and the elf-queen was attributed to Erceldoune by Robert Mannyng de Brunne, but the earliest text, in the Auchinleck ms. in the Advocates' library, Edinburgh, is in a dialect showing southern forms, and dates from the beginning of the 14th century. It may be based on a genuine work of Thomas, a version by him of the widely diffused Tristan Saga The most widely accepted opinion is that it is a translation of a French original.

See J A H Murray's edition of *The Romance and Prophecies* (E E T S, 1875); Brandl's *Thomas of Erceldoune* (Berlin, 1880), and Kolbing's *Die nordische und die englische Version der Tristransage* (Heilbronn, 1882); also McNeill's *Sir Tristrem* (S T S, 1886), Lumby's *Early Scottish Prophecies* (E E T S, 1870), and the reprint of the *Whole Prophesie of Scotland* (1603) by the Bannatyne Club (1833); J. Geddie, *Thomas the Rymour and his Rhymes* (Edinburgh, 1920).

THOMAS OF MARGĀ, a Nestorian bishop and author of an important monastic history in Syriac, who flourished in the 9th century A D. He was born early in the century, probably of Persian parents, in the region of Salakh to the north-east of Mosul As a young man he became in 832 a monk of the famous Nestorian monastery of Beth 'Ābhē, about 25 m due east of Mosul when he acted as secretary to Abraham, who had been abbot of Beth 'Ābhē, and was catholicus (patriarch) of the Nestorians from 837 to 850 Thomas was promoted by Abraham to be bishop of Margā, and afterwards to be a metropolitan of Beth Garmai It was during the period of his life at Beth 'Ābhē and his bishopric that he composed *The Book of Governors,* which is in the main a history of his own monastery, but includes lives of holy men in other parts of Mesopotamia and elsewhere.

The Book of Governors has been edited with an English translation and a copious introduction by E W Budge (2 vols, London, 1893)

There is a later edition by P. Bedjan (Paris, 1901).

THOMASON, GEORGE (d. 1666), English book and tract collector, was a London bookseller, who is famous for having brought together a great collection of books and tracts published during the time of the Civil War and the Commonwealth; this was formerly called the "King's Pamphlets," but is now known as the "Thomason Collection." He possessed nearly 23,000 separate publications in 1662, and having arranged these in chronological order he had them bound in 1,983 volumes The collection was bought in 1761 from his descendants by George III, who presented it to the British Museum He died in April 1666

THOMASVILLE, a city of south-western Georgia, U S A, the county seat of Thomas county, 12 m. from the Florida State line, on Federal highway 84, and served by the Atlanta, Birmingham and Coast and the Atlantic Coast Line railways Pop 8,196 in 1920, 53% negroes, estimated locally at over 11,000 in 1928. The city is beautifully situated on a ridge 273 ft above sea-level, in the yellow-pine belt of the State, and has a mild and equable climate It is famous for its rose gardens, and its "big oak" has a spread of 110 ft Thomasville is one of the oldest winter resorts in the South It was settled about 1825, incorporated as a town in 1831 and chartered as a city in 1889.

THOMOND, EARL AND MARQUESS OF, Irish titles borne by the great family of O'Brien, the earldom from 1543 to 1741 and the marquessate from 1800 to 1855 Thomond, or Tuaidh-Muin, was one of the three principalities of Munster, forming the northern part of the province Its earls were descended from Turlough O'Brien (*c* 1009–1086), king of Munster, and through him from the celebrated king of Ireland, Brian Boroimhe Turlough's descendants, Conchobhar O'Brien (d 1267) and Brian Ruadh O'Brien (d. 1276), kings of Thomond, were both typical Irish chieftains Conchobhar's tomb and effigy with a crown are still to be seen in the ruined abbey of Corcomroe, Co. Clare. His descendant Conor O'Brien (d 1539), prince of Thomond, took part in the feud between the great families of Fitzgerald and Butler and was the last independent prince of Thomond. Conor's brother, MURROUGH O'BRIEN (d 1551), prince of Thomond, the succeeding chief of the race, gave up his "captainship, title, superiority and country" to Henry VIII in 1543, when he was created earl of Thomond By special arrangement the earldom descended, not to his son Dermod, but to his nephew, Donough, who became the 2nd earl Dermod, however, inherited the barony of Inchiquin, which was conferred upon his father at the same time as the earldom

CONOR O'BRIEN, the 3rd earl (*c* 1534–*c.* 1582), was for some years at the outset of his career, harassed by the attacks of his discontented kinsmen. Then in his turn he rose against the English, but was defeated and fled to France; in 1571, however, he was pardoned and formally surrendered his lands

DONOUGH O'BRIEN, the 4th earl (d 1624), called the "great earl," was the son and successor of the 3rd earl He served England well in her warfare with the rebellious Irish during the closing year of Elizabeth's reign and was made president of Munster in 1605 The 8th earl, Henry (1688–1741), was created an English peer as Viscount Tadcaster. When he died the earldom of Thomond became extinct.

The estates of the earldom descended to the last earl's nephew, PERCY WYNDHAM (*c.* 1713–1774), a younger son of Sir William Wyndham, Bart He took the additional name of O'Brien and was created earl of Thomond in 1756 When he died unmarried the title again became extinct

In 1800 MURROUGH O'BRIEN, 5th earl of Inchiquin (*c.* 1724–1808), was created marquess of Thomond His brother James, the 3rd marquess (*c.* 1768–1855), was an officer in the navy and became an admiral in 1853. When he died the marquessate became extinct.

See John O'Donoghue, *Historical Memoirs of the O'Briens* (Dublin, 1860).

THOMPSON, FRANCIS (1859–1907), English poet, born at Preston on Dec. 18, 1859, was the son of Charles Thompson, a doctor, and the nephew of Edward Healy Thompson, the friend of Manning and professor of English literature at Dublin His father becoming a convert to Roman Catholicism, Francis was educated in the Catholic faith at Ushaw college, and in 1866 he proceeded to Owen's college, Manchester, to study medicine. He took little interest in the work however, and having thrice failed in his examinations, he went to London in Nov. 1885, to seek his fortune. There he fell into great destitution; ill health compelled him to take to opium, and after five years of misery, he obtained some light employment in the shop of a London bootmaker, where he found sufficient leisure to write his first poems. These he despatched to Wilfrid Meynell, then editor of *Merrie England,* who, struck with their great merit, arranged for immediate publication At the same time the Meynells sought out the young author, whom they found on the verge of starvation, and after persuading him to enter a hospital, they aided him throughout his long convalescence, and procured the publication of his first volume of poems in 1893. The volume quickly attracted the attention of sympathetic critics, notably Coventry Patmore, who praised it in the *Fortnightly Review* (Jan. 1894)

Much of Francis Thompson's verse is reminiscent of Crashaw's, but the beauty and splendid inventiveness of his diction were immediately recognized as giving him a unique place among his contemporaries Persistent ill health limited his output, but *Sister Songs* (1895) and *New Poems* (1897) confirmed the opinion formed of his genius The former, dedicated to the children of Mrs Meynell, was devoted mainly to descriptions of the days when he was an outcast; the latter, which contains some of his finest verse, indicates the influence of the older mystical poets From 1893–97, Thompson lived, with short intervals, near the Franciscan monastery in Pantasaph, North Wales, and later he spent much time at the Capuchin monastery, Tanlasapt. He died in London on Nov. 13, 1907, and was buried at Kensal Green He gave evidence of great power as a prose writer in his contributions to the *Academy* and the *Athenaeum,* and in his treatise *Health and Holiness* (1905), but it is mainly as a poet that he is remembered

Among his work there is much that may justly be termed eccentric, especially the use of poetically compounded neologisms; but nothing can be more simply beautiful than "The Daisy," nothing more intimate or reverent than his poems about children, or more magnificent than "The Hound of Heaven"

Apart from the works above mentioned Thompson wrote. *Life of Ignatius Loyola* (1909); *Life of John Baptist de la Galle* (1911) and *Essay on Shelley* (1909)

See also the *Athenaeum,* obit by Wilfrid Meynell, since reprinted in Thompson's *Selected Poems* (1908), Wilfrid Blunt in the *Academy,* Nov 23, 1907, the *Dublin Review,* cxlii, art by Alice Meynell, E V. Lucas, *One Day and Another* ("A Rhapsodist at Lords") (1909); Floris Delattre in *Revue Germanique,* July–Aug. 1909, K Rooker, *Francis Thompson* (1912), G. A Beacock, *F. Thompson* (1912), J. Thompson (1923) pp 159; and the authoritative biography, E. Meynell, *The Life of Francis Thompson* (1916), pp. 360.

THOMPSON, SIR HENRY (1820–1904), English surgeon, was born at Framlingham, Suffolk, on Aug 6, 1820. He graduated in medicine at University college, London, in 1851, and subsequently became assistant surgeon (1853), full surgeon (1863), professor of clinical surgery (1866), and consulting surgeon (1874) to University College hospital In 1884 he became professor of surgery and pathology in the Royal College of Surgeons, which in 1852 awarded him the Jacksonian prize for his *Pathology and Treatment of Stricture of the Urethra,* and again in 1860 for his *Health and Morbid Anatomy of the Prostate Gland* Specializing in the surgery of the genito-urinary tract, he acquired a high reputation He performed the operation of lithotomy with success on the king of the Belgians in 1863 Ten years later he carried out a similar operation on the emperor Napoleon.

In 1874, he helped to found the Cremation Society of England, of which he was the first president In 1892 he was instrumental in procuring the appointment of a committee to enquire into the methods of death certification. Thompson was a man of many interests, an amateur painter, a collector of China and a novelist. Thompson was knighted in 1867, and received a baronetcy in 1899. He died on April 18, 1904

Of his more important works, *Clinical Lectures on Diseases of*

the Urinary Organs (1868) passed through eight editions, *The Diseases of the Prostate* through six, *Cremation* (1874) through four, and *Food and Feeding* through twelve.

THOMPSON, SIR JOHN SPARROW (1844–1894), Canadian jurist and statesman, was born at Halifax, Nova Scotia, on Nov. 10, 1844, of Irish descent. In 1877 he was elected to the local legislature for Antigonish as a Conservative, and in 1878 became attorney-general. In May 1882 he became premier, but in June was defeated at the general election, though retaining his own seat, and in July was made a judge of the provincial Supreme Court In September 1885, he was appointed minister of justice in the Federal cabinet, and soon after was elected member for Antigonish. In 1886 he successfully defended in the Federal parliament the hanging of Louis Riel (*q.v.*), which had greatly angered the French Roman Catholics; in 1887–1888, together with Mr. Joseph Chamberlain and Sir Charles Tupper, he arranged a Fisheries Treaty with the American commissioners, which was afterwards thrown out by the United States Senate. During the following years he defended the government with great skill in various politico-religious disputes, and in November 1892 he became premier of Canada. He died suddenly on Dec. 12, 1894, at Windsor Castle, a few minutes after having been sworn in by Queen Victoria as a member of the privy council.

His *Life* has been written by J. C. Hopkins (Toronto, 1895).

THOMPSON, LAUNT (1833–1894), American sculptor, was born at Abbeyleix, Ireland, on Feb 8, 1833 In 1847 he emigrated to the United States and settled with his mother at Albany, New York After studying anatomy in the office of a physician, Dr. Armsby, he spent nine years in the studio of the sculptor, E. D. Palmer. In 1857 he opened a studio in New York, and in 1862 became a national academician. He visited Rome in 1868–69, and from 1875–87 was again in Italy, living for most of the time at Florence. He died at Middleton (N.Y.) on Sept. 26, 1894 Among his important works are· "Napoleon the First," at the Metropolitan Museum of Art, New York; "Abraham Pierson," first president of Yale university, New Haven (Conn); an equestrian statue of Gen A E Burnside, Providence (R I); "General Winfield Scott," Soldiers' Home, Washington (D C); "Admiral S F Du Pont," Washington (D C); "General John Sedgwick," West Point (N Y).

THOMSEN, HANS PETER JÖRGEN JULIUS (1826–1909), Danish chemist, was born in Copenhagen on Feb 16, 1826, and spent his life in that city. From 1847 to 1856 he was engaged in teaching chemistry at the Polytechnique, of which from 1883 to 1892 he acted as director, and from 1856 to 1866 he was on the staff of the military high school In 1866 he was appointed professor of chemistry at the university, and retained that chair until 1891 He was awarded the Davy medal in 1883 and elected a foreign member of the Royal Society in 1902. He died on Feb 13, 1909.

His name is famous for his researches in thermochemistry, a subject to which he was attracted as early as 1852, as his first published paper, entitled "Contributions to a thermochemical system," shows But his comprehensive work in this subject was not started until some years later; the results first appeared in 1869, and were published from time to time until 1882. They were collected in *Thermochemische Untersuchungen* (Leipzig, 1882–88; 4 vols), and a summary in Danish, entitled *Thermokemisker Resultater* appeared in 1905; the latter was translated into English as *Thermochemistry* by Miss K. A. Burke.

In the course of his thermochemical work Thomsen made about 3,500 calorimetric measurements and he determined the heat evolved or absorbed in a very large number of chemical reactions Incidentally he verified Kirchoff's equation connecting the change of heat of a reaction with temperature and the specific heats of the reactants and resultants, and also used his measurements to confirm Guldberg and Waage's theory of mass action (1867). Thomsen introduced the term "avidity" to indicate the tendency of an acid to unite with a base and used his results to draw up the first table of relative strengths of acids. He also worked on selenic acid, platinum compounds and hydrogen peroxide, and made accurate determinations of the atomic weights of oxygen and aluminium. In 1853 Thomsen had devised a process for manufacturing soda from cryolite, and this was first worked on a large scale in 1857; the process proved quite successful.

See obituary notice, *Proceedings of the Royal Society* (1910–11).

THOMSEN, VILHELM LUDVIG PETER (1842–1927), Danish philologist, was born on Jan. 25, 1842, at Copenhagen He took his doctor's degree in 1869 and in 1871 became a lecturer at the University of Copenhagen, where from 1887–1916 he was professor of comparative philology In 1876 he visited England and lectured at Oxford university. Thomsen came to be known as one of the most prominent linguists of modern times, and possessed an extensive and thorough knowledge of the various classes of languages In Romance philology he solved the problem of softened consonants (1856), he was the first to ascertain the palatal law in the phonic system of the Indo-European languages In 1894 he deciphered the Orkhon inscriptions from Mongolia, and made in 1899 important interpretations of Etruscan and Lycian texts In *Turcica* (1916) he treated Ancient Turkic He became president of the Royal Danish Scientific Society in 1909. Thomsen died on May 13, 1927.

His publications include.—*Den gotiske Sprogklasses Indflydelse paa den finske* (1869); *The Relations between Ancient Russia and Scandinavia and the Origin of the Russian State* (1877); *Berøringer mellem de finske og de baltiske Sprog* (1890); *Samlede Afhandlinger* (Christiania, 1919).

THOMSON, SIR CHARLES WYVILLE (1830–1882), Scottish naturalist, director of the scientific staff in the Challenger Expedition, was born at Bonsyde, Linlithgowshire, on March 5, 1830, and was educated at Edinburgh University He held professional appointments at Aberdeen and in Ireland, and finally (1870–79) was professor of natural history at Edinburgh. He died at Bonsyde on March 10, 1882. He will be specially remembered as a student of the biological conditions of the depths of the sea His interest in crinoids was stimulated by the results of the dredgings of Michael Sars (1805–1869) in the deep sea off the Norwegian coasts, and he succeeded, with Dr W B Carpenter, in obtaining the loan of H M S "Lightning" and "Porcupine," for successive deep-sea dredging expeditions in 1868 and 1869 These operations showed that animal life exists in abundance down to depths of 650 fathoms, that all invertebrate groups are represented (largely by Tertiary forms previously believed to be extinct), and, moreover, that deep-sea temperatures are by no means so constant as was supposed, but vary considerably, and indicate an oceanic circulation The results of these expeditions were described in *The Depths of the Sea* (1873). The government realised the value of the work and provided H M S "Challenger" for a circumnavigating expedition Thomson sailed at the end of 1872 as director of the scientific staff, the cruise lasting three years and a half (*See* CHALLENGER EXPEDITION.) On his return he received many academic honours, and was knighted In 1877 he published two volumes (*The Voyage of the Challenger in the Atlantic*) of a preliminary account of the voyage

See obituary notice in *Proc. Soc Edin* (1883); also Thomson and Murray, *Reports of the Voyage of H.M S. "Challenger"* (Edinburgh, 1885).

THOMSON, CHRISTOPHER BIRDWOOD, 1ST BARON, cr. 1924 (1875–), British soldier and statesman, was born on April 13, 1875. Educated at Cheltenham and the Royal Military Academy, Woolwich, he served in the Mashonaland campaign and in the South African War From 1902–05 he was instructor at the military engineering school at Chatham In 1909 he passed on to the Staff College and in 1911 to the War Office. During the World War he served as military attaché and chief of the British military mission in Rumania (1915–16), and in Palestine (1917) and was on the Supreme War Council in 1918. Having attained the rank of brigadier-general, he resigned from the service in 1920 as a protest against Allied intervention in Russia. He joined the Labour party, and accompanied, as military expert, the commissions of enquiry dispatched by that body to Ireland and to the Ruhr; later, he visited Russia In 1922, and again in 1923, he stood for Parliament in the Labour interest, but was unsuccessful. In 1924, he was appointed Air Minister in the first Labour Gov-

ernment, with a seat in the Cabinet, and raised to the peerage. A graceful and effective speaker, Lord Thomson also possesses marked literary gifts and has published various writings including *Old Europe's Suicide* (1922); *Victors and Vanquished* (1924); and *Smaranda* (1926).

THOMSON, ELIHU (1853–), American inventor, was born in Manchester, England, March 29, 1853, but removed to Philadelphia, Pa., with his parents in 1858 He received a public school education and in 1876–80 was professor of chemistry and mechanics at the Central High School in Philadelphia In 1880 he went to New Britain, Conn , as electrician for the American Electric Company and two years later he united with Edward J Houston to found the Thomson-Houston Electric Company in Lynn, Mass. In 1892 a merger took place between this company and the Edison General Electric Company to form the General Electric Company, the largest manufacturer of electrical equipment in the world. Thomson remained as director of the large laboratory in Lynn, renamed after him the Thomson laboratory Thomson made the first important research into the nature of the laws governing the electric arc, disclosing the fact that the resistance of the arc varies inversely with the current He invented and constructed an arc light dynamo with a spherical three-coil armature, and the first with an automatic regulator, which went into commercial use in 1880. He was the first to utilize a magnetic field to move an electric arc, a principle which found many uses, notably in the construction of the magnetic blow-out switches In his notable discovery of the so-called alternating current repulsion phenomena he laid the basis for successful alternating current motors He made the first high-frequency dynamo in 1890 and shortly afterwards the first high frequency transformer, and was a pioneer in the development of other high frequency apparatus. In 1886 he invented the art of electric welding by the incandescent method which was simpler and less expensive than previous methods and applicable to a wider range of metals. He also invented the electric watt-hour meter, while the arc lamp, incandescent lamp, alternator, alternating current transformers, and railway motors found improvement at his hands. He made many contributions to the field of radiology and was the first to make stereoscopic X-ray pictures He has published many articles in scientific journals, holds over 700 patents, and has received the Rumford, John Fritz, Kelvin and Faraday medals as well as other honours

THOMSON, JAMES (1700–1748), English poet, author of *The Seasons,* was born at Ednam, in Roxburghshire, on Sept 11, 1700—the third son and fourth child of Thomas Thomson, minister of that place. About 1701 Thomas Thomson removed to Southdean near Jedburgh Here James was educated at first by Robert Riccaltoun, to whose verses on Winter he owed the idea of his own poem, and then at a school at Jedburgh In 1715 he went to Edinburgh university. He became a divinity student, and it was partly to make a reputation as a preacher that he went to London in March 1725. He had already friends in London in Lady Grizel Baillie, and Duncan Forbes of Culloden, and he was introduced by them to literary society in London, where he supported himself partly by acting as tutor.

The Seasons.—Thomson's *Winter* appeared in March 1726. It was dedicated to Sir Spencer Compton, the Speaker, who rewarded the poet, to his great disgust, with a bare twenty guineas. *Summer* appeared in 1727, dedicated to Bubb Dodington In the same year Thomson published his *Poem to the Memory of Sir Isaac Newton* *Spring* appeared in 1728, published by Andrew Millar. In 1729 he produced *Sophonisba,* a tragedy now only remembered by the line "O Sophonisba, Sophonisba, O," and the parody "O Jemmy Thomson, Jemmy Thomson, O" A poem, anonymous but unquestionably Thomson's, to the memory of Congreve appeared in the same year. In 1730 *Autumn* was first published in a collected edition of *The Seasons* It was dedicated to the Speaker, Onslow. In this year, he accompanied the son of Sir Charles Talbot, solicitor-general, upon his travels. In the course of these he projected his *Liberty* as "a poetical landscape of countries, mixed with moral observations on their government and people" In December 1731 he returned with his pupil to London. His pupil died soon after, and Talbot, who became chancellor, gave Thomson a sinecure in Chancery. The first part of *Liberty* appeared in 1734–35, and it was completed in five parts in 1736. The poem was a failure; its execution did not correspond with its design, in a sense indeed it is a survey of countries and might have anticipated Goldsmith's *Traveller.* The truth is that Thomson's poetical gift was for many years perverted by the zeal of partisanship.

His patron died in February 1737 and he lost his sinecure His tragedy *Agamemnon* appeared in April 1738, not before he had been arrested for a debt of £70, from which, according to a story which has been discredited on quite insufficient grounds, Quin relieved him in the most generous and tactful manner The incident took place probably a little before the production of *Agamemnon,* in which Quin played the leading part The play is of course modelled upon Aeschylus and owes whatever of dignity it possesses to that fact; the part of Cassandra, for instance, retains something of its original force. But most of the other characters exist only for the purpose of political innuendo. Agamemnon is George, absent in Germany; Aegisthus is Walpole, and so on As a result his next tragedy, *Edward and Eleanora,* was banned. This event sufficiently accounts for the poet's next experiment, a preface to Milton's *Areopagitica* He joined Mallet in composing the masque of *Alfred,* represented at Cleveden on the Thames before the prince of Wales, on Aug 1, 1740. There can be little question that "Rule Britannia," a song in this drama, was the production of Thomson The music of the song, as of the whole masque, was composed by Arne. In 1744 Thomson was appointed surveyor-general of the Leeward Islands by Lyttelton with an income of £300 a year; this improved his circumstances considerably, and whilst completing at his leisure *The Castle of Indolence,* he produced *Tancred and Sigismunda* at Drury Lane in 1745

Eventually *The Castle of Indolence,* after a gestation of fifteen years, appeared in May 1748 It is in the Spenserian stanza with the Spenserian archaism, and is the first and last long effort of Thomson in rhyme The great and varied interest of the poem might well rescue it from the neglect into which even *The Seasons* has fallen It was worthy of an age which was fertile in character-sketches, and excels in the lifelike presentation of a noteworthy circle. It is the last work by Thomson which appeared in his lifetime In walking from London to his house at Richmond he became heated and took a boat at Hammersmith; he thus caught a chill and died on Aug. 27, 1748. He was buried in Richmond churchyard His tragedy *Coriolanus* was acted for the first time in January 1749. In itself a feeble performance, it is noteworthy for the prologue which his friend Lyttelton wrote, two lines of which—

> He loved his friends—forgive the gushing tear!
> Alas! I feel I am no actor here—

were recited by Quin with no simulated emotion

Precursor of Romanticism.—It may be questioned whether Thomson himself ever quite realized the distinctive significance of his own achievement in *The Seasons,* or the place which criticism assigns him as the pioneer of a special literary movement and the precursor of Cowper and Wordsworth. His avowed preference was for great and worthy themes of which the world of nature was but one, but fortunately his readers were wiser than himself And though he recalled the minds of his contemporaries from the town to the country, in his feeling for nature, he is a true man of his age, his descriptions are general, and purely objective There is no hint yet of the emotional reactions of the Romantic school. He has many audacities and many felicities of expression, and enriched the vocabulary even of the poets who have disparaged him. Yet it is difficult to believe that he was not the better for that training in refinement of style which he partly owed to Pope

The first collected editions of *The Seasons* bear dates 1730, 1738, 1744, 1746. Lyttelton tampered both with *The Seasons* and with *Liberty* in editions after his friend's death. Among the numerous lives of the poet may be mentioned those by his friend Patrick Murdoch, by Dr Johnson in *Lives of the Poets,* by Sir Harris Nicolas (Ald. ed , 1860), by M. Morel, *James Thomson, sa vie et ses oeuvres* (Paris, 1895), and *James Thomson,* in the English Men of Letters Series, by G C. Macaulay (1908). *See* also Dr. G. Schmeding's *Jacob Thomson, ein vergessener Dichter des achtzehnten Jahrhunderts;* the life prefixed to the Aldine edition of his works in 1897; and an excellent edition of *The Seasons* in the Clarendon Press Series by

J. Logie Robertson. Also A. H. Thompson in *Cambridge History of English Literature,* vol. 10 (1913). (D. C. To.; X)

THOMSON, JAMES (1822–1892), British physicist and engineer, was born in Belfast on Feb. 16, 1822, and, like his younger brother, Lord Kelvin, at an unusually early age began to attend the classes at Glasgow University. He trained for civil engineering but ill-health compelled him to avoid physical exertion. Accordingly, from about 1843, he devoted himself to theoretical work and to mechanical invention. To this period belong his well-known researches in thermodynamics (*q.v.*), which enabled him to predict by the application of Carnot's theorem the variation of the freezing point of a substance with pressure. His results were experimentally verified in the physical laboratories of Glasgow university under Lord Kelvin's direction, and were afterwards applied to give the explanation of regelation. In 1861 he extended them in a paper on crystallization and liquefaction as influenced by stresses tending to change of form in the crystals, and in other studies on the change of state he continued Thomas Andrews's work on the continuity of the liquid and gaseous states of matter, constructing a thermodynamic model in three dimensions to show the relations of pressure, volume and temperature for a substance like carbonic acid (*See* LIQUEFACTION OF GASES)

In 1850 he patented his "vortex water-wheel," and during the next three or four years carried on inquiries into the properties of "whirling fluids," which resulted in improved forms of blowing-fans and water-turbines. (*See* HYDRAULICS) Settling in Belfast in 1851, he was selected to be the resident engineer to the Belfast water commissioners in 1853, and four years later became professor of civil engineering and surveying in Queen's college, Belfast In 1873 he was appointed to the chair of engineering in the university of Glasgow, and retained this position until 1889, when the failure of his eyesight compelled him to resign. He died on May 8, 1892 at Glasgow His contributions to geological science included studies of the parallel roads of Glen Roy and of the prismatic jointing of basalt, as seen at the Giant's Causeway. In 1876 and later years he studied the origin of windings of rivers

THOMSON, JAMES (1834–1882), British poet, best known by his signature "B V.", was born at Port-Glasgow, in Renfrewshire, on Nov. 23, 1834, the eldest child of a mate in the merchant shipping service. His mother was a deeply religious woman of the Irvingite sect. On her death, James, then in his seventh year, was procured admission into the Caledonian Orphan Asylum. In 1850 he entered the model school of the Military Asylum, Chelsea. As assistant army schoolmaster at Ballincollig, near Cork, he encountered the one brief happiness of his life: he fell passionately in love with, and was in turn as ardently loved by, the daughter of the armourer-sergeant of a regiment in the garrison, a girl of very exceptional beauty and cultivated mind. Two years later he suddenly received news of her fatal illness and death The blow prostrated him in mind and body. Henceforth his life was one of gloom, misery and poverty, rarely alleviated

While in Ireland he had made the acquaintance of Charles Bradlaugh, then a soldier stationed at Ballincollig. In 1860 was established the paper with which Bradlaugh was so long identified, the *National Reformer,* in which, among other productions by James Thomson, there appeared (1861) the powerful and sonorous verses "To our Ladies of Death," and (1874) his chief work, the sombre and imaginative *City of Dreadful Night.* In October 1862 Thomson was dismissed the army, in company with other teachers, for some slight breach of discipline. Through Bradlaugh, with whom he lived for some years, he gained employment as a solicitor's clerk. From 1866 to the end of his life, except for two short absences from England, Thomson lived in a single room, first in Pimlico and then in Bloomsbury. He was intemperate in his habits, and made few friends. In 1869 his long poem, "Sunday up the River," appeared in *Fraser's Magazine.* In 1872 Thomson went to the western states of America, as the agent of the shareholders in what he ascertained to be a fraudulent silver mine; and in 1873 he received a commission from the New York *World* to go to Spain as its special correspondent.

On his return to England he continued to write in the *Secularist* and the *National Reformer,* under the initials "B.V."[1] In 1875 he severed his connection with the *National Reformer,* owing to a disagreement with its editor; henceforth his chief source of income (1875–1881) was from the monthly periodical known as *Cope's Tobacco Plant.* Chiefly through the exertions of his friend and admirer, Bertram Dobell, Thomson's best-known book, *The City of Dreadful Night, and other Poems,* was published in April 1880, and at once attracted attention; it was succeeded in the autumn by *Vane's Story, and other Poems,* and in the following year by *Essays and Phantasies.* All his best work was produced between 1855 and 1875 ("The Doom of a City," 1857; "To our Ladies of Death," 1861; *Weddah and Om-el-Bonain,* "The Naked Goddess," 1866–1867; *The City of Dreadful Night,* 1870–1874). He died at University College Hospital, in Gower Street, London, on June 3, 1882, and was buried at Highgate cemetery, in the same grave, in unconsecrated ground, as his friend Austin Holyoake.

To the productions of James Thomson already mentioned may be added the posthumous volume entitled *A Voice from the Nile, and other Poems* (1884), to which was prefixed a memoir by Bertram Dobell. If James Thomson has distinct affinity to any writer it is to De Quincey. The merits of Thomson's poetry are its imaginative power, its sombre intensity, its sonorous music; to these characteristics may be added, in his lighter pieces, a Heine-like admixture of strange gaiety, pathos and caustic irony. The same may be said of his best prose. His faults are a monotony of epithet, the not infrequent use of mere rhetoric and verbiage.

See the *Life,* by H. S. Salt (1905 edition).

THOMSON, JOHN ARTHUR (1861–), British naturalist, was born at East Lothian on July 8, 1861, and was educated at the universities of Edinburgh, Jena and Berlin. He was, for a time, lecturer on zoology and biology at the school of medicine in Edinburgh, and in 1899 he became regius professor of natural history at Aberdeen university. Apart from his purely zoological work, chiefly on alcyonarians, Professor Thomson did much, both by his lectures and his numerous attractive books and writings, to popularise biological science, and he was indefatigable in his efforts to correlate science and religion.

His publications include: *Outlines of Zoology,* 7th ed. (1920); *Introduction to Science* (1911); *The Wonder of Life* (1914); *Secrets of Animal Life* (1919); *The System of Animate Nature,* Gifford Lectures (1920); *Science, Old and New* (1924); *The New Natural History* (1925); *Science and Religion* (1925); *Towards Health* (1927) and many other books and papers on allied subjects.

THOMSON, JOSEPH (1858–1895), Scottish explorer in Africa, was born on Feb. 14, 1858 at Penpont, Dumfriesshire, being the fifth son of William Thomson, originally a working stonemason, who had attained the position of a master builder. In 1868 his father removed to Gatelawbridge, where he rented a farm and a quarry. Joseph Thomson worked in his father's quarry before he went up to Edinburgh University. After completing his course in 1878 he was appointed geologist and naturalist to the Royal Geographical Society's expedition to East Central Africa under Keith Johnston. The latter died at Behobeho, between the coast and the north end of Lake Nyasa, in June 1879, and Thomson then took command. He successfully conducted the expedition across the desolate region of Uhehè and Ubena to the north end of Lake Nyasa, and then by a hitherto unexplored track to Lake Tanganyika, where he investigated the Lukuga outlet. From Tanganyika he started to reach the Congo, but troubles with his carriers, who dreaded the warlike Warua, obliged him to retrace his steps. Going round the south end of Tanganyika he discovered Lake Rukwa, and marched via Tabora to the coast at Bagamoyo, reaching London in August 1880.

About this time the sultan of Zanzibar asked Thomson to report on certain supposed coal-beds on the river Rovuma, but the coal proved to be merely bituminous shale.

For a considerable time the explorer had directed his attention to Masailand, through which ran the shortest route from the sea to the headwaters of the Nile. In 1882 the Royal Geographical Society requested Thomson to report on the practicability of

[1]Bysshe Vanolis: "Bysshe," as the commonly used Christian name of Shelley, Thomson's favourite writer; and "Vanolis," an anagram of Novalis (F. von Hardenberg).

taking a caravan through the Masai country He succeeded in crossing the Njiri desert and exploring the eastern rift-valley. Thence he went with a picked company through Laikipia to Mt. Kenya and Lake Baringo, afterwards traversing the unknown region lying between Baringo and Victoria Nyanza, reached on Dec. 10, 1883.

In 1885 he undertook an expedition to Sokoto for the National African (afterwards the Royal Niger) Company, and obtained the signatures of the sultans of Sokoto and Gando to treaties with which he had been entrusted by the company In 1888 he travelled for pleasure through southern Morocco and explored a portion of the Atlas range

In 1890 he entered the service of the British South Africa Company and starting from Quilimane he traversed the region between lakes Nyasa and Bangweulu and the Zambezi. It was a period of tension between the Portuguese and the British, and Thomson's party on leaving the Portuguese frontier was fired on by the Portuguese who, too late, realized that they had allowed a treaty-making envoy to pass through their territory in the guise of a peaceful trader. Thomson concluded treaties with native potentates which gave to the chartered company political, trading and mining rights over a large part of the district since known as North-East Rhodesia. This journey, in which he covered nearly a thousand miles of hitherto unexplored country, proved disastrous to his constitution. In 1893 he visited South Africa in search of health, but unavailingly. He died in London on Aug. 2, 1895. The accounts of his travels not recorded in the books mentioned were published in magazines or in the *Proceedings of the Royal Geographical Society.* Thomson was the last, as he was one of the most successful, of the great geographical pioneers in Africa. He had an extraordinarily keen topographical instinct which enabled him to comprehend at a glance the natural features of the countries he traversed. To undaunted courage and promptness of decision he added a forbearing and patient disposition.

Thomson wrote accounts of his travels under the titles *To the Central African Lakes and Back* (1881), *Through Masailand* (1884), *Travels in the Atlas and Southern Morocco* (1889), also some articles in the *Proceedings of the Royal Geographical Society* He also wrote, in collaboration with Miss E Harris Smith, *Ulu* (1888), a novel based on his insight into the working of the African mind, *Mungo Park and the Niger* (1890), a sound critical biography and many magazine articles on African politics.

See *Joseph Thomson, African Explorer* (1896), a biography by his brother, the Rev. J. B. Thomson, which contains a list of the published writings of the explorer

THOMSON, SIR JOSEPH JOHN (1856–), British physicist, was born on Dec. 18, 1856 near Manchester, and educated at Owens college, Manchester, and at Trinity college, Cambridge, where he was elected a fellow in 1880 and became lecturer in physics in 1883. In 1884 he was appointed Cavendish professor in the University of Cambridge and in 1919 research professor, holding in addition from 1905–18, the professorship of physics at the Royal Institution, London, and subsequently an honorary appointment. He became master of Trinity college in 1918. He developed at Cambridge a great research laboratory, which attracted workers from many countries, and carried out there epoch-making investigations on the conduction of electricity through gases, the determination of the charge and mass of the electron, and analysis by means of positive rays. He became F R S. in 1884, and was president in 1915 He was knighted in 1908, and was the recipient of many awards and honours During the World War he assisted various Government departments in an advisory capacity (*See* GASES)

In addition to a large number of publications in the *Proceedings of the Royal Society* and *The Philosophical Magazine*, he published *A Treatise on the Motion of Vortex Rings* (1883), *The Application of Dynamics to Physics and Chemistry* (1888); *Recent Researches in Electricity and Magnetism* (1893); *Elements of the Mathematical Theory of Electricity and Magnetism* (1895, 5th ed 1921); *The Discharge of Electricity Through Gases* (1898); *The Conduction of Electricity Through Gases* (1903); *Rays of Positive Electricity and Their Application to Chemical Analysis* (1913, 2nd ed, 1922); *The Electron in Chemistry,* five lectures delivered at the Franklin Institute, Philadelphia (1923); and, with Professor Poynting, a number of general text-books on physics.

THOMSON, THOMAS (1773–1852), Scottish chemist, was born at Crieff, Perthshire, on April 12, 1773. He was educated at the universities of St. Andrews and Edinburgh, and after taking the degree of M.D. at the latter place in 1799 established himself there as a teacher of chemistry. From 1796 to 1800 he was connected with the *Encyclopædia Britannica,* and the chemical and mineralogical articles which he contributed to the supplement to the third edition formed the basis of his *System of Chemistry* (1st ed. 1802; 7th ed. 1831) The third edition (1807) is noteworthy as containing the first detailed account of the atomic theory, communicated to him by John Dalton himself. (*See* CHEMISTRY: *History*; ATOMIC WEIGHTS.) In 1813 he began to edit in London the *Annals of Philosophy,* later *Philosophical Magazine* In 1817 he became lecturer in chemistry at Glasgow university, and in the following year was appointed to the regius professorship This chair he retained until his death (July 2, 1852), at Kilmun, Argyleshire. Thomson was a most energetic professor and founded the first chemical laboratory for students in Great Britain He did much to spread a knowledge of Dalton's atomic theory. In addition to various text-books he published a *History of Chemistry* (1830–1831).

THONGA, a group of Bantu-speaking peoples inhabiting the southern half of Portuguese East Africa and the neighbouring regions. It comprises a number of independent tribes, each governed by a chief assisted by councillors. The people live in small household groups, which are scattered irregularly over the tribal territory They keep cattle and goats, and also raise crops of millet and maize They are organized into exogamous patrilineal clans, and have a classificatory system of relationship. Marriage is polygamous, and involves the payment of a bride-price Their religion is mainly ancestor-worship

See H A. Junod, *The Life of a South African Tribe* (1927).

THOR, one of the chief deities of the heathen Scandinavians, is represented as a middle-aged man of enormous strength, an implacable foe to the harmful race of giants (demons), but benevolent towards mankind. His figure is somewhat secondary to that of Odin, represented as his father. But in Iceland and indeed, perhaps, in all northern countries except among the royal families, he was apparently worshipped more than any other god There is evidence that a corresponding deity named Thunor or Thonar was worshipped in England and on the Continent, but little is known about him beyond his identification with the Roman Jupiter His name is the Teutonic word for thunder Outside the Teutonic area he has close affinities with Jupiter or Zeus, and still more with the Lithuanian god Perkunas, whose name (which likewise means "thunder") appears to be connected with that of Thor's mother (Fiörgyn)

See H Petersen, *Om Nordboern es Gudedyrkelse og Gudetro i Hedenold* (Copenhagen, 1876) For other references *see* TEUTONIC PEOPLES. *Religion* (*ad fin*). (H. M. C)

THORAX, the anatomical term for the chest, that part of the body which contains the heart and lungs (*see* ANATOMY: *Superficial and Artistic,* and SKELETON. *Axial*). For the surgery of the thorax reference may be made to the heading HEART AND LUNG, SURGERY OF.

THORBECKE, JAN RUDOLF (1798–1872), Dutch statesman, was born at Zwolle, in the province of Overijssel, on Jan. 14, 1798. He studied at Leyden, and, on the completion of his course, visited the principal German universities. At Giessen he lectured as an extraordinary professor, and at Göttingen, in 1824, published his treatise, *Ueber das Wesen der Geschichte.* After his return to Amsterdam in 1824 Thorbecke wrote his *Bedenkingen aangaande het Recht en den Staat* ("Objections anent Law and the State"), which procured him in 1825 a chair as professor in Ghent university. The Belgian revolt of that year drove him from Ghent to Leyden, where he became professor of jurisprudence and political science His standard work, *Aanteekeningen op de Grondwet* ("Annotations on the Constitution," 1839; 2nd ed., Amsterdam, 1841–43), became the textbook and the groundwork for the new reform party in Holland, as whose leader Thorbecke was definitely recognized. Thorbecke's political career until his death, which occurred at The Hague on June 4, 1872, is sketched under HOLLAND: *History.*

See biographies by Buys (Tiel, 1876) and J A. Levy (The Hague, 1876). There are two collections of his *Speeches* (6 vols., 1867–70, Deventer; and Gronnigen, 1900). His *Correspondence with Groen van Prinsterer* appeared in 1873.

THOREAU, HENRY DAVID (1817–1862), American recluse, naturalist and writer, was born at Concord (Mass), July 12, 1817. To Thoreau this Concord country contained all of beauty and even grandeur that was necessary to the worshipper of nature; he once journeyed to Canada; he went west on one occasion; he sailed and explored a few rivers; for the rest, he haunted Concord and its neighbourhood as faithfully as the stork its ancestral nest

As a boy, Henry drove his mother's cow to the pastures, and thus early became enamoured of certain aspects of nature and of certain delights of solitude At school and at Harvard University he in nowise distinguished himself, though he was an intelligently receptive student and read widely He was, however, proficient enough in Greek, Latin, and the more general acquirements to enable him to act for a time as a teacher But long before this he had become apprenticed to the learning of nature: when only 12 he had made collections for Agassiz, who had then just arrived in America. Thoreau gave up teaching and became a lecturer and author, though it was the labour of his hands which mainly supported him through many years: professionally he was a surveyor.

He had arrived at the conviction that the less labour a man did, over and above the positive demands of necessity, the better for him and for the community at large; he would have had the order of the week reversed—six days of rest for one of labour In 1845 he made the famous experiment of Walden Desirous of proving to himself and others that man could be as independent of his kind as the nest-building bird, Thoreau retired to a hut of his own construction on the pine slope over against the shores of Walden pond —a hut which he built, furnished and kept in order entirely by the labour of his own hands During his two years in Walden woods he lived by the exercise of a little surveying, a little job-work and the tillage of a few acres of ground which produced him his beans and potatoes He read considerably, wrote abundantly, thought actively if not widely, and came to know beasts, birds and fishes with an intimacy more extraordinary than was the case with St. Francis of Assisi. Birds came at his call, and forgot their hereditary fear of man; beasts lipped and caressed him; the very fish in lake and stream would glide, unfearful, between his hands. His *Walden* (1854), the record of this fascinating two years' experience, must always remain a production of great interest.

Some years before Thoreau took to Walden woods he made the chief friendship of his life, that with Emerson He became one of the famous circle of the transcendentalists, always keenly preserving his own individuality amongst such more or less potent natures as Emerson, Hawthorne and Margaret Fuller. From Emerson he gained more than from any man, alive or dead; and, though the older philosopher both enjoyed and learned from the association with the younger, it cannot be said that the gain was equal There was nothing electrical in Thoreau's intercourse with his fellow men; although he absorbed intensely he gave off no spiritual sparks. With children he was affectionate and gentle, with old people and strangers considerate He loved his kind as animals. but did not seem to find them as interesting as those furred and feathered In 1847 Thoreau left Walden lake abruptly, and for a time occupied himself with lead-pencil making, the parental trade. He never married, thus further fulfilling his policy of what one of his essayist-biographers has termed "indulgence in fine renouncements." At the comparatively early age of 45 he died, May 6, 1862. His grave is in the Sleepy Hollow cemetery at Concord.

Thoreau's fame will rest on *Walden; or, Life in the Woods* (Boston, 1854) and the *Excursions* (Boston, 1863), though he wrote nothing which is not deserving of notice. Up to his 30th year he dabbled in verse, but he had little ear for metrical music, and he lacked the spiritual impulsiveness of the true poet His weakness as a philosopher is his tendency to base the laws of the universe on the experience-born, thought-produced convictions of one man—himself. His weakness as a writer is the too frequent striving after antithesis and paradox If he had had all his own originality without the itch of appearing original, he would have made his fascination irresistible. As it is, Thoreau holds a unique place. He was a naturalist, but absolutely devoid of the pedantry of science; a keen observer, but no retailer of disjointed facts. He thus holds sway over two domains: he had the adherence of the lovers of fact and of the children of fancy. He must always be read, whether lovingly or interestedly, for he has all the variable charm, the strange saturninity, the contradictions, austerities and delightful surprises of Nature herself.

The standard editions of his works are *The Writings of Henry David Thoreau*, Riverside ed (11 vol., Boston, 1894–95), and Manuscript ed. (12 vol, 1907).

See also W E Channing, *Thoreau: The Poet Naturalist* (enlarged and edited by F B Sanborn, 1902); R W Emerson, an introductory note to *Excursions* (Boston, 1863); F B Sanborn, *Henry David Thoreau* (Boston, 1882), in the "American Men of Letters" series; H S Salt, *Life of Henry David Thoreau* (1890, rev ed. 1896); *Some Unpublished Letters of H D and Sophia E Thoreau* (Jamaica, New York, 1890); J Russell Lowell, *My Study Windows;* R L. Stevenson, *Familiar Studies of Men and Books;* F. H Allen, *Bibliography of H. D. Thoreau* (Boston, 1908), *The Heart of Thoreau's Journals* (ed by Odell Shephard, Boston, 1927); Brooks Atkinson, *Henry Thoreau, The Cosmic Yankee* (1927). (W. S.; X)

THORFINN KARLSEFNI or Karlsefne (*fl.* 1002–1007), Scandinavian explorer, leader of the chief mediaeval expedition for American colonization. Thorfinn belonged to a leading Icelandic family In 1002 he came to Greenland, married Gudrid, widow of Red Eric's son Thorstein, and put himself at the head of a great expedition now undertaken from Ericsfiord for the further exploration and settlement of the western Vinland (south Nova Scotia?) lately discovered by Leif Ericsson (*q v.*). Three vessels took part in the venture, with 160 men and some women, including Gudrid, and Freydis, a natural daughter of Red Eric They first sailed north-west to the Vesterbygd or "Western Settlement" of Greenland, thence to Bear island, and thence away to the south till they reached a country they named *Helluland* (some part of Labrador?) from its great flat slabs of stone (*hellur*). Two days' sail farther southward brought them to a thickly-wooded land they called *Markland* (*i e*, Woodland, our Newfoundland?). Two days after this they sighted land to the right hand, and came to a cape, where they found the keel of a ship—perhaps a relic of some earlier, possibly Scandinavian explorer—and which they called therefore *Kialarnes* (Keelness; Cape Breton, or some adjacent point?); the long bleak sandy shores of this coast they called the *Wonderstrands* (on the east coast of Cape Breton island?). After passing the *Wonderstrands* and reaching a coast indented with bays, Thorfinn put two fleet Gael runners ashore, with orders to explore southwards (*see* Leif Ericsson); they returned with grapes and wild wheat, proofs that the Northmen were not far from Vinland

The fleet now stood in to a bay called by the explorers *Streamfiord* or Firth of Currents, and wintered there (1003–04), suffering some privations, and apparently getting no more news of the fruitful country desired. Thorfinn's son Snorri was born this first autumn in the new world. Next spring nine of the party, headed by the chief malcontent Thorhall, Red Eric's huntsman, sailed off northward, intending to come to Vinland by rounding Keelness and thence working round west (and south) Adverse weather drove them to Ireland, where they were enslaved. Meanwhile Thorfinn, with the rest of the venturers, sailed south "for a long time," till they reached a spot they called *Hop*, at the mouth of a river which flows from a lake into the sea.

Here they found the "self-sown" wheatfields and vines of Leif's Vinland, and here accordingly they settled and built their huts above the lake (1004–05). After a fortnight natives, swarthy and ill-looking, with ugly hair, great eyes and broad cheeks (Beothuk or Micmac Indians?) appeared with many skin canoes; in the spring following these *Skraelings* came back and bartered with their visitors. Terrified by a bull belonging to the latter they fled, and after three weeks returned to fight They were beaten off, but two of the Northmen were slain The colony at Hop was therefore abandoned and the whole force returned to Streamfiord Thence Thorfinn revisited Hop, staying two months; and also made a voyage northward in search of Thorhall, rounding Keelness and sailing westward (along the north coast of Cape Breton island?), and apparently southward also, till they came to the

mouth of a river flowing from east to west. Here Thorvald Ericsson was killed by a (Skraeling?) arrow, and the expedition came back to Streamfiord where they passed the next winter (1005–06).

Internal dissensions now broke out, mainly about the women of the colony, and in the next summer (1006) the entire project of Vinland settlement was abandoned and the fleet sailed to Markland. Two Skraeling children were captured here and the expedition divided, Thorfinn making Greenland and Ericsfiord in safety with his own vessel, while the other was lost in the Irish sea, only half the crew escaping to Ireland in the ship's boat. (C R B)

On *Flatey Book, Red Eric Saga* and the whole bibliography for the Vinland voyages, including that of Thorfinn, *see* LEIF ERICSSON and VINLAND The six Vinland voyages of *Flatey,* we may repeat, *Red Eric* reduces to three, wholly omitting the alleged voyage of Biarni Heriulfsson, and grouping those of Thorvald Ericsson and Freydis with Thorfinn Karlsefni's in one great colonizing venture.

THORIANITE, a rare mineral found in the gem-gravels of Ceylon as small, heavy, black, cubic crystals, usually much water-worn It was so named on account of its high percentage of thorium (59–79% ThO_2); it also contains the oxides of uranium (11–33%), and the formula $(Th,U)O_2$ is similar to that of uraninite, but with thorium predominating over uranium. Helium is present, and the mineral is slightly less radio-active than pitchblende. A few isolated crystals of the mineral have been found in Transbaikalia, Siberia and in Madagascar Thorianite contains a higher percentage of thoria than any other known mineral, and it has been employed to a limited extent as a source of thoria for use in incandescent gas-mantles.

THORITE, a rare mineral consisting of thorium silicate, crystallizing in the tetragonal system and isomorphous with zircon. The theoretical formula, $ThSiO_4$, requires 81·5% of thoria, but analyses show only 50–70%, there being also some uranium, cerium, etc. The mineral is almost always altered by hydration and is then optically isotropic and amorphous Owing to differences in composition and to alteration, the specific gravity varies from 4·4 to 5·4. The colour is usually light brown, but in the variety known as "orangite" it is orange-yellow. The mineral occurs as isolated crystals and small masses in the augite-syenite near Brevik in south Norway, also at Arendal, and in the gem-gravels of Ceylon If found in larger amount it would be an important source of thoria for incandescent gas-mantles. (L. J. S.)

THORIUM, a chemical element belonging to a group of metals contained in the oxides known as the rare earths (symbol Th, atomic number 90, atomic weight 232 2). In 1828, Berzelius gave the name thoria (after the god, Thor) to the basic oxide extracted from the thorite of Lovön (Norway). Thorium is present as the main constituent in thorite and orangite, which are thorium silicates, $ThSiO_4$, auerlite, calciothorite, freyalite, mackintoshite and thorianite (ThO_2, 60–78%, with oxides of uranium), but the only commercial source is monazite sand, a complex phosphate of the rare (cerite) earths containing 2 to 10% of thoria. This sand is found in Brazil, Travancore, North and South Carolina, Idaho, Australia and the Malay Archipelago The first two sources are the most important commercially, the Travancore deposits furnishing three-fourths of the world's supply Thoria is extensively used in the construction of incandescent gas mantles (*see* LIGHTING AND ARTIFICIAL ILLUMINATION) this being the main industrial application of thorium.

Metallic Thorium.—Owing to its intense chemical reactivity towards hydrogen, nitrogen, oxygen, carbon and the metals, thorium is isolated only with considerable difficulty. Anhydrous thorium chloride when heated with sodium *in vacuo* furnishes a pure product. Thorium is also obtained (i) by passing the vapour of its iodide over heated tungsten filaments, (ii.) by the action of calcium on thoria, (iii) by passing thorium acetylacetone and sodium vapours through a red hot tube It is a leaden-grey metal of specific gravity 12·16, resembling platinum in hardness and ductility. Its melting point is 1,845° C. Thorium ribbon when heated to red heat continues to burn in air, giving a shower of sparks. At 450° C the metal combines with the halogens and with sulphur, and at 650° C with hydrogen and nitrogen. Thorium is dissolved by strong hydrochloric acid or aqua regia but other acids attack it only slowly. It is not affected by alkalis but alloys with aluminium, copper and nickel; the thorium-tungsten alloy is of industrial use for making filaments for incandescent electric lamps. Tungsten containing 0·5 to 10% of thorium, when used as the cathode of an electric discharge apparatus, gives at 1,030° C an electron emission equal to that furnished by pure tungsten at 1,700° C. Thorium is strongly radioactive.

Extraction of Thoria.—Thorite and thorianite are dissolved in mineral acid and the solution evaporated down to render silica insoluble. Ammonium sulphide is added to the aqueous extract to precipitate such common metals as iron and lead. The thoria remaining in solution is separated through its carbonate, sulphate or oxalate.

Monazite is broken up with strong sulphuric acid, the solution diluted and partially neutralised with alkali (ammonia, caustic soda or magnesia), when thorium phosphate is precipitated. This phosphate is dissolved in hydrochloric or sulphuric acid and the thorium reprecipitated as oxalate. Further purification may be effected by means of (i) thorium carbonate, which is more soluble than other rare-earth carbonates in sodium carbonate; (ii) ammonium thorium oxalate which is soluble; or (iii.) fractional crystallisation of thorium sulphate, $Th(SO_4)_2,8H_2O$ Finally, the purified thoria is converted into thorium nitrate, the salt employed in the mantle industry The world's annual consumption of monazite is about 3,000 tons, and of this, 200 tons are worked up in Great Britain, ilmenite (*see* TITANIUM) and mesothorium being useful by-products Each kilogram of monazite on acid treatment evolves one litre of helium, also obtainable by heating the mineral to redness.

Gas Mantles.—Incandescent mantles are manufactured by impregnating a woven stocking of combustible fabric (cotton or ramie) with the nitrates of thorium and cerium The impregnated stocking is ignited to convert these nitrates into oxides, the mixture of nitrates being adjusted so that the mixed oxides consist of 99% of thoria, and 1% of ceria, this mixture giving optimum luminosity at comparatively low temperatures About 300 millions of incandescent gas mantles are consumed annually, of which the United States takes approximately 80 millions

Thorium Compounds—Thorium in combination is uniformly quadrivalent. Thoria (thorium dioxide), ThO_2, a white powder of specific gravity 10·20, is obtained by heating thorium salts of volatile acids or by igniting the hydroxide, $Th(OH)_4$, a heavy white powder precipitated by alkali from thorium solutions Thoria is a refractory material utilisable in making cupels and crucibles. Thorium tetrachloride is obtained in colourless prisms melting at 820° C by heating thoria in the vapour of carbon tetrachloride or sulphur chloride. Thorium sulphate, $Th(SO_4)_2$, crystallises with 4, 8 and 9 molecules of water, and the nitrate with 5, 6 and 12 H_2O. Commercial thorium nitrate should contain a minimum of 48% ThO_2.

Thorium acetylacetone, $Th\{CH(CO{\cdot}CH_3)_2\}_4$, a white crystalline product melting at 171° C and soluble in alcohol or chloroform, is distillable *in vacuo* without decomposition. Thorium salts of organic acids have been employed medicinally for skin trouble and in cholera and dysentery on account of their radioactive character Thoria is used as a catalyst in organic syntheses (ketones from acids). Inhalations of thorium emanation (thoron) are stated to be efficacious in diseases of the respiratory organs.

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THORN or, better, **TORUN,** a town of Poland, in the province of Pomorze, situated on the right bank of the Vistula, 85 m. by rail N E. of Poznan, and 92 m. S. of Danzig. Pop. (1921), 39,300. Torun has always been an important town owing to its position between Pomerania, Poland Proper and East Prussia, and its strategical importance as a bridge head commanding the passage of the Vistula. The old town and the new town, founded in the 13th century, were united in the 15th, and both retain a number of interesting buildings dating from the 14th, 15th and 16th centuries, when Torun was a flourishing

member of the Hanseatic League. The ruined castle of the Teutonic knights, part of the old walls, the town hall, the churches of St. John, of the Virgin and of St. James, are the most interesting edifices. There is a monument to Kopernik (Copernicus) who was born in Torun. The old wooden bridge has been succeeded by a massive iron railway viaduct 3,300 ft. long. Torun carries on an active trade in grain, timber and foodstuffs, and has ironworks, saw-mills and other manufactures.

Torun was founded in 1231 by the Teutonic Order, which was given land there and invited to help the Poles against the heathen Prussians. It became a subject city of the Order and an important member of the Hanseatic League, but political and commercial interests bound it to Poland. In 1454 the city revolted against the Order and was annexed to Poland in 1466 at the Peace concluded there Religious differences were always strong in Torun, and a riot in 1724, terminating in a brutal execution, made a great stir in Europe. The town was seized by Prussia at the Second Partition, was returned to the Grand Duchy of Warsaw, and again granted, in 1815, to Prussia, in which it remained till 1918

THORN, in botany, a hard pointed structure, also termed a "spine," generally representing a small branch, as in hawthorn, where a normal branch arising in the axil of a leaf is replaced by a sharply pointed thorn, accessory buds on each side of the thorn and developed in the same leaf-axil will grow in the next season into ordinary branches. The similarly developed thorns of the honey-locust (*Gleditschia*) are branched In other cases, as the sloe or the wild pear, branches become spiny at the apex tapering into a stiff leafless point. On a cultivated tree these branches disappear owing to their more vigorous growth. Leaves may be modified into spines, as in barberry, the leaves of which show every gradation between a leaf with a spiny-toothed edge and those which have been reduced to simple or multiple spines. In some species of *Astragalus* the petiole of the pinnately compound leaf persists after the fall of the leaflets as a sharp spine In the false acacia (*Robinia*) the stipules are represented by spines

THORNABY-ON-TEES, a municipal borough in the North Riding of Yorkshire, England, 3 m S.W of Middlesbrough, on the L.N E. railway Pop (1921) 19,826 It lies on the river Tees, opposite Stockton-on-Tees, with which it is connected by a bridge. The town was formerly known as South Stockton and is still included in the parliamentary borough of Stockton, but it was incorporated as a separate municipal borough in 1892. The population is employed in blast furnaces, iron foundries, engineering works, iron ship-building yards, extensive saw-mills, flour-mills and manufactures of "blue and white" pottery.

THORNDIKE, EDWARD LEE (1874–), American psychologist, was born at Williamsburg, Mass., on Aug. 31, 1874 He prepared for college in the Roxbury Latin school. He received the A B. degree in 1896 and the A.M. degree in 1897 from Harvard His first teaching appointment was instructor in Western Reserve in 1898–99, followed by an appointment as instructor in genetic psychology at Teachers college, Columbia university, in 1899 Since that date he has remained at Teachers college and has taken a leading part in the development of that institution, having been promoted to adjunct professor of educational psychology in 1902, and professor in 1904 During the World War Thorndike was chairman of the committee on classification of personnel in the army, and in that capacity was instrumental in establishing an efficient system for the classification and distribution of troops. In 1921 he became director of the division of psychology of the institute of educational research at Teachers college. A recent compilation of his writings shows over 300 titles, more than 30 of which are well known books. Among these are *Mental and Social Measurements* (1904); *Principles of Teaching* (1905); *Elements of Psychology* (1905); *Educational Psychology* (1914); and *Measurement of Intelligence* (1926).

THORNDIKE, SYBIL (1885–), British actress, was born at Gainsborough, Lincolnshire, and educated at the high school, Rochester, when her father, Rev. A. J. W Thorndike, was a canon of the cathedral. From 1903–07 she toured America in Shakespearian repertory with Ben Greet. Returning to England she became a member of Miss Horniman's company at the Gaiety theatre, Manchester, 1908–09. In 1914, she became attached to the "Old Vic" company in London. She remained there until 1918, and acted in many principal Shakespearian parts. In 1919 she appeared in a series of matinées at the Holborn Empire, in which she played the parts of Hecuba in *The Trojan Women* and of Candida, in Bernard Shaw's play of that name. Henceforward her success was assured. Among her principal parts were those of Jane Clegg in St. John Ervine's play, and Joan of Arc in Bernard Shaw's *Saint Joan.* From 1920–22 she sustained a number of leading parts in Grand Guignol at the Little theatre, London In 1908 Miss Thorndike married Lewis Thomas Casson

THORNE, a market town in the West Riding of Yorkshire, England, 10 m. N E of Doncaster, by the L N E. railway. Pop (1921) 6,076. It lies near the right bank of the river Don, in a low, flat district, which was formerly a marshy waste. Hatfield Chase, a portion of this tract south of Thorne, was partly drained by the Dutch engineer Vermuyden in the 17th century and there were in the district numerous Dutch settlers. To-day "the levels," as the surrounding district is generally named, is drained by numerous canals, and the town has a water communication with Goole and the Humber This latter fact, together with the remarkable fertility of "the levels," contributes to the importance of Thorne as an agricultural centre and market town.

Hatfield Chase is generally considered to have been the scene of the battle of Heathfield in 633, when King Edwin of Northumbria fell before the heathen King Penda of Mercia.

THORNHILL, SIR JAMES (1676–1734), knighted 1715, English historical painter, was born at Melcombe Regis, Dorset He obtained the patronage of Queen Anne, and was in 1719–20 appointed her serjeant-painter in succession to Highmore The queen ordered him to decorate the interior of the dome of St Paul's with a series of eight designs, in chiaroscuro heightened with gold, illustrative of the life of the apostle. He also designed and decorated the saloon and hall of Moor Park, Herts, and painted the great hall at Blenheim, the princesses' apartments at Hampton Court, the hall and staircase of the South Sea Company, the chapel at Wimpole, the staircase at Easton-Neston, Northamptonshire, and the hall at Greenwich hospital, usually considered his most important and successful work, upon which he was engaged from 1708 to 1727 Among his easel pictures are the altar-pieces of All Souls and Queen's college chapels, Oxford, and that in Melcombe Regis church, the portrait of Isaac Newton, in Trinity college, Cambridge, and the picture of the House of Commons in 1730, in which he was assisted by Hogarth, who married Jane, his only daughter. He executed careful full-size copies of Raphael's cartoons, which now belong to the Royal Academy About 1724 he opened a drawing-school in his house in Covent Garden. He died on May 4, 1734

THORNHILL, an urban district in the West Riding of Yorkshire, England, 2 m. S of Dewsbury on the L M S railway Pop. (1921) 11,722 The church of St. Michael has a modern nave, but the chancel with aisles is of good Decorated work, and the tower is Perpendicular The east window contains fine fragments of stained glass of the 15th century The large industrial population is employed in the woollen mills and manufactures of shoddy and carpets.

THORNHILL, village of the parish of Morton, Nithsdale, Dumfriesshire, Scotland, 14 m. N.N W. of Dumfries by the L.M.S. railway Pop. (1921), 1,577. It lies among tree-clad hills and is watered by the Nith and such streams as the Carron, Cample and Crichope Morton parish church lies in the village. There is a natural history museum with a statue of Richard Cameron, the covenanter (1680) in the grounds There are weekly sales of livestock, and an agricultural show is held every September. Near the town are freestone quarries, and a bacon factory. Three miles N N.W. stands Drumlanrig castle, a seat of the duke of Buccleuch, begun in 1679. The fourth duke of Queensberry, "Old Q," incurred the wrath of Robert Burns and Wordsworth by his wanton destruction of the magnificent woods. On the death of "Old Q" without issue in 1810, Henry, third duke of Buccleuch, succeeded to the dukedom of Queensberry, and the property has since been adequately cared for. The gardens and park are very fine. The

ruins of Tibber's castle, dismantled in 1311 by Robert Bruce, stand in the grounds, about 1 m. from the mansion

THORNYCROFT, SIR JOHN ISAAC (1843–1928), British naval architect, brother of Sir Hamo Thornycroft (*q v.*), was born in Rome, on Feb 1, 1843, and educated privately and at Glasgow university In 1866 he established shipbuilding works at Chiswick, which later became known for the production of high-speed launches and torpedo craft In his yards was built the first British naval torpedo-boat, the "Lightning" (1877). The growing size of the torpedo-boats necessitated the removal of the works to Woolston, Southampton, in 1906 In 1916 Thornycroft built a large number of high-speed torpedo boats, constructed to skim the water, which proved very successful. He was elected F R.S. in 1893, and was knighted in 1902. He died on June 28, 1928, at Bembridge, Isle of Wight

THORNYCROFT, SIR WILLIAM HAMO (1850–1925), British sculptor He assisted his father, Thomas Thornycroft in carrying out the fountain in Park lane, London, and modelled the figures of Shakespeare, Fame and Clio, in 1871 In 1872 he exhibited at the Royal Academy, "Professor Sharpley" in marble, for the memorial in University college His "Warrior Bearing a Wounded Youth from the Field of Battle" gained the gold medal at the Royal Academy schools in 1875 In this and in "Lot's Wife" in marble (1878) and "Artemis" (1880) Thornycroft turned towards the Greek school In 1880 he was elected A R A, and R A in 1888. He was awarded a medal of honour at the Paris exhibition in 1900 He was knighted in 1917, and died in 1925

Thornycroft's sculptures include "The Mower" (1884), "Teucer" (1881), a bronze figure now in the Tate gallery, London; statues of "General Charles Gordon" (1885), in Trafalgar square, "Oliver Cromwell," at Westminster (1899), and the "Gladstone Monument," in the Strand, London. *See* M. H. Spielmann, *British Sculpture and Sculptors of To-day.*

THÓRODDSEN, THORVALDUR (1855–1921), Icelandic geographer, was born on the island of Flatey, in Breidifjördr, Iceland, on June 6, 1855, the son of Jón Thóroddsen. He was educated at Reykjavik and at the university of Copenhagen, where he studied natural science and geography In 1876 he was sent to Iceland by the Danish government with Professor Johnstrup to investigate the causes of the eruption which had occurred in 1875 at Askja in Dyngjufjoll, and this was the beginning of a long series of Icelandic explorations In 1880 he was appointed master at the school of Modruvellir in northern Iceland, and in 1882–84 made extensive explorations into the interior He travelled in England and on the Continent from 1884 until 1886 when he was appointed schoolmaster at Reykjavik Until 1898 he made a journey of exploration nearly every year, the later expeditions being undertaken from Copenhagen, where he settled in 1895

His works include several volumes on the Volcanoes of Iceland, the last being *Die Geschichte der isländischen Vulkane* (1925); other works are *Land fraedissaga Island* (1892); *Geschichte der islandischen Geographie* (2 vols, 1898); and *Island Grundriss der Geographie and Geologie* (1905).

THORPE, SIR THOMAS EDWARD (1845–1925), British chemist, was born at Harpurhey, Manchester, on Dec. 8, 1845; he studied at Owen's college and then under Bunsen at Heidelberg. In 1870 he became professor of chemistry at Anderson's college, Glasgow, and four years later at the Yorkshire college, Leeds In 1885 he obtained the chair at the Normal School of Science (now the Imperial College of Science), London, and remained there until appointed director of the Government laboratories in 1894 On his retirement, in 1909, he returned to the Imperial college for a period of three years. He was elected to the Royal Society in 1876, was made a C.B. in 1900 and knighted in 1909. He died on Feb. 23, 1925.

Thorpe is perhaps best known for his work as an organizer in connection with the Government laboratories, and as a brilliant lecturer and writer His *Essays in Historical Chemistry* is an attractive and interesting work. He also brought out, with the co-operation of a number of specialists, the well-known *Dictionary of Applied Chemistry*, a new edition of which was completed in 1927 (1st ed, 1890). His contributions to chemical knowledge include a very accurate series of measurements of the specific volumes of chemical substances of related composition. With A.E.H. Tutton, he studied the oxides of phosphorous (*q.v.*) (1886 *et seq.*); they discovered P_2O_4 and investigated this and P_4O_6. From 1884 to 1886 he made a long series of measurements (with J. W. Rodger) of the viscosities of organic substances, and attempted to correlate fluidity and composition. With Sir A. Rucker, he carried out a magnetic survey of the British Isles. See *Proc. Roy. Soc.* (1925).

THORWALDSEN, BERTEL (1770–1844), Danish sculptor, the son of an Icelander who had settled in Denmark, and there carried on the trade of a wood-carver, was born in Copenhagen on Nov. 19, 1770. He entered the Copenhagen school of art, and in 1792 won the highest prize, the travelling studentship. In 1797 he went to Rome, where Canova was at the height of his popularity. Thorwaldsen's first success was the model for a statue of Jason, highly praised by Canova, which he was commissioned to execute in marble by Thomas Hope, a wealthy English art-patron. From that time Thorwaldsen's success was assured, and he did not leave Italy for twenty-three years. In 1819 he returned to Denmark, where he was commissioned to make the colossal series of statues of Christ and the twelve apostles which are now in the Fruenkirche in Copenhagen These were executed after his return to Rome, and were not completed till 1838, when Thorwaldsen again returned to Denmark He died suddenly on March 24, 1844, bequeathing a great part of his fortune for the building and endowment of a museum in Copenhagen. His collection of works of art and the models for all his sculpture went to furnish the museum, in the courtyard of which he is buried under a bed of roses, by his own special wish.

On the whole Thorwaldsen was the most successful of all the imitators of classical sculpture, and many of his statues of pagan deities are modelled with much of the antique feeling for breadth and purity of design. For Christian sculpture he had no real feeling, and the tomb of Pius VII. in St. Peter's and the "Christ and Apostles" at Copenhagen are less successful Thorwaldsen worked sometimes with feverish eagerness; at other times he was idle for many months together A great number of his best works exist in private collections in England

See Eugène Plon, *Thorwaldsen, sa vie,* etc. (Paris, 1880); Andersen, *B Thorwaldsen* (Berlin, 1845); Killerup, *Thorwaldsen's Arbeiten,* etc. (Copenhagen, 1852), Thiele, *Thorwaldsen's Leben* (Leipzig, 1852–1856); C A Rosenberg, *Thorwaldsen . mit 146 Abbildungen* (1896, "Künstlermonographien," No. 16), S Trier, *Thorvaldsen* (1903), A Wilde, *Erindringer om Jerichau og Thorvaldsen* (1884); F. Oppermann, *Thorvaldsen, hans Barndom og Ungdom* (1924).

THOTH, the Greek name of the Egyptian god of letters, invention and wisdom, the mouthpiece and recorder of the gods, and arbiter of their disputes. Thoth is found on the earliest monuments symbolized by an ibis (*Ibis aethiopica,* still not uncommon in Nubia), which bird was sacred to him

See E. A. W. Budge, *The Gods of the Egyptians.*

THOU, JACQUES AUGUSTE DE [THUANUS] (1553–1617), French historian, was the grandson of Augustin de Thou, president of the parlement of Paris (d 1544). He studied law at Orleans and at Bourges, where he made the acquaintance of Hotman, and finally at Valence, where he had Cujas for his master and Scaliger as a friend. He was at first intended for the Church; he received the minor orders, and on the appointment of his uncle Nicolas to the episcopate succeeded him as a canon of Notre-Dame As *conseiller d'état* he served faithfully both the effeminate, bigoted and cruel Henry III. and Henry IV, a sceptic and given to love-intrigues, because they were both the representatives of legitimate authority. He succeeded his uncle Augustin as *président à mortier* (1595), and used his new authority in the interests of religious peace, negotiating, on the one hand, the Edict of Nantes with the Protestants, while in the name of the principals of the Gallican Church he opposed the recognition of the Council of Trent This attitude exposed him to the animosity of the League party and of the Holy See, and to their persecution when the first edition of his history appeared.

This history was the work of his whole life. His materials

for writing it were drawn from his rich library, which he established in the Rue des Poitevins in the year 1587, with the two brothers, Pierre and Jacques Dupuy, as librarians. His object was to produce a purely scientific and unbiassed work, and for this reason he wrote it in Latin, giving it as title *Historia sui temporis.* The first 18 books, embracing the period from 1545-1560, appeared in 1604 (1 vol. folio), and the work was at once attacked by those whom the author himself calls *les envieux et les factieux.* The second part, dealing with the first wars of religion (1560–1572), was put on the *Index librorum prohibitorum.*

The third part (up to 1574), and the fourth (up to 1584), which appeared in 1607 and 1608, caused a similar outcry, in spite of de Thou's efforts to remain impartial. In answer to his detractors, he wrote his *Mémoires,* which are a useful complement to the *History of his own Times* After the death of Henry IV., the queen-regent refused him the position of first president of the parlement, appointing him instead as a member of the *Conseil des finances.* He continued to serve under Marie de Medicis, and took part in the negotiations of the treaties concluded at Ste Menehould (1614) and Loudun (1616) He died at Paris on May 7, 1617.

Three years after the death of de Thou, Pierre Dupuy and Nicolas Rigault brought out, with pt. v., the first complete edition of the *Historia sui temporis,* comprising 138 books, they appended to it the *Mémoires,* also given in Latin (1620). A hundred years later, an Englishman, Samuel Buckley, published a critical edition, the material for which had been collected in France itself by Thomas Carte (1733). De Thou's history is a model of exact research, drawn from the best sources, and presented in a style both elegant and animated. The standard translation is *Histoire universelle,* by Le Beau, Le Mascrier, the Abbé Des Fontaines, 1734. The *Mémoires* had already been translated by Le Petit and Des Ifs (1711), in this form they have been reprinted in the collections of Petitot, Michaud and Buchon. To de Thou we also owe certain other works a treatise *De re accipitraria* (1784), a *Life,* in Latin, of Papyre Masson, some *Poemata sacra, etc.*

For his life may be consulted the recollections of him collected by the brothers Dupuy (*Thuana, sive Excerpta J A Thuani per ff P P,* 1669, reprinted in the edition of 1733), and the biographies by J. A. M. Collinson (*The Life of Thuanus,* 1807), and Duntzer, (*De Thou's Leben,* 1837) Finally, *see* Henry Harrisse, *Le Président de Thou et ses descendants, leur célèbre bibliothèque* (1905).

THOUARS (tōō-ar), a town of W France, in the department of Deux-Sèvres, on the right bank of the Thouet, 24 m S by W. of Saumur on the railway to Bordeaux Pop. (1926) 7,419. Thouars, which probably existed in the Gallo-Roman period, became in the 9th century the seat of powerful viscounts, who in later times supported the English In 1372 the latter were expelled from the town by Bertrand du Guesclin. In 1563 Charles IX created Louis III, the head of the family of La Trémoille, duke of Thouars. In 1793 the Vendeans took the town by assault. A massive stronghold built in the early 17th century by the La Trémoille family stands on a rocky hill overlooking the river. The adjoining 16th century Sainte-Chapelle is in the Gothic style with Renaissance details The church of St Médard, rebuilt in the 15th century, has a Romanesque doorway That of St Laon (12th and 15th centuries) was formerly attached to an abbey, the buildings (17th century) of which serve as town-hall Remains of the 13th century ramparts of the town, flanked by huge towers, are still to be seen, and a bridge of the same period crosses the Thouet. The manufacture of shoes, and the preparation of veterinary medicine and lime, are carried on. Wine, live stock and agricultural produce are the chief articles of trade

THOUGHT, LAWS OF. Logicians usually formulate certain ultimate principles or assumptions implied in all consistent thinking and reasoning. These principles are known as the "laws of thought" in the narrower and more usual sense of the expression, though in a wider sense the rules of the syllogism and of induction, etc., might be called laws of thought Three or four such fundamental principles are usually formulated. Perhaps a fifth ought to be added. They are as follows (1) *The Principle of Identity:* "A is A," or "a thing is what it is" or "everything has a certain character which it retains more or less" (*see* IDENTITY). (2) *The Principle of Contradiction:* "A is not non-A," or "A cannot both be B and not be B," or "A cannot be both B and non-B," "a thing cannot both have and not have a certain attribute," or "the same predicate cannot be both affirmed and denied of the same subject." (3) *The Principle of Excluded Middle:* "A either is or is not B," or "A is either B or non-B," or "a thing must either have or not have a certain character," or "of two contradictory predicates one can be asserted of every relevant subject." (4) *The Principle of Sufficient Reason:* "Nothing occurs for which one having sufficient knowledge might not be able to give a reason sufficient to determine why it is as it is and not otherwise" (Leibniz). (5) *The Principle of Uniformity of Reasons:* "Whatever is regarded as a sufficient reason in any one case must be regarded as a sufficient reason in all cases which are essentially of the same kind," or, expressed negatively, "nothing can be regarded as a sufficient reason in any one case unless it can also be regarded as a sufficient reason in all cases of that kind" (A. Wolf)

These principles are indemonstrable assumptions or postulates. If they cannot be proved, neither can they be disproved Any one, who chooses to challenge, say, the principle of contradiction, would only put himself in an absurd position. For, by refusing to accept its validity, he admits the possibility that those who accept it and those who reject it may both be right. So he has nothing to object to. Again, in describing these principles as laws of *thought* it is not intended to contrast thought with things, and to suggest that they are mere peculiarities of human ways of thinking without foundation in objective fact—as Nietzsche and some pragmatists or sceptics would maintain. Normally what we really think we believe to be true of the facts referred to. The laws of thought were originally assumed to hold good of things as well as of thought; and they are still so regarded by many thinkers. *See* LOGIC and the bibliography given there

THOUGHT-READING, the perception of another person's thoughts in the absence, or apparent absence, of normal means of communication (*See* PSYCHICAL RESEARCH.)

THOUGHT TRANSFERENCE: *see* TELEPATHY

THOUSAND AND ONE NIGHTS. In 1704 there appeared at Paris the first four volumes of a collection of Arabic stories called *Les Mille et Une Nuits,* translated by Antoine Galland (1646–1715; *q v*), an orientalist and archaeologist of high reputation in his day, but now remembered chiefly for this translation in which the *Nights* were first introduced to the Western world In 1705 volumes v and vi appeared in 1706 volume vii; in 1709 volume viii, only half of which was by Galland or from the *Nights;* in 1712 volumes ix and x, wholly by Galland; in 1717, two years after Galland's death, volumes xi and xii, from his papers The book had an enormous success pirated editions at once appeared in Holland; there were many European versions made from it At least as early as 1707, six of the volumes were rendered into English by an unknown translator, often called "the Grub Street translator," under a long descriptive title beginning with *Arabian Nights Entertainments* It is safe to say that the *Arabian Nights* of the childhood of all of us was some form or other, complete or incomplete, of a version from Galland's French.

At two points the *Nights* were fortunate in their introduction to Europe First, Galland was a born story-teller and he was able to adapt these Oriental tales not only to the taste of the France of his time but to the universal story-reading public of all countries and times Some of his versions have been rendered back even into Oriental languages and received with favour in the East. It cannot be claimed that he was a faithful translator—no one in his time was—and his recasting belongs more to French than to Arabic literature. But he produced a great French story-book and without his genius it is conceivable that the *Nights* would never have taken the place with us that they have done And, second, fortune placed in his hands excellent materials. He had begun with a translation of Sinbad the Sailor; then he learned that this was only part of a larger collection and there were sent to him from Syria three volumes of a manuscript of the *Nights* which is still the oldest manuscript known and in many respects the best and the most authentic Later, when in his seventh volume he had exhausted the material in this manuscript, fortune again favoured him and introduced him to a Maronite

from Aleppo, named Hanna, brought to France by the traveller Paul Lucas. Hanna related to him in Arabic some of the stories which fill his last four volumes and gave him copies of some of them in writing The Galland version is thus highly composite. Further details on it should be sought in H. Zotenberg's *Histoire d' 'Alâ al-Dîn ou la Lampe Merveilleuse, Texte arabe publié avec une notice sur quelques manuscrits des Mille et une Nuits* (Paris, 1888) In this volume Zotenberg gave the Arabic text of "Aladdin," known until then only in Galland's translation; and in the *Journal of the Royal Asiatic Society* (April 1910; Jan 1913) the present writer gave the only known Arabic text of "Ali Baba and the Forty Thieves," discovered by him in the Bodleian For the place which the Galland manuscript takes among the manuscripts of the *Nights*, reference may be made to an article by the present writer, "A Preliminary Classification of Some Manuscripts of the Arabian Nights" in the *Volume of Oriental Studies* presented to E. G Browne in 1922.

Early History.—But what do we know of the earlier history of this collection of tales? It is unfortunate that the Mohammedan world has never regarded it as belonging to polite literature; it fell rather into the class of recitations in the coffee-house and indicated an uncultivated, almost depraved taste in those who cared for it This has had two results (1) We are thrown back for the history of the collection on stray allusions often difficult to interpret (2) The collection has never been stable but highly fluid, consisting at different times of different stories; it has been subject to the caprice of different redactors who drew upon the vast reservoir of popular tales to fill out the number of a thousand and one nights; and it may be said, in short, that the introductory framework story and the division in consequence into nights are about the only certain features in these different recensions There is thus no such thing as a standard text of the *Nights* which has existed through its long history The text, which seems now to have attained to the dignity of a Vulgate and which is known to all through the translations of Lane, Torrens, Payne, Burton and Littmann, is quite modern. It was compiled in Egypt by an unknown redactor toward the end of our 18th century, as Zotenberg has shown in his *Notice* cited above There are numerous manuscripts of it in existence and all the printed texts are derived from it except two, the edition of the first 200 nights, known as Calcutta I, which is a remote descendant of the Galland manuscript (*see* "Classification" above, pp. 311 ff), and the Breslau edition (Breslau 1826–38) which is a compilation by the editor Habicht from a number of manuscripts including a large section from the Galland manuscript (*see* article in *Journal of Royal Asiatic Society,* July 1909, pp. 635 ff.). Of this modern Egyptian Vulgate the first Būlāq edition (A H. 1252, A D 1835) gives the most trustworthy text. The generally parallel second Calcutta edition (1839–42), also from an Egyptian manuscript, has been contaminated from Calcutta I. and Breslau.

The oldest testimony we have, apart from Indian folk-lore evidence, to the existence of a collection of stories held together by a framework story like that of our *Nights* is in the historical encyclopaedia of Mas'ūdī (d. A H. 345 = A D 956) commonly called "The Golden Meadows." In it (Paris ed iv, pp 89f), speaking of lying stories told by pseudo-traditionalists and by the popular purveyors of edifying legends, he says: "These are like the books transmitted to us and translated for us from the Persian, Indian and Greek, the origin of which was similar to these, such as 'The Book of *hazār afsāna*,' or, translated from Persian to Arabic, 'of a thousand *khurāfas*,' for a *khurāfa* is called in Persian an *afsāna*. The people call this book 'A Thousand Nights and a Night.' " He, then, goes on to give an outline of the framework story which resembles that of our *Nights* but is not quite the same. *Khurāfa* is a rather disrespectful Arabic word for a pleasant and strange but incredible story. The exact usage of it has varied at different times. As to the framework story in its different forms, Cosquin (*Revue Biblique,* January to April, 1909) has shown that a number of similar frames exist in Indian stories. It can be traced definitely back indeed to Indian folklore. Another form of the same passed into North Africa and is the framework story of a collection called *The Hundred and One Nights* (Gaudefroy-Demombynes *Les Cent et Une Nuits*, traduites de l'Arabe, Paris, no date). These folk-lore investigations show that any connections between this story and the Book of Esther and Persian national legends, according to De Goeje's hypothesis in earlier editions of this encyclopaedia, can only have been *en passant* when the story was on its way from the extreme east of Asia to the west of North Africa Cosquin has removed the whole question from literary to folk-lore tradition Further, it is to be observed that there is no evidence that this *Thousand and One Nights* of Mas'ūdī contained any of the stories which are in our manuscripts of the *Nights,* except the framework story.

The next witness to a *Nights* is the *Fihrist,* a *catalogue raisonné* of Arabic literature, compiled between A.H. 377 and 400, or, perhaps, slightly later. The author gives a wealth of information as to the origins and development of story-literature in Arabic. He describes the Persian *Hazār afsāna* with its origin; it contained 1,000 nights and less than 200 stories. It existed also in an Arabic translation, but he does not specifically call that "The Thousand and One Nights," as the earlier (Mas'ūdī) does He regarded it as a worthless and stupid book, although it is evident that he had not the learned Moslem prejudice against entertaining stories We may fairly deduce from the evidence that the first Arabic *Nights* was a straight translation of the Persian *Hazār afsāna*; that it was a comparatively small book in which each story averaged about five nights; and that it was not of much value Again, there is no evidence as to what its stories were except that they must have been of Persian origin

The next scrap of evidence is derived from an al-Qurṭī who wrote a history of Egypt under the last Fāṭimid Caliph al-'Āḍid (A.H. 555–567) In it he named specifically a book called *A Thousand and One Nights* and compared its stories to popular tales current in his time among the people We have not his history but we know this passage because it was quoted twice by al-Maqrīzī (d A H. 845) in his *Khiṭaṭ,* i, p. 485; ii, p. 181 and by al-Maqqarī (d A.H 1041) in his *Nafḥ aṭ-ṭīb, i*, p 653 This means that a *Nights,* of some form or other, was well known in Egypt in Fāṭimid times

Next comes the manuscript which Galland used It was sent to him from Syria after A D. 1700, but had evidently been written in Egypt From a note in it, it seems that it was at the Syrian Tripoli in A H. 943, A D 1536–37, and it was at Aleppo in A H 1001, A D. 1592–93. When the manuscript was written, before these dates, we do not know But we can give dates before which it could not have been written, from allusions in certain of the stories in it. In the Cycle of the Porter of Baghdad, at the beginning of the story of the second calendar, that prince tells that part of his education was in the *Shāṭibiya,* the author of which died A H 590, after al-Qurṭī's date. On the date of the story of the two Viziers, Nūr ad-Dīn 'Alī and Shams ad-Dīn Muhammad Prof. William Popper has recently gathered (*Journal of Royal Asiatic Society,* Jan. 1926) a mass of valuable material He concludes that this story cannot be earlier than the reign of Baibars, A.H. 650–76 (A D. 1260–77), and he is inclined to a date later than A.H. 706 On historical references he would also date the Hunchback Cycle after A H. 819. Further, in that Cycle, when the Barber makes his apologia in reply to the story told by the young man it is plain that he is speaking after the capture of Baghdad by Hūlāgū in A.H. 656 (A.D. 1258). But, further again, in the story told by the Christian broker, a Cairene Copt, about his dealings with the young man of Baghdad, the Khān of al-Jāwalī is mentioned. This Jāwalī died A.H. 745 (A D. 1344–45), and the date of the story can hardly be pushed back before that date and may be considerably after that date. *See* details on all these points in the present writer's article "Earlier History of the Arabian Nights" in *Journal of the Royal Asiatic Society* pp. 353–97 (July 1924).

From the above it is plain that the *Nights* to which al-Qurṭī testifies as being current in Fāṭimid times cannot have been the *Nights* of the Galland manuscript. But the Egyptian recension which Zotenberg has shown was compiled in the later 18th century and which is the present Vulgate of the *Nights,* so far as editions and translations are concerned, was based demonstrably on a sister

manuscript to that of Galland but one more complete as to the number of *Nights;* the Galland manuscript reaches only *Night 281.* On the other hand, this modern Egyptian recension has lost grievously in the course of transmission in freshness of vocabulary and wealth of details. We are left then with the apparent result that some time after A.D. 1400 an Egyptian lover of stories took the framework story of the *Nights* and built it up into a thousand and one nights, inserting the best stories current in his time that he could find An incomplete manuscript derived from his recension wandered up into Syria; others more complete remained in Egypt and formed the basis for the 18th century recension which Zotenberg identified. Still undefined is the relationship of these to certain old Syrian manuscripts which are preserved in libraries at Tübingen and Paris, and in the Rylands library at Manchester.

For the long and complicated bibliography of the *Nights* reference can be made to Victor Chauvin's *Bibliographie des Ouvrages Arabes,* pt. iv to vii (Liége, 1900–03) This is a thesaurus of the whole subject. Still worth reference is J Østrup's *Studier over Tusind og en Nat* (Copenhagen, 1891). Of this there is an abbreviated French translation by E. Galtier in *Memoires de l'Institut Français du Caire,* vol. xxvii, and a German translation by O Rescher (Stuttgart, 1925) with valuable additions bringing it to that date. English is fortunate in its direct translations from the Arabic; all, however, from the printed texts of the modern Egyptian Recension. In 1838, Henry Torrens published a very remarkable version (Calcutta and London) of the first 50 *Nights,* giving the feeling of the original in prose and verse better than almost any other Lane's incomplete version (3 vol. London, 1839–41) is from the Būlāq edition and shows his deep knowledge of Cairene Arabic; the commentary is very valuable. The version by John Payne (Villon Society, 9 vol. 1882–84) from the Calcutta edition is a faithful and complete rendering into rather sophisticated translator's English The prose part of Burton's version (*Benares,* 10 vol, 1885) is largely dependent upon Payne, but treated after Burton's fashion; the verse is his own An excellent and complete German translation by Enno Littmann is in course of publication at Leipzig; it is from the Calcutta text with additions, and five volumes out of six have appeared. The French version of J. C. Mardrus (Paris, 1899 ff.), professedly from the Būlāq edition, is unfaithful to an extensive degree and represents no known Arabic text; the same holds of the various versions derived from it in English, Spanish and Polish. (D. B. M)

THRACE, a name applied at various periods to areas of different extent. Since 1923 Thrace has been divided between Greece (Western Thrace) and Turkey (Eastern Thrace). The boundaries of the Roman province of Thrace were—north, the Haemus; east, the Euxine sea; south, the Propontis, the Hellespont and the Aegean; and west, the Nestus. The distinguishing features of the country were the chain of Rhodope (Despotodagh) and the river Hebrus (Maritza) The former separates from the Haemus at right angles, and runs southward, parallel to the Nestus, until it approaches the sea, when it takes an easterly direction. Several of the summits of this chain are over 7,000ft. in height. The Hebrus, with its tributaries, drains almost the whole of Thrace. It starts from near the point of junction of Haemus and Rhodope, and takes an easterly direction, but at Hadrianopolis it makes a sharp bend towards the south, and enters the sea nearly opposite the island of Samothrace The greater part of the country is hilly and irregular; besides Rhodope two other tolerably definite chains intersect it, one of which descends from Haemus to Adrianople, while the other follows the coast of the Euxine at no great distance inland. One district in the extreme north-west of Thrace lay beyond the watershed separating the streams that flow into the Aegean from those that reach the Danube: this was the territory of Sardica, the modern Sofia. In the later Roman period two main lines of road passed through the country. One of these skirted the southern coast, being a continuation of the Via Egnatia, from Dyrrhachium to Thessalonica, connecting the Adriatic and the Aegean; it became of the first importance after the foundation of Constantinople. The other followed a north-westerly course through the interior, from Constantinople by Hadrianopolis and Philippopolis to the Haemus, and thence through Moesia in the direction of Pannonia, taking the route by which the railway now runs from Constantinople to Belgrade.

The climate of Thrace was regarded by the Greeks as severe, and that country was spoken of as the home of the north wind, Boreas. The coast of the Euxine was feared by sailors, as the harbours were few and the sea tempestuous; but on the southern shore we find the Greek colonies of Abdera and Mesambria on the Aegean, Perinthus on the Propontis, and, the most famous of all, Byzantium (*q.v.*). Colonies were also planted in the Thracian Chersonese, between the Hellespont and the Bay of Melas; among its cities were Sestos and Callipolis (Gallipoli). In order to prevent the incursions of the Thracians, a wall was built across its isthmus, which was less than 5m. in breadth.

History.—The most striking archaeological monuments of the prehistoric period are the sepulchral mounds, which are found especially in the neighbourhood of the ancient towns. Roman implements and ornaments have been found in some of them The country was overrun several times by Darius and his generals, and the Thracian Greeks contributed 120 ships to the armament of Xerxes (Herod. vii. 185). The most powerful Thracian tribe was the Odrysae, whose king, Teres, extended his dominion so as to include the greater part of Thrace During the Peloponnesian War his son Sitalces was an ally of the Athenians against the Macedonians During the early period of the Roman empire the Thracian kings were allowed to maintain an independent sovereignty, while acknowledging the suzerainty of Rome, and it was not until the reign of Vespasian that the country was reduced to the form of a province. It was much exposed to the inroads of barbarian invaders, was overrun by the Goths on several occasions, and subsequently by the Huns; but its proximity to Constantinople caused its fortunes to be closely connected with the capital of the Eastern empire In the middle ages the northern parts of Thrace were occupied by Bulgarians; in 1361 the Turks made themselves masters of Adrianople, which became the Turkish capital. When Constantinople fell in 1453, the whole country passed into the hands of the Turks, and in their possession it remained until 1878, when the northern portion of it was placed under a separate administration, with the title of Eastern Rumelia; this province has now become a part of Bulgaria

Ancient Peoples.—The name "Thracians," from being used both ethnically and geographically, has led to confusion There were the indigenous Thracians, and also Celtic tribes, such as the Getae. These were the "red" Thracians of Greek writers, and they differed not merely in complexion, but also in their customs and religion, from the native Thracians (Herod., v. 14). The native Thracians were inferior in morals, allowing their girls complete licence until marriage. The chief native deities were Dionysus, Ares and Bendis (Artemis). The ancient Dionysiac rites, including a ritual play by "goat-men" carrying a wooden phallus, may still be seen at Bizye, the old residence of the Thracian kings (*see* R. M. Dawkins in *Hellenic Journal,* 1906, p. 191). The true Thracians were a dark-complexioned, long-skulled race, which had been in the Balkan peninsula from the stone age, closely akin to the Pelasgians (*q.v.*), to the Ligurians, and to the Iberians. In Homer, the term Thracian is applied to all the tribes dwelling from Pieria to the Euxine. There is no well-defined difference between aboriginal Thracians and Illyrians (*see* ILLYRIA). Thus there was an Illyrian tribe, Brygi; a Thracian tribe, Bryges, and, in Strabo's time, a tribe called Dardanii, then reckoned Illyrian, living next the Thracian Bessi (in whose land was the oldest oracle of Dionysus), were probably as much Thracian as Illyrian. All the Thracian and Illyrian tribes tattooed, thus being distinguished from the Celtic tribes. The Thracians differed only dialectically from the Illyrians, their tongue being closely allied to Greek. The Thracians of the region from Olympus to the Pangaean district, worked the gold and silver of that region, began to strike coins almost as early as the Greeks, and displayed on them much artistic skill. Alexander I. of Macedon, on his conquest of the Bisaltae, adopted the native coinage of their country placing on the coins his own name (*see* NUMISMATICS.) (X)

THE 20th CENTURY

Thrace was one of the three theatres of the first Balkan war of 1912, when the Bulgarians entered it and defeated the Turks in the great battle of Lule Burgas, subsequently marching up to the ramparts of Chatalja, where the armistice with the Turks was signed. With the assistance of Serbian troops the Bulgarians took Adrianople, and the Treaty of London of May 30, 1913 put back the frontier of European Turkey to a line drawn from Enos on the Aegean to Midia on the Black Sea Nearly all Thrace had thus fallen to the share of Bulgaria, but her quarrel with her allies over the spoils in Macedonia led to the second Balkan war of 1913, and the Turks took the opportunity to recapture Adrianople, to reoccupy Western Thrace and create the "independent government of Gümuljina," a mainly Moslem district.

The treaty of Constantinople of Sept 29, 1913 set back the Turco-Bulgarian frontier in Thrace to the mouth of the river Rezvaya on the Black Sea, considerably to the north of Midia, and, while making the right branch of the Maritsa the frontier on the Aegean, so drew the line between those points as to include Kirk Kilisse and Adrianople within Turkish Thrace But Gümüljina was restored to Bulgaria, with the result that 14 Moslem deputies of Western Thrace held the balance of power in Bulgaria and, under the influence of their compatriot Talaat, helped to bring Bulgaria over to the Central Empires Meanwhile the third Treaty of Bucharest fixed the Greco-Bulgarian frontier at the mouth of the Mesta; thus the Thracian coast from the Mesta to the Maritsa gave Bulgaria her coveted outlet on the Aegean. But the frontier cut the latter river and the Mustafa-Pasha (Svilen) Adrianople-Dedeagach railway so that Bulgarian trains had to traverse Turkish territory before reaching their Bulgarian port The Maritsa was consequently declared free to the transit of both states till they had made fresh lines on their own territories. The cession of this awkward bend in the railway to Bulgaria in 1915 was a further inducement to enter the War on the Turkish side. Thrace was not long left in peace, for the operations at the Dardanelles brought her again within the war zone. The Treaty of Neuilly of 1919 again changed her boundaries Bulgaria was moved back from the Thracian sea coast in favour of Greece, which by Article 27 of the Treaty of Sèvres of 1920 obtained the lion's share of Thrace as far as "a point near the mouth of the Biyuk Deré" on the Black Sea, and "a point on the sea of Marmora about one kilometre southwest of Kalikratia"—in other words, up to the Chatalja lines.

But the Allies undertook to make the Maritsa an international river and "to ensure the economic outlet of Bulgaria to the Aegean" by Article 48 of the Treaty of Neuilly This they effected —in theory—by "the Thracian Treaty," signed on the same day as that of Sèvres, which decreed, as a condition of the recognition of Greek sovereignty over the former Bulgarian territories in Thrace, that Bulgaria should have "freedom of transit over the territories and in the ports assigned to Greece in the present Treaty," that "in the port of Dedeagach Bulgaria will be accorded a lease in perpetuity, subject to determination by the League of Nations, of a zone," and that Dedeagach be "declared a port of international concern," free to all members of the League. In practice, Bulgaria did not avail herself of this provision, rejecting Venizelos' offer in 1922 of a lease of the port and preferring a corridor and actual possession. The Greek tenure of Eastern Thrace was brief After the disaster in Asia Minor, Article 2 of the second Treaty of Lausanne of July 24, 1923 restored Eastern Thrace up to the Maritsa to Turkey, leaving Western Thrace, *minus* the enclave of Karagach, to Greece. By conventions 3 and 6, on either side of these Greco-Turkish and Bulgaro-Turkish frontiers in Thrace demilitarized zones of about 30 km. were established and existing fortifications ordered to be dismantled, and the Moslem inhabitants of Western Thrace were exempted from the obligatory exchange of populations. Thus Thrace became divided between Turkey, Greece and Bulgaria.

Economic Conditions.—Heavy damage was inflicted on south-western Thrace, the most fertile portion of the country, during the Balkan wars of 1912–13. Railway communications are complicated by the unscientific frontier near Adrianople, whereby the line from Western Europe to Constantinople traverses a tiny strip of Turkish territory, re-enters Greece and then recrosses into Turkey The Turks have in hand (1928) a scheme to build a line farther to the north, which will obviate the necessity of passing through Greek territory Thrace is in a primitive condition, but amongst the steps taken by the Turkish Government to improve the position is the establishment of a modern sugar factory and the encouragement of modern methods in the cheese manufacture of the Adrianople area. Turkish Thrace is now ethnologically overwhelmingly Turkish, while the Greeks find the remaining Muslims of the western half useful for the tobacco culture. The demilitarization of the Gallipoli peninsula by the Lausanne Treaty should spare Thrace the spectacle of hostile armies. But the situation created by the treaties following the World War must be regarded as provisional and artificial

(W M)

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THRASEA PAETUS, PUBLIUS CLODIUS, Roman senator and Stoic philosopher. lived during the reign of Nero He was the husband of Arria the daughter of Arria (*q.v.*), father-in-law of Helvidius Priscus, and a friend and kinsman of the poet Persius At first he was treated with great consideration by Nero, probably owing to the influence of Seneca, and became consul in A D. 56 and one of the keepers of the Sibylline books. In 59 Thrasea retired from the senate without voting after the emperor's letter justifying the murder of Agrippina had been read. In 62 he prevented the execution of the praetor Antistius, who had written a libel upon the emperor, and persuaded the senate to pass a milder sentence. From this time (63) till his death in 66 Thrasea retired into private life and did not enter the senate-house again Various charges were brought against him, and the senate, awed by the presence of large bodies of troops, condemned him to death When the news was brought to Thrasea at his house, where he was entertaining a number of friends, he retired to his room and had the veins of his arms opened He wrote a panegyric on Cato of Utica, largely used by Plutarch

See Tacitus, *Annals* (ed Furneaux), xiii 49, xiv 12, 48, xv. 20–22, xvi. 21–35, containing a full account of his trial and condemnation.

THRASHER, a group of birds belonging to the same American family *Mimidae* as the mocking-bird (*q v.*). Perhaps the best of these accomplished songsters is Sennett's thrasher (*Toxostoma longirostre*) of south-east Texas and north-east Mexico, but the brown thrasher (*T. rufum*) of eastern North America also has a fine song A third species is the sage thrasher (*Oroscoptes montanus*) of the South-western States of the United States

THRASHING or **THRESHING,** the process by which the grain or seed of cultivated plants is separated from the husk or pod which contains it. The flail was the chief means of threshing grain until about 1860

The flail consisted of two pieces of wood, the handstaff or helve and the beater, fastened together loosely at one end by a thong of rawhide or eelskin, which made a very durable joint. The handstaff is a light rod of ash about 5 ft. long, slightly increasing in girth at the farther end to allow for the hole for the thong to bind it to the beater; its length enabled the operator to stand upright while working The beater is a wooden rod about 30 in. long, made of ash, though a more compact wood such as thorn is less likely to split. This also has a hole at one end for the thong to bind it to the handstaff. The shape of the beater was cylindrical, of about 1¼ in. diam. and constructed so that the edge of the grain of the wood received the force of the blow; 30 to 40 strokes per min. was the average speed.

After the grain had been beaten out by the flail or ground out by other means the straw was carefully raked away and the corn and chaff collected to be separated by winnowing when there was

a wind blowing. This process consisted in tossing the mixture of corn and chaff into the air so that the wind carried away the chaff while the grain fell back on the thrashing floor. The best grain fell nearest while the lightest was carried some distance before falling, thus a rough-and-ready grading of the grain was obtained. It was also performed when there was no wind by fanning while pouring the mixture from a vessel. Later on a fanning or winnowing mill was invented.

The flail is still in use for special purposes such as flower seeds and also where the quantity grown is so small as to render it not worth while to use a thrashing mill For a day's work with it a fair average quantity was 8 bushels of wheat, 30 bushels of oats, 16 bushels of barley, 20 bushels of beans, 8 bushels of rye or 20 bushels of buckwheat.

Meikle's Machine.—The first really successful thrashing machine—the type which is embodied in modern thrashers—was invented by a Scotsman named Andrew Meikle in 1786 In this the loosened sheaves were fed, ears first, from a feeding board between two fluted revolving rollers to the beating cylinder This cylinder or "drum" was armed with four iron-shod beaters or spars of wood parallel to its axle, and these striking the ears of corn as they protruded from the rollers knocked out the grain The drum revolved at 200 to 250 revs. per min. and carried the loose grain and straw on to a concave sieve beneath another revolving drum or rake with pegs which rubbed the straw on to the concave and caused the grain and chaff to fall through Another revolving rake tossed the straw out of the machine The straw thus passing under one peg drum and over the next was subjected to a thorough rubbing and tossing which separated the grain and chaff from it These fell on to the floor beneath, ready for winnowing

The present-day thrashing machine embodies the main features of Meikle's and will thrash up to 16 qrs. of oats per hr, according to its size For further details *see* HARVESTING MACHINERY

Thrashing Work.—The minimum number of hands required in Great Britain are: An engine-driver, a feeder, a sackman and ten other men to handle the sheaves, straw, chaff, grain, etc., while half as many more may be needed where the sheaves or grain have to be carted, as when the thrashing is done in the field in harvest time An 8-h p steam engine is the usual motive power, but the development of the oil engine has provided a very satisfactory substitute. The engine is usually of the "traction" type, so that it can move the thrashing machine or "barn work" (as it is sometimes called) and elevator from place to place, but a further advance has been to combine oil engine and thrasher in one so that the combination is self-moving. The usual quantities thrashed with a "double blast finishing machine," as described, in the United Kingdom are, with a 5 ft. wide drum, from 60 to 80 bushels per hour of wheat and one-third to one-half more of oats and barley.

Sometimes the straw is stacked loose, while sometimes it is tied up with twine by a tier exactly like that on a "string binder" and then stacked up. Where all the straw is used at the farm for fodder, etc., the fixed thrashing machine set up in the barn is the most convenient The sheafed corn has to be carried to it, but, on the other hand, everything is under cover, the work can be done on a wet day, and all the products of thrashing in the shape of grain, straw, cavings, chaff, etc, are kept dry. In the great corn districts, however, the portable thrasher is most convenient; it is set alongside the stack and only the grain and chaff are carried under cover, while the thrashed straw, etc., is restacked up on the spot as the work goes on. (P. McC.)

THRASYBULUS, an Athenian general, whose public career began in 411 B.C., when he frustrated the oligarchic rising in Samos (*see* PELOPONNESIAN WAR). Elected general by the troops, he effected the recall of Alcibiades and assisted him in the ensuing naval campaigns, contributing to the victories of Cynossema (411) and Cyzicus (410). He commanded a ship at Arginusae and after the engagement was commissioned with Theramenes (*q.v.*) to rescue the men on the wrecks.

In 404, when exiled by the Thirty Tyrants he retired to Thebes. Late that year, with seventy men, he seized Phyle, a hill fort on Mt. Parnes. A force sent by the Thirty was routed by a surprise attack Thrasybulus then gained the Peiraeus, 1,000 strong, and held Munychia against the oligarchs. Eventually a Spartan expedition under king Pausanias arrived and effected a settlement by which the democracy was restored. Thrasybulus was now the hero of the people; but a decree by which he secured the franchise for all his followers, including many slaves, was rescinded as illegal

In 395 Thrasybulus induced Athens to join the Theban league against Sparta, and in 389 he led a new fleet of 40 ships against the Spartans at Rhodes. Sailing first to the Bosporus he effected a democratic revolution at Byzantium and renewed the corn-toll After a successful descent on Lesbos and the renewal of the 5% import tax at Thasos and Clazomenae he sailed south in quest of further contributions, and was killed in a skirmish at Aspendus

See Thucydides, viii 75–105; Xenophon, *Hellenica;* Lysias, *c. Eratosth* 55–61 and *c Ergocl* 5, 8; and *Const ath.* xl Diodorus xiii., xiv, Justin v. 9, 10, and Nepos depend almost wholly on Xenophon.

THREAT, a statement made for the purpose of overcoming the will of the person to whom it is addressed. The employment of threats or other forms of intimidation to induce a person to enter into a contract will give the right to sue for its rescission or avoidance, or to sue for damages occasioned by entering into the contract. (*See* COERCION; CONTRACT.)

In criminal law the sending of threatening letters (or causing them to be received), demanding with menaces and without reasonable cause money or other valuable thing, is a felony It is also a felony to threaten to accuse a person of a crime for the purpose of extorting money, or merely to demand money or other property, without having any claim to it, by means of a threat. (*See* BLACKMAIL, LARCENY)

In the United States, threat very largely is covered by statutes in the several States, with variations, but following in the main the English law.

THREE BODIES, PROBLEM OF, the problem of determining the motion of three bodies moving under no influence but that of their mutual gravitation. No general solution of this problem is possible. As practically attacked it consists in the problem of determining the perturbations or disturbances in the motion of one of the bodies around the principal or central body, produced by the attraction of the third Examples are the motion of the moon around the earth as disturbed by the action of the sun, and of one planet around the sun as disturbed by the action of another planet.

THREE-COLOUR PROCESS: *see* COLOUR PRINTING.

THREE RIVERS or TROIS RIVIÈRES, a city and port of entry of Quebec, Canada, and capital of St. Maurice county, situated at the confluence of the rivers St Maurice and St Lawrence The St Maurice flows in from the north, and, being divided at its mouth by two islands, the channels give the town its name. It is on the line of the Canadian Pacific and Canadian National railways, 78 m S.W. of Quebec and 92 m. N E. of Montreal. Founded in 1634 by Champlain, Three Rivers is one of the oldest towns in Quebec. It is the centre of a large lumber trade, which is carried on along the St. Maurice and its tributaries. Some miles from the city are the St. Maurice forges, where iron wares were manufactured as early as the 17th century. The city is the seat of a Roman Catholic bishopric. A large trade is carried on in lumber, grain, cattle, etc., which are shipped to South America, the West Indies, Great Britain and the United States, and a great development has been caused by the utilization of the water-power of the St Maurice at Shawinigan, Grand'Mère and other falls, for the manufacture of wood pulp. As a result, the population, long stationary or slightly declining, increased from 8,334 (1891) to 9,981 (1901) and 22,367 (1921).

THRING, EDWARD (1821–1887), English schoolmaster, was born at Alford, Somerset, on Nov. 19, 1821. He was educated at Eton and at King's college, Cambridge. On leaving the university in 1846 he was ordained, and served for a short time in two curacies. In 1853 he became headmaster of Uppingham school, a post which he retained until his death in 1887 Thring found only 25 boys in the school, but he raised it, both in numbers and repute, to the rank of the best English public schools

Among the distinctive features of his plans and achievements were: (1) his strong sense of the need for a closer study of the characteristics of individual boys than is generally found possible in large public schools; (2) his resolute adherence to the discipline of the ancient languages, in connection with English, as the staple of a liberal education; (3) his provision of additional employments and interests, in studies and in games, to suit the aptitudes of different pupils; (4) the value he attached to the aesthetic side of school training, to music and to drawing and to the artistic decoration of the schoolrooms; and above all (5) his rebellion against mere routine, and his constant insistence on the moral purpose of a school as a training-ground for character

See J. H. Skrine, *Uppingham by the Sea* (1878) and *A Memory of Edward Thring* (1889); J. G. Fitch, *Educational Aims and Methods* (1889); G R Parkin, *Life of Edward Thring* (1898), H. D Rawnsley, *Edward Thring, Teacher and Poet* (1900), W F. Rawnsley, *Edward Thring, Maker of Uppingham School* (1926).

THROAT, the term applied to the front external part of the neck from below the chin to the collar-bone in human and animal anatomy, and to the internal parts, which include the gullet, viz. the fauces, pharynx and oesophagus and the windpipe, viz, the larynx and trachea (*see* PHARYNX, ALIMENTARY CANAL and RESPIRATORY SYSTEM. *Anatomy;* and for diseases *see* PHARYNGITIS, LARYNGITIS, DIPHTHERIA, TONSILLITIS and OESOPHAGUS)

THROAT, DISEASES OF: *see* EAR, NOSE AND THROAT, DISEASES OF

THROCKMORTON (or THROGMORTON), **FRANCIS** (1554–1584), English conspirator, was the son of Sir John Throckmorton of Feckenham in Warwickshire, and his wife Margery Puttenham. Sir John had been concerned in Wyat's rebellion against Queen Mary Tudor, but was afterwards known as a sympathizer with the Roman Catholic party in the reign of Queen Elizabeth, and in 1580 was removed from his office of chief justice of Chester for irregularities in his office, but probably because he was suspected of disloyalty by the government Francis entered Hart Hall, Oxford in 1572, and in 1576 he was enrolled in the Inner Temple. At Oxford he came under the influence of the Roman Catholics, and when Campion (*q v*) and Parsons came to England in 1580 to conduct the Jesuit propaganda against Queen Elizabeth, Francis Throckmorton was one of a society of members of the Inner Temple who united to hide and help them. In that year he went abroad where he consorted with exiled papists, and engaged in treasonable intrigues In 1583 he returned to act as the confidential agent of a conspiracy which had for its object the invasion of England by a French force for the purpose of releasing Mary Queen of Scots and restoring the papal authority.

Throckmorton occupied a house on Paul's wharf, London, which served as a meeting-place for the conspirators The suspicions of the government being aroused, Throckmorton was arrested in October 1583. He was ciphering a letter to Queen Mary when the constables came upon him, but he found time to send a casket of compromising papers to Mendoza, and a card in cipher in which he promised to reveal nothing On being threatened with a second application of the torture, however, his strength and courage failed and he made a full confession His trial, took place on May 21, 1584, and he was executed at Tyburn on the 10th of July The arrest and confession of Throckmorton eventually led to the expulsion of the Spanish ambassador and so to war with Spain

THROCKMORTON (or THROGMORTON), **SIR NICHOLAS** (1515–1571), English diplomatist and politician, was the son of Sir George Throckmorton of Congleton in Warwickshire, and uncle of the conspirator Francis Throckmorton (*See* above.) Brought up in the household of Catherine Parr, the last wife of Henry VIII., he was favourable to the reformers in religion. He sat in parliament from 1545 to 1567. During the reign of Edward VI. he was in high favour with the regents. In 1547 he was present at the battle of Pinkie during the invasion of Scotland. When on the death of Edward VI. an attempt was made to place Lady Jane Grey on the throne, he contrived to appear as the friend of both parties, and secured the favour of Queen Mary Tudor. He was, however, suspected of complicity in Wyat's rebellion in 1554, was brought to trial but was acquitted.

Throckmorton was, however, detained in the Tower till the following year. But he made his peace with Queen Mary. After the accession of Elizabeth he rose rapidly into favour. He became chamberlain of the exchequer, and from May 1559 to April 1564 he was ambassador in France. During this period, in which he was associated with Sir Thomas Smith, Throckmorton became acquainted with Mary Queen of Scots. He conducted the negotiations which accompanied her return to Scotland, and though he supported the reformers on political grounds, he became her personal friend. On returning to England he was sent as ambassador to Scotland in May 1565, to prevent Queen Mary's marriage with Darnley, which however he was unable to do After the murder of Darnley he was again sent to Scotland in June 1567 with the still more hopeless task of persuading the Scottish barons who had just imprisoned the queen to restore her to her authority.

Throckmorton's known friendship for Queen Mary and his constant support of her claim to be recognized as Elizabeth's successor, made him an unwelcome representative of England in that crisis In Edinburgh Throckmorton could effect little, but he exerted himself to secure the personal safety of the queen He offended his mistress by showing his instructions to the Scottish barons, and was recalled in August. In 1569 he fell under suspicion during the duke of Norfolk's conspiracy in favour of Mary, and was imprisoned for a time at Windsor, but was not further proceeded against He died on Feb. 12, 1571. Sir Nicholas married Anne Carew, and his daughter Elizabeth became the wife of Sir Walter Raleigh.

THROMBOSIS AND EMBOLISM. Under normal circumstances the blood within a blood-vessel remains fluid so long as the lining endothelium is living, but if from injury, or extension of inflammation from outside or circulatory failure from weakness of heart action the nutrition of the endothelium in any vessel is impaired, coagulation of blood or thrombosis occurs. Since the veins have thinner walls than arteries and the blood flow is slow in them owing to their relative greater diameter spontaneous thrombosis is far commoner in veins than in arteries

A thrombus is always most extensive in that direction in which the blood pressure is least; hence with reference to the heart, the greater part of an arterial thrombus is distal, a venous thrombus is proximal. On the proximal and distal sides respectively thrombosis extends at least as far as the nearest lateral branch The effect of thrombosis depends upon the seat of blockage and its extent as well as on the character of the vessels affected and on the question whether the clot is aseptic or septic. In advanced old age when heart action is feeble thrombosis is apt to occur in the cerebral and meningeal veins leading to local death of brain matter (cerebral softening). When the formation of clot once begins the process is liable to extension partly because the primary cause is central, partly because every portion of clot is foreign material upon which more clot will be deposited. Hence in old age cerebral thrombosis in time—it may be a week or more—ends fatally.

In another condition in which the wall of arteries is the seat of advanced calcareous degeneration (atheroma) even a fairly normal degree of heart action is unable to prevent extensive clotting in arteries of distal parts (*e g.*, leg) and collateral circulation being unattainable gangrene on the part occurs. Where the vessel is larger and particularly where it is the seat of aneurism (*q.v*) this same process of thrombus-formation is conservative, for the deposited blood clot strengthens the weakened vessel wall and sometimes even brings about complete filling up of a saccular aneurism.

Where the thrombus is septic the whole series of changes is dominated by the local presence of bacteria; in most cases a local abscess forms and the character of the morbid condition is determined by that fact (*see* ABSCESS; INFLAMMATION; PATHOLOGY). In "white leg," a condition usually met with in women after childbirth, in which thrombosis extends from the uterine sinuses into the iliac veins and thence into the femoral vein the seriousness of the condition is infinitely greater if the clot be septic.

The cohesion of a thrombus varies widely and is much reduced where suppurative changes are involved. Moreover the thrombus is rarely attached to the vessel wall over its whole extent; usually

the greater portion is non-adherent and simply occupies the lumen of the vessel Hence variations in posture, sudden movement, even such variations as are occasioned by cardiac action are apt to detach portions of thrombus. Such detached portions are then carried in the blood stream (embolism) to distant parts. Where they will become lodged and what will happen at the seat of their lodgement depends upon their size, the site of their parent thrombus and above all on their aseptic or septic character

If the parent thrombus be formed in the systemic veins or the right side of the heart (particularly the auricular appendix) the embolus will be carried to the lungs and may be large enough to block a main pulmonary artery and cause sudden death Many cases of sudden death after childbirth or surgical operation are due to such "pulmonary embolism." If smaller the clot may be arrested in the substance of the lung itself leading to localized obliteration of the corresponding amount of pulmonary tissue This will give rise to a variable degree of distress, but recovery is not impossible particularly if the clot be aseptic If septic it occasions local abscess or gangrene and empyema (*q v*) If the parent thrombus be in the left side of the heart (*q.v*), left auricular appendix or on a diseased mitral or aortic valve (*see* HEART, DISEASES OF) the embolus is carried into one of the systemic arteries and the effect depends upon whether the blocked vessel is an "end artery" or has anastomotic branches (*see* ARTERIES) If an end artery, *e g*, the middle cerebral or the arteries of kidney or spleen, local death of the part normally supplied by the blocked artery occurs and an "infarct" results; if the blocked artery has free anastomoses, *e g*, superior mesenteric artery, practically no ill effects follow unless the embolus be septic

When septic emboli are carried from the left ventricle, whether locally formed or carried thither from a focus in the lung, they cause abscesses wherever lodged and produce the form of blood poisoning known as pyaemia (*see* SEPSIS). Since venous blood from the greater part of the alimentary tract is carried to the liver by the portal system, thrombosis in the alimentary tract is liable to be followed by hepatic embolism; hepatic abscess in association with amoebic dysentery (*q v*) and pylephlebitis following appendicitis (*see* LIVER, DISEASES OF, APPENDICITIS) essentially depend upon lodgement in the liver of an infected embolus carried in the portal stream from the intestine

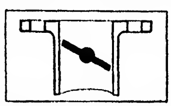
Though blood clot is the commonest material of which an embolus is composed, fat emboli and air emboli are known, the former occurring when severe fracture of bone has liberated fat from the bone marrow, the latter when air has gained entrance to a vein. (W. S. L-B)

THRONE. The throne is the ancestor of all chairs, which were originally symbols of authority and rule. In early days and in Oriental countries thrones were of barbaric magnificence. Solomon's was of ivory "overlaid with the best gold" There were two figures of lions at the sides, with two other lions on each of the six steps The remains of a throne in rock-crystal were found in the ruins of Sennacherib's palace The Persian throne made for Abbas the Great was of white marble This monarch in 1605 presented a throne to the Russian Tsar Boris, covered with sheets of gold and decorated with precious stones and pearls. Michael Feodorovitch, grandfather of Peter the Great, had a "golden throne" set with 8,000 turquoises, 1,500 rubies, 4 great amethysts and 2 large topazes. One of the glories of Delhi, until it was sacked by Nadir Shah, was the "peacock throne," which was ascended by silver steps and stood on golden feet set with jewels. It was adorned with two open peacocks' tails composed of magnificent diamonds, rubies and other stones.

The mediaeval emperors of Byzantium had a throne, which is supposed to have been imitated from, as well as named after, that of Solomon, was guarded by golden lions, which rose to their feet and roared when some artful mechanism was set in motion An exceedingly ancient chair of State is the so-called throne of Dagobert. The most recent writers on this remarkable relic suggest that it is a bronze copy of Dagobert's golden throne. However that may be, there can be no doubt that it possesses at least one illustrious modern association, for Napoleon sat in it when he distributed the first decorations of the Legion of Honour in his camp at Boulogne in 1804. The throne which Napoleon had made for himself was a heavy gilded chair with an abundance of Egyptian ornament, lions' heads and imperial eagles. One of the many curiosities of a conclave for the electing of a pope is that every cardinal present occupies a throne, since, during the vacancy of the Holy See, each member of the Sacred college is a potential sovereign. When the election has taken place the canopy of every throne is lowered, with the exception of that occupied by the new pontiff The palaces of the great Roman nobles contained—and still in some cases contain—a throne for use in the event of a visit from the pope. The papal throne itself is an antique bronze chair which stands in St Peter's. The British coronation chair is not, properly speaking, a throne, since it is used only during a portion of the coronation ceremonies The actual throne of Great Britain is the oaken Gothic chair in the House of Lords occupied by the sovereign at the opening and prorogation of parliament.

THROOP, an anthracite-mining borough of Lackawanna county, Pennsylvania, U S A., on the Lackawanna river, 3 m N E. of Scranton; served by the Lackawanna and the New York, Ontario and Western railways Pop. (1920) 6,672 (35% foreign-born white); 1928 local estimate 9,500 The borough was incorporated in 1894

THROTTLE is a valve which controls admission of steam to an engine or turbine or of an explosive mixture to an internal-combustion engine or of draught to a boiler furnace The amount of opening can be variously regulated by hand, by foot or by a governor in different cases The butterfly throttle is an established type for large valves, and is a favoured type in the small passages which lead from carburettors in automobile and aero-engines (*see* fig) The turning of the spindle causes the valve gradually to close the passage An altitude cock is employed in conjunction with the throttle for aero-engines to provide compensation for the different conditions at various heights Large throttle-valves for steam engines have a piston-valve construction with packing rings, and the action is such that opening and closing can be performed with great ease Governor control acts on a throttle to regulate the engine speed, in winding engines the safety overwinding apparatus closes the throttle and applies the brakes in case of neglect on the part of the driver to reduce speed or stop at the correct times. Big rolling-mill engines are throttled and reversed with great precision by a steam servo-motor mechanism set in motion by the driver's control lever



THE BUTTERFLY THROTTLE PIVOTED IN THE OUTLET TUBE OF A CARBURETTOR

THROWING THE DISCUS: *see* DISCUS THROWING

THRUSH, the name of two English species of the genus *Turdus,* the type of the family *Turdidae;* and of six American species of the family The first of these is the song thrush or mavis (*T. philomelus*), one of the finest songsters in Europe Common throughout Europe, this bird has a brown back and a speckled breast in both sexes

It feeds very largely on worms and snails, which latter it "shells" by beating on a stone and then rubbing off the fragments of the mollusc's "house" It is an early breeder, rearing two broods a year; the nest, a deep cup, is lined with mud, cow-dung and rotten wood, formed into a smooth layer by the pressure of the bird's breast The eggs, four or five in number, are a bluish green, spotted with black

The second species is the missel thrush (*T viscivorus*) also called mistletoe thrush, from its fondness for the berries of that plant, and storm-cock, from its habit of singing in squally weather. It is larger than the last species, reaching a length of 11 in. Otherwise it resembles its relative in appearance, but is greyer and has a white edge to the tail Its song is loud and wild, but less sweet than that of the mavis. The bird boldly attacks marauding crows, jays and even cats, driving them away from its nest. The hermit thrush (*Hylocichla guttata*) of North America is the finest songster of the continent. The rufous tail and whitish eye ring are distinctive features. The wood-thrush (*H. mustelina*), is little inferior to the last as a singer and has spotted sides as well as breast. The olive-backed thrush (*H. ustu-*

lata) has a similar lovely song.

The genus *Turdus* includes also the blackbird (*q.v.*), ring-ousel (*see* OUSEL), fieldfare (*q.v.*), redwing (*q.v.*), and others. Included in the *Turdidae* are the wheatears, stonechats and whinchats (*see* WHEATEAR), redstarts (*q.v.*), robins (*see* REDBREAST), and hedge sparrows (*see* SPARROW). The "ant-thrushes" belong to a different family (*see* PITTA).

THRUSH, a contagious disease of nursing infants, known also as sprue or infantile sore mouth It is caused by a fungus (*Oidium albicans* or *Saccharomyces albicans*) which produces small, roundish, white patches on the lining membrane of the mouth and throat and also on the surface of the tongue. These patches, called *aphthae*, consist of slight elevations of the outer (epithelial) layer of the mucous membrane, covering a small quantity of watery (serous) fluid. When this outer layer, which contains the fungoid growth, peels off, a raw surface is exposed. During an attack, which is of about 10 days' duration, crops of *aphthae* usually succeed each other at brief intervals, rendering the mouth very sore, so that sucking becomes extremely painful The onset of the disease is accompanied by fever, colic and diarrhoea. Thrush rarely occurs in infants of normal health, and is dangerous only when the *aphthae* develop a gangrenous condition. However, nursing infants whose normal vigor has been depressed by eruptive diseases, pneumonia or intestinal disorders, are liable to attack. Effective preventive measures require not only absolute cleanliness of nipples and nursing bottles but also sterilization of milk and other food. When the characteristic *aphthae* have appeared a thorough but gently managed washing of the mouth with a solution of boracic acid, potassium permanganate or other mild antiseptic is recommended.

THRUST BLOCK: *see* BEARINGS, SHIPBUILDING.

THUBURBO MAIUS (mod HENCHIR-KASBAT), an ancient city of Roman North Africa, in the province of Africa proper; 2 m. N. of the station of Pont-du-Fahs on the railway from Tunis to Kef. Octavian founded it near a native town, which was fused with it under Commodus The forum and its surroundings have been completely excavated The Capitolium is well preserved

See A. Merlin, *Le Forum de Thuburbo Maius* (1922).

THUBURSICU NUMIDORUM (mod. KHAMISSA), some 20 m. by road S W. of South Ahras, the junction of the railway to Tebessa from the main line from Algiers to Tunis It was originally a native town, and became a Roman municipality under Trajan There are extensive Roman remains, including two temples, a large civil basilica, and a well preserved theatre

THUCYDIDES (Θουκυδίδης), Athenian historian. Materials for his biography are scanty, and the facts are of interest chiefly as aids to the appreciation of his life's labour, the *History of the Peloponnesian War.* He was anciently believed to have been born in or about 471 B C, but modern criticism inclines to a later date, about 460 (*see* Busolt, *Gr Gesch* iii, pt 2, p. 621) Thucydides' father Olorus, a citizen of Athens, belonged to a family which derived wealth from the possession of gold-mines at Scaptē Hylē, on the Thracian coast opposite Thasos His supposed connection with Miltiades's family was presumed from a similarity of names (Olorus was the name of Miltiades's father-in-law), and rests on no surer evidence It is plain, too, that the statement that his tomb was at Athens, a statement containing one manifestly anachronistic detail, is not to be trusted No one knew where or how he died. Even in antiquity there were three or four legends on the question, all of them obvious guesses As to the date of his death, it cannot have been very long after his return to Athens either at, or shortly after the time of the Tyranny of the 30.

The development of Athens during the middle of the 5th century was, in itself, the best education which such a mind as that of Thucydides could have received The expansion and consolidation of Athenian power was completed, and the inner resources of the city were being applied to the embellishment and ennoblement of Athenian life (*see* CIMON; PERICLES). Yet the *History* tells us nothing of the literature, the art or the social life under whose influences its author had grown up. The "Funeral Oration" contains, indeed, his general testimony to the value and the charm of those influences But he leaves us to supply all examples and details for ourselves. Beyond a passing reference to public "festivals," and to "beautiful surroundings in private life," he makes no attempt to define those "recreations for the spirit" which the Athenian genius had provided in such abundance. He alludes to the newly-built Parthenon only as containing the treasury; to the statue of Athena Parthenos which it enshrined, only on account of the gold which, at extreme need, could be detached from the image; to the Propylaea and other buildings with which Athens had been adorned under Pericles, only as works which had reduced the surplus of funds available for the war He makes no reference to Aeschylus, Sophocles, Euripides, Aristophanes; the architect Ictinus, the sculptor Pheidias; the physician Hippocrates, the philosophers Anaxagoras and Socrates Herodotus, if he had dealt with this period, would have found countless occasions for invaluable digressions on men and manners, on letters and art The difference between the methods of the two historians arises from the fact that Thucydides was writing of events which were contemporary with the audience for which he wrote, whereas Herodotus dealt with the story of a war which had taken place 30 years before the time of his writing, and of preliminaries of that war which extended into an unstoried past.

The biography which bears the name of Marcellinus states that Thucydides was the disciple of Anaxagoras in philosophy and of Antiphon in rhetoric. There is no evidence to confirm this tradition But Thucydides and Antiphon at least belong to the same rhetorical school and represent the same early stage of Attic prose It is probable that both of them were fired with enthusiasm for that Sicilian Greek rhetoric with which Gorgias amazed the Athens of 427. Both writers used words of an antique or decidedly poetical cast; both point verbal contrasts by insisting on the precise difference between terms of similar import, and both use metaphors somewhat bolder than were congenial to Greek prose in its riper age The differences, on the other hand, between the style of Thucydides and that of Antiphon arise chiefly from two general causes. First, Antiphon wrote for hearers, Thucydides for readers; the latter, consequently, can use a degree of condensation and a freedom in the arrangement of words which would have been hardly possible for the former Again, the thought of Thucydides is often more complex than any which Antiphon undertook to interpret, and the greater intricacy of the historian's style exhibits the endeavor to express each thought[1]. Few things in the history of literary prose are more interesting than to watch that vigorous mind in its struggle to mould a language of magnificent but immature capabilities The obscurity with which Thucydides has sometimes been reproached often arises from the very clearness with which a complex idea is present to his mind, and his strenuous effort to present it in its entirety. He never sacrifices thought to language, but he will sometimes sacrifice language to thought. A student may always be consoled by the reflection that he is not engaged in unravelling a mere rhetorical tangle Every light on the sense will be a light on the words; and when, as is not seldom the case, Thucydides comes victoriously out of this struggle of thought and language, having achieved perfect expression of his meaning in a sufficiently lucid form, then his style rises into an intellectual brilliancy (thoroughly manly, and also penetrated with intense feeling) which nothing in Greek prose literature surpasses In one sense, a moral sense, Thucydides is unique among Greek authors. To him the "good" is not a term with the peculiar Greek connotation of it, but one which he uses with the same meaning which it possesses to-day.

The uncertainty as to the date of Thucydides' birth renders futile any discussion of the fact that before 431 he took no prominent part in Athenian politics. If he was born in 455, the fact needs no explanation; if in 471, it is possible that his opportunities were modified by the necessity of frequent visits to Thrace, where the management of such an important property as the gold-mines must have claimed his presence. The manner in which he refers to his personal influence in that region is such as to suggest that he had sometimes resided there (iv. 105, 1). He was at Athens in the spring of 430, when the plague broke out. If his account of the symptoms has not enabled physicians to

[1]*See* Jebb's *Attic Orators*, i. 35.

agree on a diagnosis of the malady, it is at least singularly full and vivid. He had himself been attacked by the plague; and, as he briefly adds, "he had seen others suffer."

The turning point in the life of Thucydides came in the winter of 424. He was then 47 (or, according to Busolt, about 36), and for the first time he is found holding an official position. He was one of two generals entrusted with the command of the regions towards Thrace (τὰ ἐπὶ Θρᾴκης), a phrase which denotes the whole Thracian seaboard from Macedonia eastward to the vicinity of the Thracian Chersonese, though often used with more special reference to the Chalcidic peninsula His colleague in the command was Eucles. About the end of Nov 424 Eucles was in Amphipolis, the stronghold of Athenian power in the north-west To guard it with all possible vigilance was a matter of peculiar urgency at that moment. The ablest of Spartan leaders, Brasidas (*q v*), was in the Chalcidic peninsula, where he had already gained rapid success; and part of the population between that peninsula and Amphipolis was known to be disaffected to Athens Under such circumstances we might have expected that Thucydides who had seven ships of war with him, would have been ready to cooperate with Eucles It appears, however, that, with his ships, he was at the island of Thasos when Brasidas suddenly appeared before Amphipolis Eucles sent in all haste for Thucydides, who arrived with his ships from Thasos just in time to beat off the enemy from Eion at the mouth of the Strymon, but not in time to save Amphipolis The profound vexation and dismay felt at Athens found expression in the punishment of Thucydides, who was exiled.

From 423 to 404 Thucydides lived on his property in Thrace, but much of his time appears to have been spent in travel He visited the countries of the Peloponnesian allies (*cf.* his account of the battle of Mantinea in 418, the Spartan version of the story), recommended to them by his quality as an exile from Athens; and he thus enjoyed the rare advantage of contemplating the war from various points of view He speaks of the increased leisure which his banishment secured to his study of events He refers partly, doubtless, to detachment from Athenian politics, partly also, we may suppose, to the opportunity of visiting places signalized by recent events and of examining their topography The local knowledge which is often apparent in his Sicilian books was acquired at this period He visited Syracuse after the siege was over This is shown by the accuracy of his topography, and by the fact that his knowledge of affairs at Athens contemporary with the siege came to an end at the time of the departure from Athens of the last reinforcements sent to Syracuse, showing that he drew information from the Athenian prisoners The mind of Thucydides was naturally judicial, and his impartiality (which seems almost superhuman by contrast with Xenophon's *Hellenica*) was in some degree a result of temperament. But it cannot be doubted that the evenness with which he holds the scales was greatly assisted by his experience during these years of exile

His own words make it clear that he returned to Athens, at least for a time, in 404, though the precise date is uncertain. The older view was that he returned some six months after Athens surrendered to Lysander More probably he was recalled by the special resolution carried by Oenobius prior to the acceptance of Lysander's terms (Busolt, *ibid*, p. 628). The preponderance of testimony certainly goes to show that he died in Thrace, and by violence It would seem that, when he wrote chapter 116 of his third book, he was ignorant of an eruption of Etna which took place in 396 There is indeed, strong reason for thinking that he did not live later than 399 The abruptness with which the *History* breaks off agrees with the story of a sudden death. The historian's daughter is said to have saved the unfinished work and to have placed it in the hands of an editor This editor, according to one account, was Xenophon, to whom Diogenes Laërtius (ii 6, 13) assigns the credit of having "brought the work into reputation, when he might have suppressed it." The tradition is, however, very doubtful; it may have been suggested by a feeling that no one then living could more appropriately have discharged the office of literary executor than the writer who, in his *Hellenica*, continued the narrative

The History.—At the outset of the *History* Thucydides indicates his general conception of his work, and states the principles which governed its composition His purpose had been formed at the very beginning of the war, in the conviction that it would prove more important than any event of which Greeks had record. The leading belligerents, Athens and Sparta, were both in the highest condition of effective equipment. The whole Hellenic world (including Greek settlements outside of Greece proper) was divided into two parties, either actively helping one of the two combatants or meditating such action Nor was the movement confined within even the widest limits of Hellas; the "barbarian" world also was affected by it—the non-Hellenic populations of Thrace, Macedonia, Epirus, Sicily and, finally, the Persian kingdom itself The aim of Thucydides was to preserve an accurate record of this war, not only in view of the intrinsic interest and importance of the facts, but also in order that these facts might be permanent sources of political teaching to posterity. His hope was, as he says, that his *History* would be found profitable by "those who desire an exact knowledge of the past as a key to the future, which in all probability will repeat or resemble the past The work is meant to be a possession for ever, not the rhetorical triumph of an hour." As this context shows, the oft-quoted phrase, "a possession for ever," had, in its author's meaning, a more definite import than any mere anticipation of abiding fame for his *History* It referred to the permanent value of the lessons which his *History* contained

Such being the spirit in which he approached his task, it is interesting to enquire what were the points which he himself considered to be distinctive in his method of executing it His Greek predecessors in the recording of events had been, he conceived, of two classes First, there were the epic poets, with Homer at their head, whose characteristic tendency, in the eyes of Thucydides, is to exaggerate the greatness or splendour of things past Secondly, there were the Ionian prose writers whom he calls "chroniclers" (*see* Logographi), whose general object was to diffuse a knowledge of legends, preserved by oral tradition, and of written documents (usually lists of officials or genealogies) preserved in public archives; and they published their materials as they found them, without criticism Thucydides describes their work by the word ξυντιθέναι but his own by ξυγγράφειν—the difference between the terms answering to that between compilation of a somewhat mechanical kind and historical composition, in a higher sense The vice of the "chroniclers," in his view, is that they cared only for popularity, and took no pains to make their narratives trustworthy Herodotus was presumably regarded by him as in the same general category

In contrast with these predecessors Thucydides has subjected his materials to the most searching scrutiny The ruling principle of his work has been strict adherence to carefully verified facts "As to the deeds done in the war, I have not thought myself at liberty to record them on hearsay from the first informant or on arbitrary conjecture My account rests either on personal knowledge or on the closest possible scrutiny of each statement made by others The process of research was laborious, because conflicting accounts were given by those who had witnessed the several events, as partiality swayed or memory served them"

The Speeches—It might be supposed that the speeches which Thucydides has introduced into his *History* conflict with this standard of scientific accuracy; it is, therefore, well to consider their nature and purpose rather closely The speeches constitute between a fourth and a fifth part of the *History* If they were eliminated, an admirable narrative would indeed remain, with a few comments, usually brief, on the more striking characters and events But we should lose all the most vivid light on the inner workings of the Greek political mind, on the motives of the actors and the arguments which they used—in a word, on the whole play of contemporary feeling and opinion To the speeches is due in no small measure the imperishable intellectual interest of the *History*, since it is chiefly by the speeches that the facts of the Peloponnesian War are so lit up with keen thought as to become illustrations of general laws, and to acquire a permanent suggestiveness for the student of politics When Herodotus made his persons hold conversations or deliver speeches, he was following the precedent of epic poetry; his tone is usually colloquial rather

than rhetorical; he is merely making thought and motive vivid in the way natural to a simple age. Thucydides is the real founder of the tradition by which historians were so long held to be warranted in introducing set speeches of their own composition. His own account of his practice is given in the following words: "As to the speeches made on the eve of the war, or in its course, I have found it difficult to retain a memory of the precise words which I had heard spoken; and so it was with those who brought me reports But I have made the persons say what it seemed to me most opportune for them to say in view of each situation; at the same time I have adhered as closely as possible to the general sense of what was actually said" So far as the language of the speeches is concerned, then, Thucydides plainly avows that it is mainly or wholly his own. As a general rule, there is little attempt to mark different styles The case of Pericles, whom Thucydides must have repeatedly heard, is probably an exception: the Thucydidean speeches of Pericles offer several examples of that bold imagery which Aristotle and Plutarch agree in ascribing to him, while the "Funeral Oration," especially, has a certain majesty of rhythm, a certain union of impetuous movement with lofty grandeur, which the historian has given to no other speaker Such strongly marked characteristics as the curt bluntness of the Spartan ephor Sthenelaidas, or the insolent vehemence of Alcibiades, are also indicated. But the dramatic truth of the speeches generally resides in the matter, not in the form. In regard to those speeches which were delivered at Athens before his banishment in 424 (and seven such speeches are contained in the *History*) Thucydides could rely either on his own recollection or on the sources accessible to a resident citizen In these cases there is good reason to believe that he has reproduced the substance of what was actually said In other cases he had to trust to more or less imperfect reports of the "general sense"; and in some instances, no doubt, the speech represents simply his own conception of what it would have been "most opportune" to say. The most evident of such instances occur in the addresses of leaders to their troops. The historian's aim in these military harangues (which are usually short) is to bring out the points of a strategical situation; a modern writer would have attained the object by comments prefixed or subjoined to his account of the battle The comparative indifference of Thucydides to dramatic verisimilitude in these military orations is curiously shown by the fact that the speech of the general on the one side is sometimes as distinctly a reply to the speech of the general on the other as if they had been delivered in debate. We may be sure, however, that, wherever Thucydides had any authentic clue to the actual tenor of a speech, he preferred to follow that clue rather than to draw on his own invention Why, however, did he not content himself with simply stating in his own person, the arguments and opinions which he conceived to have been prevalent? The question must be viewed from the standpoint of a Greek in the 5th century B C Epic poetry had then for many generations exercised a powerful influence over the Greek mind. Homer had accustomed Greeks to look for two elements in any complete expression of human energy—first, an account of a man's deeds, then an image of his mind in the report of his words. The Homeric heroes are exhibited both in action and in speech Further, the contemporary readers of Thucydides were men habituated to a civic life in which public speech played an all-important part. Every adult citizen of a Greek democracy was a member of the assembly which debated and decided great issues. The law courts, the festivals, the drama, the market-place itself, ministered to the Greek love of animated description. To a Greek of that age a written history of political events would have seemed strangely insipid if speech "in the first person," had been absent from it, especially if it did not offer some mirror of those debates which were inseparably associated with the central interests and the decisive moments of political life. In making historical persons say what they might have said, Thucydides confined that oratorical licence to the purpose which is its best justification; with him it is strictly dramatic, an aid to the complete presentment of action, by the vivid expression of ideas and arguments which were really current at the time. Among later historians who continued the practice, Polybius, Sallust and Tacitus most resemble Thucydides in this particular

Divisions of the Book.—The present division of the *History* into eight books is one which might well have proceeded from the author himself, as being a natural and convenient disposition of the contents. The first book, after a general introduction, sets forth the causes of the Peloponnesian War. The first nine years of the war are contained in the second, third and fourth books —three years in each The fifth book contains the tenth year, followed by the interval of the "insecure peace." The Sicilian expedition fills the sixth and seventh books The eighth book opens that last chapter of the struggle which is known as the "Decelean" or "Ionian" War, and breaks off abruptly in the year 411.

The principal reason against believing that the division into eight books was made by Thucydides himself is the fact that a different division, into 13 books, was also current in antiquity, as appears from Marcellinus (§ 58) It is very improbable (indeed hardly conceivable) that this should have been the case if the eight-book division had come down from the hand of the author We may infer, then, that the division of the work into eight books was introduced at Alexandria—perhaps in the 3rd or 2nd century B C That division was already familiar to the grammarians of the Augustan age. Dionysius of Halicarnassus, who recognizes it, has also another mode of indicating portions of the work, viz, by *stichometria,* or the number of lines which they contained Thus, in the ms which he used, the first 87 chapters of book i contained about 2,000 lines (equivalent to about 1,700 lines in Bekker's stereotyped 8vo. text). (On the order of composition, *see* PELOPONNESIAN WAR, *ad init*; and GREECE: *Ancient History,* § Authorities)

The division of the war by summer and winter (κατὰ θέρος καὶ χειμῶνα)—the end of the winter being considered as the end of the year—is perhaps the only one which Thucydides himself used, for there is no indication that he made any division of the *History* into books. His "summer" includes spring and autumn and extends, generally speaking, from March or the beginning of April to the end of October His "winter" (November to February inclusive) means practically the period during which military operations, by land and sea, are wholly or partly suspended When he speaks of "summer" and "winter" as answering respectively to "half" the year (v. 20, 3), the phrase is not to be pressed; it means merely that he divides his year into these two parts The mode of reckoning is essentially a rough one, and is not to be viewed as if the commencement of summer or of winter could be precisely fixed to constant dates. For chronology, besides the festivals, he uses the Athenian list of archons, the Spartan list of ephors and the Argive list of priestesses of Hera

There is no reference to the *History* of Thucydides in the extant Greek writers of the 4th century B.C.; but Lucian has preserved a tradition of the enthusiasm with which it was studied by Demosthenes. The great orator is said to have copied it out eight times, or even to have learnt it by heart. The Alexandrian critics acknowledged Thucydides as a great master of Attic Sallust, Cornelius Nepos, Cicero and Quintilian are among the Roman writers whose admiration for him can be traced in their work, or has been expressly recorded. The most elaborate ancient criticism on the diction and composition of Thucydides is contained in three essays by Dionysius of Halicarnassus.

BIBLIOGRAPHY—Among the best mss. of Thucydides, the Codex Vaticanus 126 (11th century) represents a recension made in the Alexandrian or Roman age. In the first six books the number of passages in which the Vaticanus alone has preserved a true reading is comparatively small; in book vii. it is somewhat larger; in book viii. it is so large that here the Vaticanus, as compared with the other mss., acquires the character of a revised text. Other important mss. are the Palatinus 252 (11th century); the Casselanus (A D. 1252); The Augustanus Monacensis 430 (A.D. 1301). A collation, in books i., ii., of two Cambridge mss. of the 15th century (NN. 3, 18; KK. 5, 19) has been published by Shilleto. Several Parisian mss. (H. C. A. F.) and a Venetian mss. (V.) collated by Arnold, also deserve mention. The Aldine ed. was pub. in 1502. It was formerly supposed that there had been two Juntine eds. Shilleto, in the "Notice" prefixed to bk. i, first pointed out that the only Juntine ed. was that of 1526, and that the belief in an earlier Juntine of 1506, arose merely from the accidental omission of the word *vicesimo* in the Latin

version of the imprint. Some papyrus fragments were published in Grenfell and Hunt's *Oxyrhynchus papyri* (1908), vi., which also contains an anonymous commentary (pub. 1st century) on Thuc. ii. A useful ed. is Classen's, in the Weidmann series (1862–78, new ed. by Steup, 1882–92); each book can be obtained separately. Arnold's ed. (1848–51) contains much that is still valuable. For bks. i. and ii. Shilleto's ed. (1872–76) furnishes a commentary which, though not full, deals admirably with many difficult points. Among other important complete eds., it is enough to name those of Duker, Bekker, Goeller, Poppo and Krüger. For eds. of separate books and selections (up to 1895) *see* J. B Mayor's *Guide to the Choice of Classical Books.* Special mention may be made of those by E. C. Marchant. Later eds. of the text are by H Stuart Jones (1900–01), in the Oxford *Scriptorum classicorum bibliotheca,* and C. Hude ("Teubner Series," 1901; ed. minor, 1903). Bétant's lexicon to Thucydides (1843) is well executed. Jowett's trans. (1883) is supplemented by a vol. of notes. Dale's version (Bohn) also deserves mention for its fidelity, as Crawley's (1876) for its vigour. *Thucydides and the History of His Age* by G. B. Grundy, discusses various general questions connected with the history of the time, and has a long summary of the controversy on the mode and times in which the historian composed his work. *Hellenica* (1880) contains an essay on "The Speeches of Thucydides," which has been trans. into German (*see* Eduard Meyer, *Forschungen zur alten Geschichte* Bd. ii. pp. 269–436). The best clue to Thucydidean bibl. is in Engelmann's *Scriptores graeci* (1880), supp. by the arts by G Meyer, in Bursian's *Jahresbericht* (1895) lxxix., (1897) lxxxviii. Busolt, *Griechische Geschichte,* iii. 616–693, is invaluable. For the life of Thucydides, U. von Wilamowitz-Moellendorff, "Die Thukydides-Legende," *Hermes* (1878) xii., is all important All works on ancient Greek history contain discussions of Thucydides, and see J B Bury's *Anc Greek Historians* (1909) and *Cambridge Anc History,* vol iv and v (1926–27) (R C J , X)

THUGGA (mod Dougga), an ancient city of North Africa, lying on a commanding site about 1 m. W. of the military road from Carthage to Tebessa (68 m by road S W. of Tunis) Its importance dates from Punic times, and it appears to have been taken from Carthage by the Numidian king Masinissa in the 2nd century B C Its most important buildings date from *c.* A D 150–250 and it only became a municipality under Septimius Severus, and a colony even later The well preserved Capitolium, or Temple of Jupiter, Juno and Minerva, built by Marcus Aurelius, occupies the finest position in the city; to the west of it lies the forum, and to the east the Temple of Mercury West of the forum, which is surrounded by fortifications of the Byzantine period, lies the beautiful crescent-shaped Temple of Caelestis, the Phoenician Tanit, built in the time of Alexander Severus.

To the north-east of the forum is a well preserved theatre, built in A D 166–169, with a splendid view over the surrounding country. To the north is a large temple of Saturn (A D 195), the Romanized form of Baal-Hammon, with six large columns, and close to it is a small Christian church; while to the west lie the remains of what may have been the pre-Roman acropolis, with native tombs, dolmenic in form, beyond it, and further on again are the remains of a circus. To the south-east of the forum, built against the hill side, is a group of interesting private houses decorated with mosaics and fountains.

THUGS, a well-organized confederacy of professional assassins, who travelled in gangs through India, wormed themselves into the confidence of wayfarers and, when a favourable opportunity occurred, strangled them by throwing a handkerchief or noose round their necks, and then plundered and buried them (Sanskrit *sthag,* to conceal, hence *sthaga,* a cheat, in modern vernaculars *thag*). All this was done according to certain ancient and rigidly prescribed forms and after the performance of special religious rites, in which the consecration of the pickaxe and the sacrifice of sugar formed a prominent part. From their using the noose they were also frequently called *Phansigars,* or "noose-operators." Though they themselves traced their origin to seven Mohammedan tribes, Hindus appear to have been associated with them at an early period; at any rate, their religious creed and practices as staunch worshippers of Kali (Devi, Durga), the Hindu goddess of destruction, had certainly no flavour of Islam. The fraternity possessed also a jargon of their own (*Ramasi*), as well as certain signs by which its members recognized each other.

Though sporadic efforts were made towards the extinction of the gangs, it was not till Lord W. Bentinck (1828–35) took vigorous steps that the system was seriously attacked. His chief agent, Captain (afterwards, Sir William) Sleeman, with the co-operation of a number of native states, succeeded so well in grappling with the evil that, up to Oct. 1835, no fewer than 1,562 Thugs had been committed, of whom 382 were hanged and 986 transported or imprisoned for life. According to the *Thuggee and Dacoity Report* for 1879, the number of registered Punjabi and Hindustani Thugs then still amounted to 344; but all of these had already been registered as such before 1852, and the whole fraternity may now be considered as extinct.

Full particulars concerning the system of Thagi are given by Dr. Sherwood, *On the Murderers called Phansigars,* and J. Shakespear, *Observations regarding Budheks and Thegs* (both treatises in vol xiii. (1820), of the *Asiatic Researches*); W. N Sleeman, *Ramaseeana, or a Vocabulary of the Language used by the Thugs, with an Introduction and Appendix* (Calcutta, 1836); Meadows Taylor, *Confessions of a Thug* (1839; new ed. 1879).

THUGUT, JOHANN AMADEUS FRANCIS DE PAULA, Baron (1736–1818), Austrian diplomatist, was born at Linz on May 24, 1736. In 1769 he was appointed chargé d'affaires at Constantinople, and in that capacity secured a grant of money and a promise of the territory of Little Wallachia from the Turks during the negotiations connected with the first partition of Poland. (*See* Poland· *History.*) In 1771 he was ennobled and appointed internuncio at Constantinople and was actively engaged, under the direction of Prince Kaunitz, in all the diplomacy of Austria in Turkey and Poland until he secured the cession of the Bukovina on May 7, 1775.

After 1775 Thugut travelled in France and Italy, partly on diplomatic service In 1778 he acted as intermediary in Maria Theresa's negotiations with Frederick the Great In 1780 he was Austrian envoy in Warsaw, but in 1783 applied for leave and spent four years in Paris, where he invested his savings and became acquainted with many of the leaders in the Revolution. From 1787 to 1789 he was minister at Naples In 1790 he was sent by the emperor Joseph II to Bucharest, nominally as commissioner with the hospodar of Wallachia, but in reality in order that he might open negotiations for peace with the Turks In 1792 he was associate diplomatic agent at the headquarters of the allied army which invaded France, and was then appointed "director of the foreign affairs of Austria" (March 25, 1793), becoming chancellor in 1794, on the death of Kaunitz

The selfish policy which Thugut followed (1793–1800) in Austria was bitterly resented by her allies, and although Thugut probably thought that he was only doing his duty, he committed many acts which were more than dubious. After the defeats of Austria in Italy in 1796–97 and the Peace of Campo Formio, it became a fixed object with the French, and with a growing party in Austria who held him responsible for the disasters of the war, to secure Thugut's removal.

The battle of Hohenlinden (Dec. 3, 1800) made his position untenable He retired from public life, and left Vienna for Pressburg. He afterwards returned to Vienna and lived quietly on a pension of 7,000 florins till his death on May 28. 1818

THUILLE, LUDWIG (1861–1907), German composer, was born at Bozen (Bolzano) on Nov 30, 1861 After being taught by his father, an amateur, and by Pembour at Innsbruck, he went to Munich in 1879 to finish his studies under Barmen and Rheinberger In 1883 he was appointed professor at the Munich school of music, and while there became a close friend of Alexander Ritter and Richard Strauss. His first opera, *Theuerdank,* was produced in Munich in 1897; a second, *Lobetanz,* at Mannheim in 1898 and a third, *Gugeline,* at Bremen in 1901. Two interesting choral works are *Traumsommernacht,* for female voices, and *Weihnacht im Walde,* for men's chorus (op. 14) His chamber music includes a sextet, op. 6, for piano and wind instruments (1887) and a violoncello sonata.

See Friedrich Munter, *Ludwig Thuille* (Munich, 1923).

THULE (thōō'lē), Greek and Roman name for the most northerly known land in the Atlantic. Pytheas (*c.* 300 B.C.) calls it the most northerly of the British Isles, reached after 6 days' sail from Britain; it was inhabited, but corn grew there sparingly and ripened ill; in summer the nights were long and bright. The few surviving fragments of his works do not determine where his Thule was, but Müllenhoff is probably right in thinking it

was the Shetlands The Faeroes, Iceland and Norway are much less likely Agricola's fleet in A.D 84 sailing up the east coast of Scotland is said to have espied but not to have reached Thule (*dispecta est Thule*) but the phrase is merely literary. The actual point meant may be the Orkneys or the Shetlands, or even some fragment of Scotland seen across the water. In some later writers (Procopius, etc) Thule seems sometimes used to denote Scandinavia The phrase "ultima Thule" is commonly used to describe the farthest limit possible.

THULIUM, a very rare metallic element (symbol Tm, atomic number 69, atomic weight 169 4) of the rare-earth group, was discovered by Cleve in 1879 while examining crude erbium oxide It was first obtained in the form of a pure compound by C James in 1911 by the fractional crystallization of its bromate Thulium occurs to a very slight extent along with its commoner associates in the minerals gadolinite, euxenite, xenotime, etc. Very large quantities of the minerals must be employed to obtain a little pure salt. The oxide, of a greenish-white colour, gives a beautiful carmine glow when gently heated in the Bunsen burner Salts of thulium possess a pale green colour and solutions show a very characteristic absorption spectrum. (*See* RARE EARTHS) (C J)

THUN, a picturesque town in the Swiss canton of Bern, built on the banks of the Aar, just as it issues from the Lake of Thun, and by rail 19 m S E of Bern Its population in 1920 was 14,162, mostly German-speaking and Protestants, in 1928 (Jan. 1st) it was estimated at 18 450 From 1798 to 1802 Thun was the capital of the canton Oberland of the Helvetic Republic. It is now the capital of the Bernese Oberland

THUN, LAKE OF, in the Swiss canton of Bern, the second lake (the first being that of Brienz) into which the river Aar (*q v*) expands. These two lakes occupy an ancient terminal basin of a glacier and are separated by a lacustrine delta on which Interlaken stands. Lake Thun (with the town of Thun at its north-western end) is 11½ m. long, 2 m. wide, its maximum depth is 712 ft, while its area is 18½ sq m, and its altitude 1,837 ft

THUNDER, the noise which accompanies or follows a flash of lightning (*q v*), on account of the air disturbance caused by the sudden heating and expansion of air during the electrical discharge (*See* ATMOSPHERIC ELECTRICITY and METEOROLOGY.)

THUNDERSTORMS. Since the middle of the 18th century it has been realized that lightning is an electric spark, and that thunder is the noise produced by the spark The natural tendency was to assume that the meteorological phenomena of the thunderstorm, and especially the heavy rainfall, were produced by electricity The modern view is that the rainstorm is the primary phenomenon and that the electricity is incidental.

AS METEOROLOGICAL PHENOMENA

The common feature of thunderstorms is their great vertical extent. The base of a cloud may be between 1 and 2 km. above the ground The summit may reach the level of the cirrus clouds, at a height of 9 km. or more

To explain the motive power required for the production of such a cloud we must consider the behaviour of dry air and moist air when subject to changes of pressure. Air is heated by compression and cooled by expansion If, however, the air contains drops of water, the rise of temperature causes evaporation, and some of the energy used in compressing the air is converted into latent heat The same increase of pressure produces less rise of temperature in wet air than in dry air Conversely, the expansion of saturated air in which condensation is taking place will be accompanied by a smaller fall of temperature than the expansion of dry air Further, if two masses of air have the same temperature initially, and both are cooled by the reduction of pressure, the wet air will not only be the warmer at the end of the process but will also be lighter, and occupy more space. In the atmosphere, where masses of air can move freely, those masses which contain cloud tend, on the whole, to be the more buoyant. Thus we have a general explanation of the formation of cumulus cloud. The air in the lower part of the atmosphere is warm, and contains water in the form of vapour. If some of this air is carried upwards to a level where the pressure is lower, the temperature falls, and at a certain height condensation begins. The air brought from below may be at the same temperature as the surrounding air at this height, but as condensation proceeds the rising air remains comparatively warm, and it may be lighter than its surroundings. A cloud has begun to form, and, as the top of the cloud rises, air from below takes its place, and the cloud tends to grow The conditions favourable for the growth of a cumulus cloud are. (1) The upper air into which the cloud grows is cold, preferably with a lapse rate approaching the limiting value 10° C per kilometer (2) The lower air contains much water vapour, and is not too stable; if vigorous convection is taking place, the lapse rate in this lower air may even exceed 10° C per kilometer By the time the cloud has grown to a height of some kilometers, the difference between the pressure at the bottom of the cloud and at other points at the same level will be very great, and the upflow of air through the cloud very violent In the rising air condensation proceeds rapidly. Some of the drops are carried up by the air They are frozen to form soft hail, and then covered by more ice to become true hail. The raindrops or hailstones get thrown out of the more vigorous ascending currents and are able to fall through and out of the clouds

Experience shows that these are the circumstances in which the electrical phenomena which characterize thunderstorms occur According to some observers there is no true thunderstorm without the formation of false cirrus at the top of the cloud In the early stages of growth the air surrounding the top of a cloud is comparatively dry, and the parts of the cloud carried away by eddies re-evaporate When the cloud towers up to the cirrus level, where the temperature is so low that very little moisture can be held in the gaseous state, evaporation can no longer take place at the top of the cloud, and when the ascending air mixes with the other air of that height, numerous ice crystals build up the cap of false cirrus.

Types of Thunderstorms.—Thunderstorms can be divided into four classes:—

(*a*) *Storms Produced in Air Which Is More or Less Stationary* —The condition for the production of these storms is the development of instability by the warming of the ground; water evaporated from the ground and from vegetation is carried up by the convection currents to the level at which condensation takes place If the air originally above this level is cold enough, the lapse of temperature being greater than in a nascent cloud, these thunder clouds will develop freely

(*b*) *Storms Produced in Air Which Has Travelled from a Colder Region to a Warmer* —When air flows over warm ground or warm water, heat may be communicated to the air sufficiently rapidly for the stratification to become unstable Under these conditions, thunder showers develop. They are usually of small extent.

(*c*) *Storms Produced by the Interaction of Converging Air Currents* —When a current of cold air meets a current of warm air, the warmer air, being lighter, is forced upwards. As the warm air reaches the condensation level, cloud is formed, and if conditions are favourable the clouds tower upwards so that the passage of the "cold front" is marked by a brief thunderstorm.

(*d*) *Storms Produced by the Interaction of Parallel Currents.*—If the general distribution of pressure is such that a current of polar air flows alongside a current of warmer air, a travelling area of instability is produced. Thunderstorms of great intensity develop and may extend for a hundred miles or more in the direction of the currents

The Distribution of Thunderstorms.—The storms of class (*a*) are most frequent in the Tropics; they occur also in summer in the temperate zone. These storms show a well-marked diurnal variation, they develop generally during the afternoon.

The storms of class (*b*) are characteristic of the rear of barometric depressions, and occur over the sea, in winter, when air from high latitudes is blowing over comparatively warm water. On the western coasts of the British Isles such storms are not infrequent The storms which occur at night on certain coasts in the Tropics, when the off-shore breezes set in, may also be included in class (*b*).

The "cold-front" storms of class (*c*) are met with in the tem-

perate zone. They are associated with line-squalls. The progress of a cold-front and its attendant thunderstorms can sometimes be followed for hundreds of miles by observers of "atmospherics."

Thunderstorms are most frequent in the Tropics. The average number of days in which thunder is reported, annually, is as high as 143 at Leon, in Mexico, and 133 at Batavia, in Java On the other hand, in the desert countries thunderstorms are almost unknown. They are rare in high latitudes For numerous land stations in the Northern Hemisphere, Brooks has computed the annual average of 25; for the land of the Southern Hemisphere (excluding Antarctica), the average is 44. His estimate for the whole globe, land and sea, is 16 As in all such statistics, the number is intended to refer to the number of days on which thunder is audible at any time.

In many parts of the world thunderstorms are not most frequent in summer because that is a dry season This is the case in Mediterranean countries. At Barcelona and at Rome, thunderstorms are most common in September. Similar influences are felt in Switzerland, where thunderstorms are less frequent at the end of June than at its beginning, or in the last part of July

AS ELECTRICAL PHENOMENA

To the eye, a lightning flash is instantaneous, and it cannot be seen whether it begins at one end or the other. It is clear, however, that the resistance of the air to the electric stress must break down, in the first instance, at one definite point The air at this point is ionized and becomes a conductor, and the greatest electric stress is transferred to a neighbouring point. The discharge is therefore progressive From theoretical considerations and from laboratory experiments, G C Simpson has proved that such a progressive discharge always proceeds from a positively charged body towards a negatively charged body The spark is frequently branched, and it is the rule for the branches to lead away from the positively charged body When a branched lightning flash is seen, the direction in which electricity is passing can, therefore, be stated

The absence of branches indicates that the flash has passed from a positive charge spread over a wide area to a more concentrated negative charge Simpson classified numerous photographs of lightning, amongst which were 418 flashes which appeared to be approximately vertical In 242 of these flashes there were branches pointing downwards; in only three were branches pointing upwards In the former cases the clouds from which the lightning proceeded must have been positively charged, in the latter cases the cloud must have been negatively charged Even if negatively charged clouds preponderated in the cases in which the flashes were unbranched, the positively charged clouds were in the majority

The colour of lightning flashes varies considerably According to Trabert's observations at the mountain station on the Sonnblick, where the electric field during a thunderstorm is so strong that brilliant St Elmo's fire can be observed, blue lightning is to be seen when negative electricity is being discharged by St Elmo's fire, and red lightning is associated with the positive discharge It may be noted that the difference between the types of St Elmo's fire is striking The negative fire is concentrated; an object like a flagstaff may be completely enveloped in fire. On the other hand, the positive fire takes the form of streamers, some as much as 10 cm long.

The quantity of electricity which is transferred in a lightning flash can be estimated from the change which occurs in the electric field near the ground. The quantity is generally between 10 and 50 coulombs As the discharge takes about one-thousandth of a second to pass, the maximum current is comparable with 50,000 amperes. The difference of potential between the cloud and the earth before the discharge is of the order 10^9 volts. The energy dissipated by the discharge of 20 coulombs through such a voltage is 10^{10} joules, or about 3,000 kilowatt hours. This energy would suffice to lift 500 tons through 2 kilometers.

The Electrical Structure of a Thundercloud.—As to what should be regarded as the typical distribution of electricity in a thundercloud, agreement has not yet been reached. The majority of investigators favour the view that, in general, the positive charges are at greater heights than the negative

When a lightning discharge occurs there is an immediate change in the electric force. The change is appreciable even at distances of 100 m. or more In the case of nearby disturbances, there is in the interpretation of the observations some ambiguity. This disappears, however, when the distance of the electric charges is great compared with their height. In a series of observations made at Khartum on April 23, 1924, and lasting four-and-a-quarter hours, the appearance of lightning estimated at between 30 and 300 km away was noted at the same time as changes in the electric field. There were 37 discharges accompanied by a descent of negative electricity, and 444 accompanied by a descent of positive electricity. With regard to the discharges of the former type, it was observed: (1) That they appeared to reach the earth, whereas the others appeared to be in the clouds; (2) that they were of greater brilliance; (3) that the illumination from the lightning lasted longer (as long as three seconds)

Some observations seem to imply that, throughout the storm a structure is being built up continuously in which there is a positive charge high in the cloud and a negative charge near the base. According to this view, the majority of flashes pass between the upper and lower charged regions, the minority between the lower charged region and the earth Simpson maintains, however, that the downward discharges of positive electricity do not originate very high in the cloud He believes that many of these discharges terminate in the free air below the cloud The most direct evidence in favour of this view is the frequency with which branching discharges occur in photographs.

The Electric Field Near Thunderstorms. *Discharges from the Earth*—The interchange of electricity between the ground and the atmosphere is carried on, to a large extent, by the discharges from pointed objects. When a pointed object stands up high above its surroundings, the discharge seen after dark is luminous, and is then known as St. Elmo's fire.

Measurements of the strength of the discharges from pointed objects have been undertaken Wormell, working at Cambridge, used a single point 8·3 metres above the ground Schonland, in South Africa, used a small tree, the top of which was 4 metres above the ground The largest discharge recorded by Wormell in a single shower was 30 millicoulombs, Since the electricity displaced in a single lightning flash is of the order 30 coulombs, we may say that the current from a thousand such points would provide enough electricity to make a flash

Schonland gives the following table, showing the relation between the strength of the electric field over level ground and the current passing through his tree

Field (volts per metre)	3,500	5,500	11,000	16,000
Current (microamperes)	·07	·20	1·00	4·00

It will be seen that the current increases much more rapidly than the field This is in accordance with other observations of the discharge from points.

The Electrification of Rain.—The electric charge carried by rain can be positive or negative. Moreover, either sign can occur with a positive potential gradient, and equally with a negative potential gradient According to Gschwend, the charge on individual raindrops varies between ·005 and 1 electrostatic units On the whole, the positive charges predominate This is especially the case in heavy rain In Simla, Simpson found the ratio of the total positive charge to the total negative charge brought down by rain was 2·9 For Potsdam, the corresponding ratio is given by Kähler as 1·4 The highest charge measured at Potsdam was 40 electrostatic units per cubic centimetre

The Net Displacement of Electricity.—Schonland compares the discharge from points with the quantity of electricity carried from earth to cloud by lightning and by charged rain The total current for the whole area affected by a thundercloud is made up as follows: Point discharges 2·1 ampere. Lightning discharges 0·1 ampere. Charged rain—·02 amperes; total about 2·2 amperes.

The observations confirm Wilson's remark that "of the three kinds of electric current which may accompany precipitation, the convection current of lightning discharges and continuous currents

due to the intense electric fields, it is quite possibly the last which contributes most to the interchange of electricity between the earth and the atmosphere." The thunderstorms studied by Schonland produced little rainfall, but the preponderance of positively charged rain in his experiments is consistent with general experience. If the rainfall over the area of his hypothetical storm, 20 km.^{2}, had been at the rate appropriate to heavy thunderstorms, say 1 mm. per minute, and if the rain had been highly charged so as to carry four electrostatic units per cubic centimetre of water, the average current would have been of the order 0.4 amperes. Other observers have found strong positive gradients as frequent as strong negative ones during storms.

If the conclusions of Schonland can be accepted as generally true, it will follow that the net flow of positive electricity from ground to atmosphere in thunderstorms is adequate to supply the electricity needed to maintain the air-earth current over the parts of the globe enjoying fine weather. According to Wilson, positive electricity and negative are separated in the cloud, the positive charge being uppermost Between this upper charge and the Heaviside layer there is a conduction current, facilitated by the comparatively high conductivity of the air. The Heaviside layer may be regarded as a perfect conductor. The current between this layer and the ground in the fine-weather regions is downwards That there is such a connection as is postulated by Wilson is borne out by the striking agreement between the daily changes of potential gradient over the oceans and the variations in the number of thunderstorms which are likely to be in progress

Simpson's Theory of Thunderstorm Mechanism.—Of the explanations which have been suggested for the production of electrification in clouds, the only one which appears at all adequate is that proposed by G C. Simpson This theory is based on the observation that, when water-drops are broken by an air-blast the spray is electrified positively, the air negatively. In a cumulo-nimbus cloud there are regions in which the upward currents are powerful enough to prevent any rain falling through them. Simpson contends that such currents are so persistent that the water accumulates in them for several minutes As the raindrops are continually breaking up and recombining, they acquire large positive charges The air currents convey the negative charge to less turbulent regions, and the droplets which form in such regions become negatively charged Thus negatively charged rain is to be expected in the greater part of the cloud

Simpson has applied numerical tests to prove that the causes are adequate to produce the observed effects. In his typical thunderstorm, the region in which water accumulates is equivalent to a sphere 2 km in diameter, and is about one-hundredth part of the whole cloud It is supposed that, after a quarter-of-an-hour, there is enough water to make 10 cm. of rain on the ground immediately below. This estimate is arrived at by consideration of the volume of air carried up by a current of 8 metres per second, and of the amount of water vapour contained in the air at the temperatures prevailing at 2 km. and 4 km above the ground. The accumulated water is equivalent to 4.4×10^{12} drops 5 millimetres in diameter. If all these drops were broken into spray, about 7 coulombs of positive electricity would remain on the spray, and an equal quantity of negative electricity would be carried away by the air currents.

To explain the great strength of the electric field necessary to start a lightning flash, Simpson supposes that the density of the electric charge in one part of the region of separation is very great. A sphere 500 metres in diameter would occupy one sixty-fourth of the whole region in which electrification was taking place. If the water drops in the sphere were broken up 256 times a charge of 28 coulombs would be developed, and if the process took 4 minutes, the strong air-currents of 8 metres per second would remove the complementary negative charge to a distance averaging about a kilometre.

Now, 28 coulombs are rather less than the average quantity of electricity in a lightning discharge. Further, it is easily proved that the force due to the 28 coulombs in a sphere with diameter 500 metres is, at the surface of the sphere, equivalent to 4×10^6 volts per metre, and therefore sufficient to break down the resistance of the air and initiate a lightning flash. It is supposed that the lightning does not discharge the whole cloud.

The theory accounts for the flashes which convey positive electricity downwards from the lower part of the cloud towards the earth or upwards inside the cloud.

The lightning flashes by which positive electricity is conveyed upwards to the cloud, are thought by Simpson to be rather rare.

Criticisms of Simpson's Theory.—The theory is based on the observed facts that water drops which are uncharged or slightly charged, acquire positive charges when broken up, and that charged drops, when they collide, will combine. There is, however, no experimental evidence that the processes of breakage and combination can be so active simultaneously that all the water passes through the two processes each second. Such a rate seems to be necessary to account for the frequency of lightning flashes Moreover, it is difficult to believe that the persistence for a quarter-of-an-hour of a vertical current localized in one small part of the cloud is an essential feature of a thunderstorm.

The theory has been attacked more generally on the ground that the natural interpretation of observations of the changes in the electric field in a storm is that the upper part of a thundercloud is usually the seat of a positive charge. Simpson's reply to this criticism is that the observations in question can be explained on the assumption that the most frequent discharges are those in which positive electricity is displaced from the region of separation inside the cloud to the air between the cloud and the ground To the criticism that observations such as those of Wormell and Schonland imply a great transfer of positive electricity from the ground upwards during a thunderstorm, Simpson's reply is that the observations are not representative, being taken under such circumstances that positive fields were exceptionally infrequent More observations are needed, especially in parts of the world where tropical storms occur.

The literature of thunderstorms is extensive. The following list is almost confined to works quoted in the foregoing article.

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(F. J W. W)

THURET, GUSTAVE ADOLPHE (1817–1875), French botanist, was born in Paris on May 23, 1817. He spent a great part of his time, up to 1857, on the Atlantic coast of France, assiduously observing the marine Algae in their natural habitat and at all seasons. He and his friend Édouard Bornet, became the recognized authorities on this group of plants. Their work, while remarkable for taxonomic accuracy, was more especially concentrated on the natural history, development and modes of reproduction of the plants investigated The discovery of sexual reproduction in seaweeds is almost wholly the work of these two men The researches on the fecundation of the Fucaceae were published by Thuret in 1853 and 1855; the complicated and difficult question of the sexual reproduction in Floridae was solved by the joint work of Thuret and Bornet (1867). These great discoveries—of far-reaching biological significance—stand out as the chief, but every group of marine Algae was elucidated by the researches of Thuret and his colleague The *Notes algologiques* (1876–1880), and the *Études phycologiques* (1878) were posthumously published. In 1857 Thuret removed to Antibes, where he established a botanic garden which became famous He died at Nice, on May 10, 1875.

See notices by Bornet in *Ann. des Sci. Nat.* (1876) and Farlow in *Journ. of Bot.* (1876).

THURGAU, a canton of north-east Switzerland, bordered by the Lake of Constance and, for a short distance, by the Rhine below the lake. It is in contact with Schaffhausen and Zürich to the west and St. Gall to the south. Thurgau is divided into three well-wooded hill masses running north-west to south-east by the middle course of the river Thur (rising in the Toggenburg, *q v*) and by its affluent, the Murg

The canton is traversed by the main railway line from Winterthur to Romanshorn (with branches to Constance, to the Toggenburg and to St Gall); another important line extends from Rorschach along the lake shore via Constance, thence to Schaffhausen. The canton is a highly prosperous agricultural area, and though termed the "garden and granary of Helvetia" it also possesses an important cotton-spinning, dyeing and printing industry Its estimated pop. in 1926 was 139,100 Of its pop in 1920, 131,815 were German-speaking, 3,187 Italian-speaking and 537 French-speaking, while there were 90,665 Protestants, 44,467 Catholics and 157 Jews Its capital is Frauenfeld (pop 8,711) on the Murg, other towns are Arbon (9,393), Kreuzlingen and Romanshorn (6,474), which is the chief lake port of the canton

History.—The Thurgau originally took in all the country, roughly speaking, between the Reuss, the Lake of Lucerne, the Rhine and the Lake of Constance, but many smaller districts (Zurichgau, Toggenburg, Appenzell, St. Gall) were gradually carved out of it, and the county was reduced to about the size of the present canton when in 1264 it passed by the gift of the last count of Kyburg to his nephew Rudolph of Habsburg, chosen emperor in 1273 In 1460–61 it was seized by the Confederates and henceforth it was ruled as a "subject district" by seven members of the League—Bern occupied in the west, not being admitted to a share in the government till 1712, after one of the wars of religion In 1499 the Confederation obtained from the emperor the supreme jurisdiction

In 1798 it became free, and was one of the 19 cantons of the Helvetic republic, being formally received (like the other "subject lands") as a full member of the Swiss Confederation in 1803 by the Act of Mediation The very advanced Cantonal Constitution dates to 1869 (*See* SWITZERLAND, *Administration*)

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THURIBLE, the ecclesiastical term for a censer, a portable vessel in which burning incense (*q.v.*) can be carried The censer, to use the more general term, is a vessel which contains burning charcoal on which the aromatic substances to be burned are sprinkled The early Jewish portable censer would seem to have been a bowl with a handle, resembling a ladle. A similar form was used by the ancient Egyptians long prior to the Jewish use. The Greek and Roman censers (*θυμιατήριον* and *turibulum* or *thuribulum*) are of quite different shape. They are small portable braziers (*foculi*) of bronze or sometimes of silver and of highly ornate design.

The censers or thuribles in Christian usage have been specially adapted to be swung, though many early specimens of heavy weight were obviously not meant to be used in this way.

THURII or THURIUM, a city of Magna Graecia on the Gulf of Tarentum, near the site of the older Sybaris (*q.v*). It owed its origin to an attempt made in 452 B.C. by Sybarite exiles and their descendants to repeople their old home. The new settlement was crushed by Crotona, but the Athenians lent aid to the fugitives, and in 443 Pericles sent out to Thurii a mixed body of colonists from various parts of Greece, among whom were Herodotus and the orator Lysias. In 390 it was severely defeated by the Lucanians, and at length called in the help of the Romans against the Lucanians, and then in 282 against Tarentum. Thenceforward it was dependent, and in the Second Punic War it was depopulated and plundered by Hannibal (204). In 194 a Roman colony was founded, known for a time as Copiae, but afterwards as Thurii.

THURINGIA (Ger. Land Thüringen), a Republic and a component state of the German Republic It consists of the former Thuringian States of Saxe-Weimar-Eisenach, Saxe-Meiningen, Reuss, Saxe-Altenburg, Saxe-Gotha (Coburg having been merged with Bavaria), Schwarzburg-Rudolstadt, and Schwarzburg-Sondershausen, which decided in 1919 to combine into one State. They maintained their identity as administrative districts until April 1, 1923, but were then completely merged into Thuringia. The country falls into two main divisions: the southern division is bounded on the north and west by Prussia, on the east by Saxony and on the south by Bavaria, while the smaller northern division is surrounded by Prussia. Its total area is 4,540·5 sq m

A considerable part of the country is occupied by the picturesque, rounded hills of the Thuringian forest Among the chief elevations are the Beerberg (3,225 ft), the Schneekopf (3,179 ft.) and the Inselberg (2,957 ft), on the northern slopes of the Thuringian forest The Altenburg district in East Thuringia is traversed by the westerly offshoots of the Erzgebirge, while the Rhön mountains extend into West Thuringia The south-eastern portion of Thuringia belongs to the bleak, mountainous region of the Frankenwald and the Vogtland The principal river is the Saale, which runs in a north-westerly direction as far as Saalfeld, and then flows north-east by Rudolstadt and Jena. Among the other rivers are the Werra, Ilm, Gera, Unstrut, Elster, Weisse, Wipper, Helbe and Pleisse The district watered by the Pleisse contains some of the richest agricultural soil in Germany

Of the total area of Thuringia, about 44% is occupied by arable land, 33% by forest, and 10% by pasture land. The chief mineral resources of Thuringia are lignite (found mainly in the Altenburg district), and potash in the valley of the Werra and in the Sondershausen district Iron ore, marble, cobalt, copper, slates, chalk and basalt are also found, and there are salt works at Salzungen and Neusalza, and brine springs at Heinrichshall and elsewhere Among the principal industrial products of Thuringia are textiles, glass and porcelain, iron goods and machinery, paper and leather goods, musical instruments, beer, chemicals, wooden toys, etc The manufacture of toys and textile goods is largely carried on under the domestic system The optical instruments of Jena and the scientific instruments of Ilmenau are well known

In 1925 Thuringia had 1,624,675 inhabitants, or 357·8 to the sq m. The population is mainly Teutonic, but there is a Wendish or Slavonic element The population is 90% Protestant. The University of Jena is the chief centre for higher education.

The constitution of Thuringia dates from March 11, 1921. The Landtag consists of 72 members For administrative purposes the country is divided into 10 town and 15 country districts (Kreise), and one sub-district (Kreisabteilung) The capital is Weimar, but Gera and Jena are larger towns and Gotha, Eisenach, Altenburg and Greiz are also noteworthy

History.—In the 5th century the Thuringians lived between the Harz mountains and the Thuringian Forest They were tributary to Attila the Hun, under whom they served at the battle of Châlons in 451 In the 6th century they were conquered by the Franks and remained under the direct rule of the Frankish kings until 634, when King Dagobert I appointed Radulf duke of the Thuringians, under whom they became virtually independent They were again brought under Frankish rule by Charles Martel, who abolished the office of duke and divided the country among Frankish counts. About 804 Charlemagne, in order to defend the line of the Saale against the Slavs, founded the Thuringian mark In 849 King Louis the German recognized Tlakulf as duke and some of his successors bore the title of margrave until the death of Burkhard in 908, when the country was seized by Otto the Illustrious, duke of Saxony. Thuringia was retained by Otto's son and successor, Henry I. the Fowler

In the 11th century a new dominion was founded by Louis the Bearded, who by purchase, gift or marriage obtained several counties in Thuringia. These passed on his death in 1056 to his son Louis the Springer (d. 1123), who took part in the Saxon risings against the emperors Henry IV. and Henry V. His son Louis was appointed landgrave of Thuringia in 1130 by the emperor Lothair II.; by his marriage with Hedwig of Gudensberg in 1137 he obtained a large part of Hesse. Louis was succeeded in 1140 by his son Louis II the Hard, who married Judith, a sister

of the emperor Frederick I., and on his behalf took a leading part in the opposition to his powerful neighbour Henry the Lion, duke of Saxony. In 1172 he was succeeded by his son Louis III. the Pious He acquired the Saxon palatinate in 1179, on the death of Adalbert, count of Sommerschenburg, went to Italy to assist Frederick I. in 1157, joined in the war against Henry the Lion in 1180, and distinguished himself at the siege of Acre in the Third Crusade, on the return from which he died at Cyprus in 1190. He was succeeded by his brother Hermann I., during whose reign Thuringia suffered greatly from the war between Philip duke of Swabia and Otto of Brunswick The next landgrave (1217–27) was his son Louis IV., a celebrated figure in mediaeval German literature, who married St. Elizabeth, daughter of Andrew II, king of Hungary, and died at Otranto while accompanying the emperor Frederick II. on crusade The next ruler was Henry Raspe, who made himself regent on behalf of his nephew Hermann II from 1227 to 1238 and in 1241 succeeded his former ward as landgrave.

After a disputed succession to the landgraviate it fell in 1263, together with the Saxon palatinate, to Henry III. margrave of Meissen Two years later Henry apportioned Thuringia to his son Albert the Degenerate, who sold it in 1293 to the German king Adolph of Nassau for 12,000 marks of silver Albert's sons Frederick the Undaunted and Dietrich contested this transaction, and the attempts of Adolph and his successor Albert I to enforce it led to the infliction of great hardships upon the Thuringians Frederick defeated Albert decisively and in 1314 was formally invested with Thuringia by the emperor Henry VII His son Frederick II the Grave (1323–49) consolidated the power of his dynasty against rebellious vassals and the neighbouring counts of Weimar and Schwarzburg His son Frederick III the Strong (1349–81) and his grandson Balthasar (1381–1406) further extended their dominion by marriage and conquest, and the latter of these founded the university at Erfurt (1392). Balthasar's son, Frederick the Peaceful, became landgrave in 1406 but left the government largely to his father-in-law Gunther, count of Schwarzburg He died childless in 1440, and Thuringia then passed to the electoral dynasty of Saxony After a joint rule by Frederick II and his brother William, the latter in 1445 became sole landgrave as William III and died without sons in 1482. In 1485 his nephews and heirs Albert and Ernest made a division of their lands, and Thuringia was given to the Ernestine branch of the family of Wettin, with which its history down to 1918 is identified (*see* SAXONY)

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THURLES, a town of Co. Tipperary, Ireland, on the Suir and on the main line of the Great Southern and Western railway, 87m S.W of Dublin Pop (1926) 4,796. Originally the town was called Durlas O'Fogarty In the 10th century it was the scene of a defeat of the Irish by the Danes. A preceptory was founded here by the Knights Templars, who held a 13th century castle, of which there are remains A castle was subsequently erected by James Butler, first lord palatine of Tipperary, of which the keep collapsed in 1868. The Cistercian abbey of Holy Cross stands 3½ m. S.W of the town It was founded by Donnell O'Brien (1168–94) Thurles is the seat of the Roman Catholic archdiocese of Cashel.

THURLOE, JOHN (1616–1668), English politician, son of Thomas Thurloe, rector of Abbot's Roding in Essex, was baptized on June 12, 1616 He studied law, entered the service of Oliver St John, through whose interest he was appointed a secretary to the parliamentary commissioners at Uxbridge in 1645; other employments followed. On March 29, 1652, he was appointed secretary to the council of state. His duties included the control of the intelligence department and of the posts, and his perfect system of collecting information and success in discovering the plans of the enemies of the administration astonished his contemporaries. In the parliaments of 1654 and of 1656 he represented Ely; he was appointed a member of Cromwell's second council in 1657.

After Oliver's death Thurloe supported Richard Cromwell's succession, and took part in the administration, sitting in the parliament of January 1659 as member for Cambridge University. Appointed secretary of state on Feb. 27, 1660, he appears to have steadily resisted the Restoration, and his promises of support to Hyde in April inspired little confidence On May 15, 1660, he was arrested on the charge of high treason, but was freed on June 29, subject to the obligation of attending the secretaries of state "for the service of the state whenever they should require." He subsequently wrote several papers on the subject of foreign affairs for Clarendon's information He died on Feb. 21, 1668.

His extensive correspondence, the originals of which are in the Bodleian Library at Oxford and the British Museum (*Add MSS* 4156, 4157, 4158), is one of the chief sources of information for the period A portion was published with a memoir by T Birch in 1742, and other correspondence is printed in R. Vaughan's *Protectorate of Oliver Cromwell* (1836).

THURLOW, EDWARD THURLOW, 1ST BARON (1731–1806), English lord chancellor, was born at Bracon Ash, in the county of Norfolk, on Dec. 9, 1731, the eldest son of the Rev Thomas Thurlow. He was educated at Canterbury Grammar school and Caius college, Cambridge, but went down without a degree. In 1754 he went on the western circuit and after a successful brush with Fletcher Norton his reputation rose. He took silk in 1761, and in 1768 became M.P. for Tavistock in the Tory interest. The next year he led for the plaintiff in the Douglas peerage case. In 1770 he was made solicitor-general, and supported the Government views against the rights of juries in libel cases (*R.* v. *Miller,* 20 *St. Tr.* 870) and the liberty of the press (16 *Parl. Hist.* 1144), in 1770, he became attorney-general Politically he was factious and violent, he was a venomous opponent of the American colonies, he made a savage speech in aggravation of punishment in the Horne Tooke case (20 St. Tr 777), and was opposed to all interference with the slave trade In 1778 he became lord chancellor with a peerage. His position in the Lords was almost autocratic, and he continued to oppose the reforming schemes of Burke. Under Rockingham and Shelburne he remained chancellor; under the coalition he worked in opposition for the king; got the India bill rejected; and returned to the woolsack under Pitt (1783) Finally he came out openly in opposition to the National Debt Redemption scheme Pitt then insisted on his dismissal (1792), and he retired with the title of Baron Thurlow of Thurlow. He continued to speak in the Lords till 1802 and died at Brighton on Sept. 12, 1806

Thurlow was a master of caustic wit, habitually displayed in profanity. His judicial and his ecclesiastical patronage were wisely exercised; he was the patron of Dr. Johnson and of Crabbe; and was the first to detect the great legal merits of Eldon. Thurlow's personal appearance was striking. His dark complexion, harsh but regular features, severe and dignified demeanour, piercing black eyes, and bushy eyebrows, doubtless contributed to his political eminence, and provoked the sarcasm of Fox that he *looked* wiser than any man ever *was*.

See Lord Campbell's *Lives of the Chancellors,* vii. 153–333; Foss's *Judges of England,* viii. 374–385; *Public Characters* (1798); *Notes and Queries,* 2nd series, vol. iii p. 283, 3rd series, vol. iii p 122, *Reports* of his decisions by Brown, Dickens and Vesey (Jun); Brougham's *Statesmen of the Time of George III.*

THURMAN, ALLEN GRANBERY (1813–1895), American jurist and statesman, was born at Lynchburg (Va.), on Nov. 13, 1813. In 1819 he removed with his parents to Chillicothe (O.), where he attended the local academy for two years, studied law in the office of his uncle, William Allen, and in 1835 was admitted to the bar, becoming his uncle's law partner. He began to take an active part in politics in 1844, and in 1845–47 was a Democratic representative in Congress, where he advocated the Wilmot Proviso.

He was Democratic candidate for governor of Ohio in 1867, and was defeated by Rutherford B. Hayes by a majority of less than 3,000 votes; but the Democrats gained a majority in both branches of the State legislature, and Thurman was elected to

the United States Senate, where he served from 1869 until 1881—during the 46th Congress (1879–81) as president *pro tempore.* Here he became the recognized Democratic leader and in 1879–81 was chairman of the judiciary committee. He introduced the Thurman bill, for which he was chiefly responsible, which became law in May, 1878, and readjusted the Government's relations with the bond-aided Pacific railways.

Thurman was a member of the electoral commission of 1877, and was one of the American delegates to the international monetary conference at Paris in 1881 In 1876, 1880 and 1884 he was a candidate for the presidential nomination, and in 1888 was nominated for vice-president on the ticket with Grover Cleveland, but was defeated in the election. He died at Columbus (O.), on Dec. 12, 1895.

THURSDAY ISLAND, a small island belonging to Queensland, Australia, situated 30 miles to the north-west of Cape York in Torres Straits. It has an excellent harbour (Port Kennedy) which is the centre for the pearl, etc, fleets of the north-east. (*See* AUSTRALIA. *Fisheries.*) Pop (1926) 1,700.

THURSO, burgh of barony, police burgh, parish and seaport of Caithness, Scotland Pop (1921), 3,039 It is situated at the mouth of the Thurso, on Thurso bay, 21 m N W of Wick, and 319 m N of Edinburgh, by rail, on a branch line of the L.M.S. railway from Georgemas junction, the most northerly town on the mainland of Scotland.

In Macdonald square there is a statue of Sir John Sinclair The town-hall contains a public library and museum, which possesses the geological and botanical specimens of Robert Dick (1811–1866), the "Thurso baker," and a collection of northern birds To the east is Thurso castle, home of the Ulbster branch of the Sinclairs, and near it is Harold's tower, built over the grave of Earl Harold, once owner of half of Caithness, and half of the Orkneys and Shetlands, who fell in battle with Earl Harold the Wicked in 1190 About three-quarters of a mile west stand the ruins of the bishop's palace, which was destroyed by fire in 1222 Thurso was the centre of the Norse power on the mainland when at its height under Thorfinn (1014), and afterwards till the battle of Largs (1263) Count Modach, nephew of King Duncan, quartered his army for a time at Thurso and despoiled it till he was surprised and slain by Thorfinn in 1040.

THURSTAN or TURSTIN (d. 1140), archbishop of York, was the son of a certain Anger, or Auger, prebendary of St Paul's, London, and a brother of Audoen (d. 1139), bishop of Evreux. He himself was a prebendary of St. Paul's, and was also a clerk in the service of William II and then of Henry I., who secured his election as archbishop of York in Aug 1114. He now entered upon the great controversy which occupied him during a large part of his subsequent life and made him for several years an exile from England Archbishop Ralph of Canterbury refused to consecrate him unless he made a profession of obedience to the southern see; this Thurstan refused and asked the king for permission to go to Rome to consult Pope Paschal II. Henry I. declined to allow him to make the journey, while Paschal declared against Archbishop Ralph At the Council of Salisbury in 1116 the English king ordered Thurstan to submit, but instead he resigned his archbishopric, although this did not take effect. The new pope, Gelasius II, and also his successor, Calixtus II., espoused the cause of the stubborn archbishop, and in Oct. 1119, he was consecrated by Calixtus at Reims

Enraged at this the king refused to allow Thurstan to enter England, and he remained for some time in the company of the pope At length, however, his friends succeeded in reconciling him with Henry, and, after serving the king in Normandy, he was recalled to England. In 1138 he made a truce at Roxburgh between England and Scotland, and took active part in gathering together the army which defeated the Scots at the Battle of the Standard in Aug. 1138. Early in 1140 he entered the order of the Cluniacs at Pontefract and here he died on Feb. 6, 1140. Thurstan displayed marked generosity toward the churches of his diocese during his bishopric and was also the founder of a number of religious houses.

See his life in the *Fasti eboracenses*, ed. J. Raine (1863)

THYLACINE or **TASMANIAN WOLF** (*Thylacinus cynocephalus*). The only living species of this genus, though smaller than a wolf, is the largest predaceous marsupial existing. Its remarkable resemblance to a dog or wolf is entirely due to convergent evolution It is confined to the island of Tasmania, although a closely allied species once inhabited the Australian mainland. (*See* MARSUPIALIA.)

THYMBRA, BATTLE OF. This battle of 546 B C. was the decisive act in Cyrus the Great's overthrow of Croesus, king of Lydia, which in turn led to his subjugation of Asia Minor, and thus brought the Persians in contact with the Greeks—with momentous consequences to both (*See* GRAECO-PERSIAN WARS) As described in Xenophon's *Cyropaedia* the battle is rather instructional than historical, yet even so of far-reaching historical importance For this projection on to an historical screen of Xenophon's conception of the "model" commander and the "model" battle, affected the course of many wars yet undreamt of It served as the foundation of the study and reflection of the great captains of antiquity—Scipio, for example, is said to have carried the *Cyropaedia* with him throughout his campaigns. And with the Renaissance, and the revival of Greek studies, it lightened afresh the path of the great captains of the 16th, 17th and 18th centuries. As pictured by Xenophon, Croesus draws up his army in the customary single line many ranks deep, while Cyrus forms his in a deep series of lines, each only a few deep, capable of mutual support and manoeuvre When Croesus uses his superiority of numbers to wheel inwards his far-stretching wings in order to crush Cyrus's wedge-like formation between them, Cyrus fends them off by lines of scythed chariots charging outwards, while his cavalry and camelry reserve attacks the flanks of the inwheeling Lydian wings Then under cover of a frontal chariot attack on Croesus's centre, a small picked reserve of horse and foot is hurled at the point where one of the enemy wings joins on to the centre This pierced, the cut off centre is "played on" by arrows and javelins until it surrenders

There is an extraordinary parallel between this sequence of action—distention of the enemy's line, dislocation of a joint, followed by a disruption which decides the issue—and the fundamentals of Napoleon's tactic more than 2,000 years later

See Herodotus, i 79–80; Xenophon, *Cyropaedia*

THYME. The genus *Thymus* (family Labiatae) comprises a number of fragrant aromatic undershrubs, with very small leaves and whorls of small, purple, honey-bearing flowers in the axils of the leaves or at the ends of the branches The common garden thyme, a native of the Mediterranean region, is *T. vulgaris;* the wild thyme of English banks is *T serpyllum*, now naturalized in eastern North America from Nova Scotia to Pennsylvania Marjoram (*Origanum*) is also closely allied All these plants are remarkable for their essential oil, from which thymol is produced.

THYMOL: *see* CAMPHORS

THYMUS: *see* DUCTLESS GLAND, LYMPHATIC SYSTEM, DISEASES OF

THYROID, in anatomy, a term applied (1) to the largest of the cartilages of the larynx (*see* RESPIRATORY SYSTEM), (2) to one of two arteries which lie near the thyroid cartilage and gland (*see* ARTERIES), and (3) to a vascular ductless gland, which rests on the larynx and upper part of the trachea In human beings two conditions may occur both the result of a lack of thyroid secretion, but differing according as the condition is congenital or has started in early life, *i.e*, cretinism (*q v*), or occurs later in life, *i.e*, myxoedema (*q v*) (*See* also DUCTLESS GLAND)

The thyroid gland is used in medicine in two forms *Thyroideum siccum* is a light, dull brown powder, prepared by drying the thyroid gland of a sheep Its chief constituent is a proteid known as thyreoglobulin, the active principle of which contains 9·3% of iodine and 0·5% of phosphorus, and is known as iodothyrin or thyroiodin The dried gland easily becomes damp and deteriorates. *Liquor thyroidei* is a pink turbid liquid made by macerating the fresh gland of a sheep with glycerin and phenol The active principle in pure form—thyroxin—was isolated in 1914 by E. C. Kendall at the Mayo Clinic, Rochester, Minnesota.

Thyroid gland administered to man increases the pulse rate, causes increased and enfeebled cardiac beat and leads to increased metabolism, consequently excess of urea, uric acid and phosphates are excreted in the urine; it therefore reduces the body weight. Glycosuria develops from the inability of the body to ingest glucose. Overdoses of thyroid cause rapid pulse, headache and vomiting, together with diarrhoea and pruritus, emaciation and weakness These symptoms are known as *thyroidism*

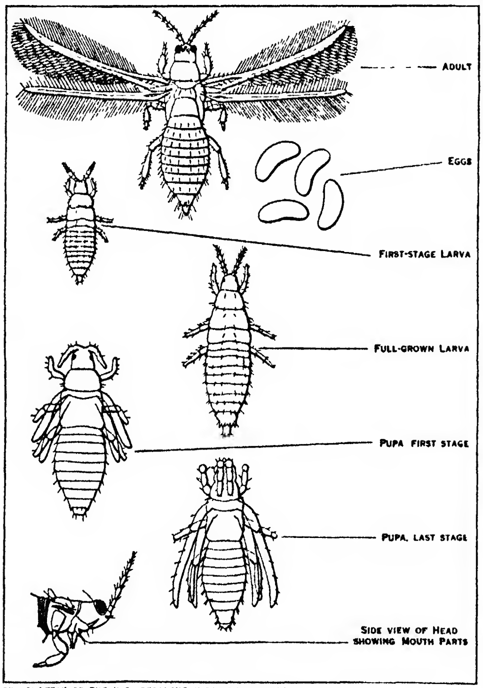
Thyroid gland was introduced for the treatment of goitre, myxoedema and cretinism (*q.v*). It has also been used in dwarfism, excessive obesity, psoriasis and scleroderma.

Rodagen is a white powder consisting of the dried milk of thyroidectomized goats, mixed with 50% of milk sugar In exophthalmic goitre this preparation causes a reduction of the swelling and of the pulse rate, and an increase of body weight

THYRSUS, a kind of staff carried by Dionysus (*q.v.*) and his votaries (Gr. θύρσος). It was a reed, sometimes having a spear-point at one end, topped with a pine-cone

See F. J. M. de Waele, *The Magic Staff or Rod* (1927).

THYSANOPTERA, the name used in zoological classification for a small order of the class Hexapoda commonly known as thrips The majority of these creatures are very small, varying in length from $\frac{1}{50}$ to $\frac{1}{3}$ of an inch, and they are mostly yellow, yellow-brown or black in colour. They are found among all kinds of growing vegetation—on the buds, flowers or foliage: others frequent decaying plant-remains especially wood and fungi. A small number are predators and suck the body fluids of aphides and Acari They are elongate, slender-bodied insects, with short six- to nine-jointed antennae, and asymmetrical piercing mouth-parts. The wings are very narrow and strap-like with greatly reduced venation and long fringes of marginal hairs. The tarsi are one- or two-jointed and the apex of each tarsus is terminated by a minute protrusible bladder or vesicle which enables them to climb almost any surface. The young forms closely resemble the adults in their general form and they ultimately pass into a resting stage or incipient pupa prior to becoming adults. Numerous thrips are wingless and some species consist of both winged and wingless individuals. Parthenogenesis is frequent in the order and males are either unknown, or very rare, in several species: in others the eggs are capable of developing parthenogenetically, although males are common.



BY COURTESY OF THE U S DEPARTMENT OF AGRICULTURE

LIFE HISTORY OF THE PEAR THRIPS (TAENIOTHRIPS PYRI)

Thysanoptera are divided into two sub-orders (1) *Terebrantia* in which the last segment of the abdomen is conical, that of the male being rounded, and the female has a saw-like ovipositor most of the species feed on living plants. (2) *Tubulifera* in which the last segment of the abdomen is tubular in both sexes and the female is without a saw-like ovipositor· the species chiefly feed upon dead organic matter, fungi, etc , or form galls in a few cases

Only a few hundred members of the order have been described, and in most tropical lands thrips, as yet, have been very little studied, but the order is probably world-wide in its range. Australia contains numerous species including some of the largest forms, but no indigenous species have been found in New Zealand

BIBLIOGRAPHY—For the British species, *see* the papers by R Bagnall in *Journ Econ. Biology* (1911–13) and other journals; C B. Williams' account of the pea thrips in *Annals Applied Biology* (1915) is also valuable. For the North American species, *see* W. E Hinds, *Proc , U S Nat Museum* (vol xxvi, 1902) and for the structure of the mouth-parts, *see* A. Peterson, *Annals Entom Soc America* (vol. viii 1915) ; *see* also H. Priesner, *Thysanopteren Europas* (1926–28). (A. D. I)

THYSANURA, the name of an order of primitive wingless insects known as springtails and bristletails. They are recognizable by their elongate feelers and tail-processes (*cerci*). *Campodea* (*q v.*) *Machilis* and *Lepisma*—to which belongs the "silver-fish" (*q v.*)—are the best known genera. (*See* also APTERYGOTA)

THYSDRUS, an ancient city of North Africa (the site is occupied by the modern village of EL DJEM, 43 m S of Sousse by rail). It acquired importance owing to the fertility of its environs, and also as the meeting place of six ancient roads The amphitheatre, 163 by 133 yd., is the finest Roman monument in North Africa, and is second in size only to the Flavian amphitheatre (the Colosseum) in Rome.

THYSSAGETAE, an ancient tribe described by Herodotus (iv. 22, 123) as occupying a district to the north-east of Scythia separated from the Budini by a desert seven days' journey broad

THYSSEN, AUGUST (1842–1926), German industrialist, was born at Eschweiler on May 17, 1842, and, with his brother Josef, founded a firm in Duisburg for the manufacture of hoop iron, which became exceedingly prosperous during the Franco-Prussian war. After the war Thyssen established a factory at Mulheim, and then began the policy of grouping interdependent industries. In 1903 he began the formation of a metal "vertical" trust, which had interests in the iron-fields of Lorraine, in other raw materials of heavy industry, in shipping and in electrical power. The power of the group was consolidated in the World War of 1914–18 August Thyssen himself conducted the business personally until 1922. He died on April 15, 1926.

TIARA, the papal crown, a bee-hive shaped, somewhat bulging head-covering, ornamented with three crowns (whence *triregnum* or "triple crown"). It has no sacral character, being solely the ensign of sovereign power (*cf.* Innocent III. Serm. vii. *in S. Silvest*), and is therefore never worn at liturgical functions, when the pope always wears the mitre. The tiara is first mentioned, under the name of *camelaucum,* in the *Vita* of Pope Constantine (d 715), and next under the name of *pileus phrygius* or *phrygium,* or the *Constitutum Constantini,* the so-called "Donation of Constantine." In the 9th century it appears in the 9th *Ordo* of Mabillon in connection with the description of the consecration of the pope. On papal coins it first appears on those of Sergius III. (d. 911) and then on those of Benedict VII. (d. 983). At this period it was, according to the *Ordo* above mentioned, a sort of cap of white stuff, and helmet-shaped. Before the 9th century the tiara was certainly without any crown; any such ornament would not have been in keeping with the circumstances of the time, and seems also to be excluded by the terms of the *Constitutum Constantini.*

At the beginning of the 12th century, however, the papal tiara was already decorated with a circlet, as the 12th *Ordo* and statements made by Bruno of Segni (d. 1123) and Suger, abbot of St. Denys (1121–51), prove; but it is only in representations of the tiara dating from the late 13th century that the circlet appears as a regular spiked crown. The two pendants at the back of the tiara (*caudae, infulae*) are likewise only traceable to this period. The second circlet was added by Boniface VIII., as is proved by three statues executed during his lifetime (one in the Lateran church and two in the crypt of St. Peter's). The earliest effigy of a pope with a triple-crowned tiara is, therefore, that of Benedict XII. (d 1342), of which the head is preserved in the museum at Avignon, while an effigy of the same pope in the crypt of St. Peter's at Rome has a tiara with only two crowns.

TIARET (*Tahert*), a town of Algeria, in the Tell Atlas, department of Oran, 122 m S E of Mostaganem by rail. It occupies an important strategic position on a pass through the mountains at an elevation of 3,552 ft The Wadi Tiaret flows through the town in a series of cascades. The upper town, the residential quarter, is on the right bank of this stream. The citadel occupies a separate hill on the other side of the wadi. The chief business centre is the lower town where are also the principal public buildings. On another hill opposite the citadel is the native town. The railway, which ended there and which has been extended to Trumelet, forms the outlet of the fertile Sersou plateau, the 400,000 hectares of which have been completely transformed by colonization since 1900

The citadel occupies the site of a Roman station Tiaret (Berber for "station") was a town of note at the time of the Arab invasion of North Africa in the 7th century. In 761 it was taken by Abdurrahman ibn Rostem, the founder of the dynasty of the Beni Rustām (Rostem) Their empire, which during the reign of Abdurrahman (761–784) and his son Abdul Wahab (784–823) extended over the greater part of the modern Algeria, was known as the Ibadite Empire from Abdallah ibn Ibad, the founder of the heretical sect to which Abdurrahman belonged. The Ibadites represented the moderate section of the Kharijites (*See* Islam) Seven princes of the Rustamite house succeeded Abdul Wahab at Tiaret, but in 909 the dynasty was overthrown by the Fatimites The Ibadites, after being expelled from the Tell, took refuge in Wargla They were driven thence in the 11th century and migrated to Mzab, where their descendants still profess the Ibadite doctrines and traditions After its second capture by the Fatimites, Tiaret ceased to be the capital of a separate state For a long period it was included in the sultanate of Tlemçen, and in the 16th century fell to the Turks. It was one of the chief towns of Abd el Kader, but was occupied by the French in 1843 (*See* Algeria *Archaeology*.)

TIBER, a river of central Italy (anc. *Tiberis;* Ital. *Tevere*). It traverses the Tuscan Apennines—in which it rises at a point some 12 m N. of Pieve San Stefano, 4,160 ft. above sea-level, nearly 20 m east from the headwaters of the Arno—in a series of picturesque ravines, flows nearly south by Borgo S. Sepolcro and Città di Castello, then runs between Perugia and Todi to Orte, where it receives the Nera (which brings with it the waters of the Velino, *see* Terni), skirts the west foot of the Sabine Mountains in a broad shallow valley, then crosses the Roman Campagna, cutting its way through Rome, and finally enters the Tyrrhenian (Mediterranean) Sea by two arms at Ostia and Fiumicino, the latter artificial Its principal tributaries are the Paglia, the Nera and the Anio or Teverone, and it is generally navigable by boats up to the confluence of the Nera, a distance of 104 m., though, owing to the rapidity of the current, there is very little navigation above Rome. The total length of the river is 253 m., of which 21 m. lie between Rome and the sea. This latter portion of the river's course is tortuous, but in spite of this, and although the depth varies from only 7 to 20 ft., and in places at low water does not exceed 4 ft., it is nevertheless navigated by vessels up to 180 tons burden. The area of the Tiber basin is 6,719 sq m., and it is the largest in Italy except the Po The stream is heavily charged with sediment, and from that circumstance got its ancient epithet of *flavus* (tawny) The discharge at the mouth is 230 cubic metres per second, but it can fall as low as 90, and in floods rise to 3,400. It has advanced at each mouth about 2 m. since Roman times, while the effect of the sediment it brings down is seen on the north-west almost as far as Palo (anc *Alsium*), and on the south-east beyond Tor Paterno (*see* Laurentina Via) in the gradual advance of the coast The rate of advance at Fiumicino is estimated at 13 ft. per annum From Rome to the sea the fall is only 6 1,000. The arm which reaches the sea at Fiumicino is a canal, dug by Claudius and improved by Trajan (*see* Portus)

In the prehistoric period the mouth of the Tiber must have been situated at the point where the hills which follow it on each side cease, about 12 m. below Rome. On the right bank they are of Pliocene gravel, on the left of tufa; and on the latter, on a cliff above the river (the ancient *Puilia saxa*) stood Ficana (marked by the farmhouse of Dragoncello), which is said to have owed its origin to Ancus Martius. Beyond these hills the low coast belt formed by the solid matter brought down by the river begins; and on each side of the mouth in the flat ground were salt marshes. (*See* Ostia, Portus)

TIBERIAS, a town on the western shore of the Sea of Galilee, attractively situated on a narrow strip of land between the high ground and the water, 680 ft below sea-level (mod *Tabariyeh*); pop *c.* 7,000 The old city lay to the south of the modern Not much of archaeological interest remains visible, but excavations on the site of the old town are being conducted by the Jewish Exploration Fund.

History.—Tiberias was built about A D. 21 by Herod Antipas, and was so called after the emperor Tiberius Herod made it his capital and developed its life on Greek lines. The town was built on an ancient site, probably Rakkath (Josh. xix 35), and in the course of construction a graveyard was disturbed. In consequence the Jews, fearful of uncleanness, refused to live there, and Herod had to resort to compulsion to people his town (Joseph *Antiq.* xviii 2, 3). No mention is made of Tiberias in the gospels, except the casual reference in John vi 23. The city was of too recent date and too Hellenistic in outlook to invite attention; and it is unlikely that Christ ever visited it. It flung open its gates to Vespasian and his legions to earn consideration and favour. Hadrian sought to implant paganism by erecting a temple, but with no marked success. Towards the close of the 2nd century, the Sanhedrin transferred itself thither from its first Galilean home at Sepphoris From the rabbinic school at Tiberias came Judah hak-Kādhōsh, the collector and editor of the *Mishnah* (*c.* 220) The Talmud was there edited 200 years later The Jewish philosopher, Maimonides, and Rabbi 'Akiba are buried there.

Christianity found in Tiberias no congenial soil, and not until the 4th century could it make headway In the 5th century there was a bishop of Tiberias, who subscribed to the acts of the Council of Chalcedon In 637 came the Arabs When the crusaders established their kingdom of Jerusalem, Tancred was appointed ruler in Galilee, Tiberias became his capital and was in part rebuilt on a new site farther north In 1187, before the battle of Hattin, it fell into the hands of Saladin In the 18th century, Dhāhir el-Amir fortified the town; and in their advance on Damascus, British troops seized it in Oct. 1918. (E. Ro.)

TIBERIUS [Tiberius Claudius Nero] (42 B C.–A.D 37), Roman emperor, was born on Nov 16, 42 B C His father, who bore the same name, was an officer of Julius Caesar, who, after a stormy career, returned to Rome when the general amnesty was proclaimed in 39 B.C. Livia, the mother of Tiberius, was also of the Claudian family; her husband ceded her to Octavian in 38 shortly before Drusus, Tiberius's brother, was born. Livia had no children by Augustus, and therefore devoted all her remarkable gifts to the advancement of her sons. Tiberius passed through the list of state offices in the usual princely fashion, beginning with the quaestorship at the age of eighteen, and attaining the consulate for the first time at twenty-nine.

But from 22 to 6 B.C and again from A.D. 4 to 10 by far the greater part of Tiberius's time was spent in the camp. His first service was as legionary tribune in one of the desperate wars in the Spanish peninsula. In 20 B C. Augustus sent Tiberius with

an army to seat Tigranes of Armenia on the throne as a Roman vassal This he did without opposition He spent the following year as governor of Transalpine Gaul In the next year (15) he was despatched to aid his brother Drusus in subjugating the Raeti and Vindelici in the mountains at the source of the Rhine and Danube. Drusus attacked from the eastern side, while Tiberius operated from the upper waters of the Rhine, and the mountaineers were subdued, which ensured the safety of communications between northern Italy and Gaul. In 12 B C. Agrippa, the great general of Augustus, died at the age of fifty-one, leaving Julia, the emperor's only child, a widow. Agrippina, daughter of Agrippa by an earlier marriage, was wife of Tiberius, and had borne him a son, Drusus, afterwards father of Germanicus Livia, with great difficulty, prevailed upon Augustus to replace Agrippa by Tiberius, who was compelled to exchange Agrippina for Julia, to his bitter grief During the year of mourning for Agrippa, which delayed his new marriage, Tiberius was occupied with a victorious campaign against the Pannonians, followed by successful expeditions in the three succeeding summers For this he received the triumphal insignia, now first separated from the triumph itself Drusus died in 9 B C., and Tiberius became the first soldier of the empire

In the campaign of the year after Drusus's death Tiberius traversed all Germany between the Rhine and the Elbe, and met with slight opposition He was rewarded with the full triumph, the military title of "imperator," and his second consulship. In 7 B C there was another but insignificant campaign in Germany. Next year Augustus bestowed on his stepson the tribunician authority for five years.

Tiberius at this time suddenly begged permission to retire to Rhodes and devote himself to study He seems to have declined absolutely at the time to state his reasons for this course, but he obstinately adhered to it. The departure from Italy was as secret as it could be made. Years afterwards, when Tiberius broke silence about his motives, he declared that he had retired in order to allow the young princes, Gaius and Lucius, sons of Agrippa and Julia, a free course.

At Rhodes Tiberius lived simply, passing his time mainly in the company of Greek professors, with whom he associated on pretty equal terms After five years' absence from Rome, he begged for leave to return; but the boon was angrily refused, and Livia with difficulty got her son made nominally a legate of Augustus, so as in some degree to veil his disgrace The next two years were spent in solitude and gloom Then, on the intercession of Gaius, Augustus allowed Tiberius to come back to Rome, but on the express understanding that he was to hold aloof from public functions He had scarcely returned before death removed (A D. 2) Lucius, the younger of the two princes, and a year and a half later Gaius also died The emperor was thus left with only one male descendant, Agrippa Postumus, youngest son of Julia, and still a boy Four months after Gaius's death Augustus adopted Agrippa and at the same time Tiberius The emperor now indicated clearly his expectation that Tiberius would be his principal successor.

In A D 5 it became necessary to attack the formidable confederacy built up by Maroboduus, with its centre in Bohemia At the most critical moment, when Pannonia and Dalmatia broke out into insurrection, Maroboduus accepted an honourable peace. The four serious campaigns which the war cost displayed Tiberius at his best as a general. When he was about to celebrate his well-won triumphs, the terrible catastrophe to Varus and his legions (A D. 9) produced a profound change in the Roman policy towards Germany. Although Tiberius with his nephew and adopted son Germanicus made in A D 9 and 10 two more marches into the interior of Germany, the Rhine was permanently accepted as the frontier Tiberius was thus robbed in great part of the fruit of his campaigns; but nothing can deprive him of the credit of being a chief founder of the imperial system in the lands of Europe. From the beginning of 11, when he celebrated a magnificent triumph, to the time of the emperor's death in 14 Tiberius remained almost entirely in Italy, and held rather the position of joint emperor than that of expectant heir.

Tiberius ascended the throne at the age of fifty-six. What struck every one of his contemporaries most was his absolute impenetrability. Tiberius proved himself capable in every department of the state more by virtue of industry and application than by genius. His mind moved so slowly and he was accustomed to deliberate so long that men sometimes made the mistake of deeming him a waverer.

The change of masters had been anticipated by the Roman world with apprehension, but it was smoothly accomplished Livia expected to share the imperial authority with her son. At first Tiberius allowed some recognition to the claim; but he soon shook himself free, and later became estranged from his mother and held no communication with her for years before her death. The history of Tiberius's relations with other members of his family is hardly less miserable. Perhaps with any other commander than Germanicus the dangerous mutiny of the troops on the Rhine which broke out soon after Tiberius's accession would have ended in a march of the discontented legions upon the capital. The perilous episode of Arminius caused the recall of Germanicus and his despatch to the East on an honourable but comparatively inactive mission Tiberius seems to have set Piso to watch and thwart him, but there is no authority for the suspicion that he had him poisoned The death of Germanicus was followed four years later by that of the emperor's son Drusus When Drusus died, Tiberius nominated two of the sons of Agrippina, Germanicus' widow, as his heirs But Seianus, Tiberius's minister, had grown strong by nursing the emperor's suspicions and dislike for the household of Germanicus, and the mother and the princes were imprisoned on a charge of crime In his memoirs of his own life Tiberius declared that he killed Seianus because he had discovered that he entertained a mad rage against the sons of Germanicus But the destruction of Seianus did not save Agrippina and her two children. The third son, Gaius Caesar (Caligula), lived to become emperor when Tiberius died in 37

The care expended by Tiberius on the provinces was unremitting Soldiers, governors and officials of all kinds were kept in wholesome dread of vengeance if they oppressed their inferiors or encouraged irregularity of any kind Strict economy permitted light taxation and enabled the emperor to show generosity in periods of exceptional distress Public security both in Italy and abroad was maintained by a strong hand, and commerce was stimulated by the improvement of communications. Jurisdiction both within and without the capital was on the whole exercised with steadiness and equity, and the laws of the empire were at many points improved

Our ancient authorities are Tacitus, to some extent biased by senatorial traditions; Suetonius, a rather scandalous biographer; and Velleius Paterculus, the nearest in point of time, an officer who had served under him Dio is probably dependent on Tacitus The chief account of Tiberius in English is that contained in Dean Merivale's *History of the Romans under the Empire*. Professor E. S Beesly has written an interesting defence of him in his *Catiline, Clodius and Tiberius* (1878) The best recent history of this period is Hermann Schiller's *Geschichte der romischen Kaiserzeit* (Gotha, 1883) Much historical information is given in the editions of the *Annals* of Tacitus, of which the best in English is that of Furneaux (Oxford, 1884), Freytag, *Tiberius and Tacitus* (Berlin, 1870) (following Stahr, *Tiberius*, Berlin, 1863), exposes the inconsistencies of Tacitus' account. *See* also Ihne, *Zur Ehrenrettung des Kaisers Tiberius* (Strassburg, 1892), Gentile, *L'Imperatore Tiberio secondo la moderna critica storica* (1887); J C Tarver, *Tiberius the Tyrant* (1902); E S Beesly, *Cataline, Clodius and Tiberius* (1907); A Lang, *Kaiser Tiberius* (Jena, 1911); O Kuntz, *Tiberius Caesar and the Roman Constitution* (Seattle, 1924). For the imperial administration of the provinces by Tiberius *see* Mommsen, *History of Rome*, vol. v

TIBESTI, a mountainous region of the central Sahara, inhabited by the Tibbu (*q.v.*). Tibesti includes the highest summit of the Sahara, the volcanic massif of Kussi, which reaches 3,400 metres. The eruptive rocks have forced their way through a substratum of crystalline rocks covered by enormous thicknesses of horizontal Silurian grits, the scarp of which is quite brusque above the surrounding plains, which are some hundreds of metres above sea-level. Great dry water-courses, deeply cut in all the faces of the massif, indicate a climate formerly more humid. The daily variations of temperature reach 30° at times. The inhab-

itants, at most 10,000, are very poor. Tibesti had been partly explored by Nachtigall in 1870, since when no European went there till 1915, when Col Tilho wrote a very complete description of it, and mapped it. The frontier was fixed by the Franco-English convention of Sept. 8, 1919.

See S Tilho, *Exploration en Afrique centrale* (*La Géographie*, xxi, 1916–17); id *Carte de Tibesti* (*La Géographie*, xxxvi, 1921); C. Lofler, *La pacification du Tibesti* (*L'Afrique française*, 1916); D. A. A Rottier, *Étude sur le Tibesti* (*Bulletin du Comité d'études historiques et scientifiques de l'Afrique occidentale française*, 1922).

TIBET or **THIBET,** a country of Central Asia. It is the highest country in the world, comprising table-lands, averaging about 16,000ft. above the sea, the valleys being at 12,000 to 17,400ft, the peaks at 20,000 to 24,600ft, and the passes at 16,000 to 19,000 feet. It is bounded on the north by Sinkiang, on the north-east by Kuku-nor (Koko-nor, *q v*), on the east by Chwanben (or Chamben or Chwampien or Kham), on the west by Kashmir and Ladakh, and on the south by India, Nepal and Bhutan. The indefinite position of Chwanben (Chwampien) and Kuku-nor, and the doubtful limits between Tibet and Sinkiang prevent any calculation of the area of Tibet; its population is probably less than 3,000,000.

Origin of Name.—The Tibetans call their country Bod, which word in colloquial pronunciation is aspirated into *Bhod* or *Bhot*, and in the modern Lhasa dialect is curtailed into *Bho* Hence the country is known to Indians as *Bhōt*, and the inhabitants as *Bhōt-ias*. This territory came to be known to Europeans as "Tibet," evidently because the great plateau, with its uplands bordering the frontiers of China, Mongolia and Kashmir, through which travellers communicated with this country, is called by the natives *Tò-bhot* (written *stod-bod*) or "High *Bod*" or "Tibet"

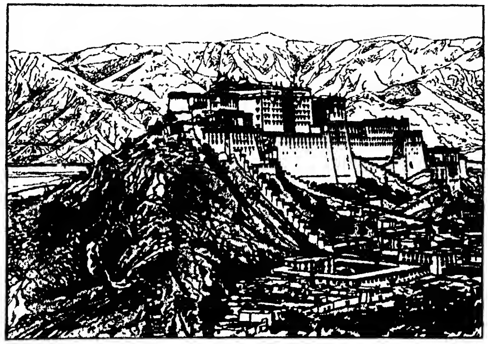
Physical Geography.—Almost all the country from the south of the Takla-makan desert to the Himalaya was formerly included under the name of Tibet in general usage The Kuenlun mts were, under this scheme, the northern mountains of Tibet, they are in any case the oldest of the great mountain-systems of the Tibetan highland. Their rocks are mostly Lower Palaeozoic and highly metamorphosed, while Mesozoic deposits occur only as land sediments in the valleys of the chain; this part and the region to the north and north-east have thus apparently been land since Triassic times To the south of the Kuenlun Mesozoic deposits become more important, and suggest that the broad zone between that chain and the Deccan (part of the ancient Gondwanaland) was then largely under water at times, though during the Upper Jurassic phase land conditions prevailed over wide areas In the Cretaceous epoch began the great upfolding of the Himalayan region, which probably reached its maximum activity in the Eocene age. Parts of this folding seem to have been directed southward, as is indicated in the Garwhal thrust-plane, but the story is highly complex and there is much penetration of young volcanic rocks, while geysers and hot springs tell the same tale. In the uprise of the younger mountains not only did great fault-lines appear in the south and east of the Tibetan highland, but also the Kuenlun was much broken, and the old Tarim block to the north of it sank In several parts of its area the Kuenlun attains a height of 7,000 metres, while, in the west, the peak Mustagh (Muztagh or K5) attains 7,282 metres (23,890 ft), and is, perhaps, the highest point in the chain, though it has been claimed that there are within it heights of nearly 8,000 metres.

Between the western Kuenlun and the Himalaya is the great dissected highland of the Karakorum The heights attained in the Karakorum are very great, several summits attaining about 8,000 metres, while K2 is 8,610 metres or 28,248 ft. high

On the general Tibetan highland the oldest formation exposed is the Upper Jurassic, betraying land conditions followed in the next phase by submersion. The highland seems to pass into the mountain-systems of its periphery and to have a general height of 15,000–16,000ft.; the highest point known in this region is about 23,600 feet. There are many fault-lines, thrust lines and hot springs. This plateau of inland drainage, characterized by lakes, mostly salt, and hot springs, is called Chang-t'ang.

The southern rim of the general highland just described is the trans-Himalaya or Hedin range of mountains, the average height of which may exceed that of the Himalaya, though the highest peaks (nearly 24,000ft) are not so great as those of either the Himalaya or the Karakorum This great series of mountains was very little known until Sven Hed'n explored there

South of the trans-Himalaya lie the deep valley lines of the Indus, Sutlej and Brahmaputra, so this range forms the watershed between an area of internal drainage to the north and a region of the sources of great rivers to the south; it is noteworthy that the three great rivers mentioned make their way through the Himalaya to the south, and many feeders of the Brahmaputra, Ganges and Indus have also penetrated into the Himalaya Between Bunji, in Gilgit, and the Darel district the bed of the Indus is about 915 metres above sea-level, while the crests on either side of the gorge rise to 6 000 metres, or 20,000 feet. The Brahmaputra way through is as striking, for the river reaches down to the 10,000ft. contour only as it begins to work around the base of Nameha Batwa, 25,445ft high



LHASA, SHOWING THE POTALA, THE EARLY 17TH CENTURY FORTRESS PALACE OF THE DALAI LAMA, AND THE CITY BELOW

The long line of the Upper Indus and Upper Brahmaputra is the most marked feature of southern Tibet, and the Upper Sutlej follows a closely related line between them Some tributaries of the Brahmaputra join the main river in such a way as to suggest that it once flowed westwards, and that its present course is a result of capture Near the source of the Sutlej are the two sacred lakes, Manasarowar and Rakas-tal, which communicate by a channel of water after heavy rain.

The snow line is usually, but not quite always, higher on the north than in the south, because of the much heavier precipitation on the south; on this latter side it is said to run near the 5,000 metre (16,400ft) contour Near Leh it is at 5,300–5,800 metres, and in the Karakorum at 5,600–5,900 metres The glaciers formerly reached down to 3,300–3 600 metres in the Spiti region and to 2,100 metres in the Upper Indus region It is thus highly probable that during the maximal ice phases the whole of the great highland was glaciated, with no doubt some lines of crest projecting above the ice-sheets The Pleistocene deposits are enormously thick in many places, an estimate of 3,000ft. having been made for this in the upper Sutlej valley

A remarkable economic feature is the almost universal distribution of gold through Tibet. The gold-digging is referred to in somewhat mythical terms by Herodotus Every river which rises in Tibet washes down sands impregnated with gold, and it has been proved that this gold is not the product of intervening strata, but must have existed primarily in crystalline rocks of the main axes of upheaval In western Tibet the gold mines of Jalung have been worked since 1875

Iron is found in eastern Tibet in the form of pyrites, and is rudely smelted locally. Salt, soda, potash and borax exist in abundance in the western lake regions (Chang-t'ang).

Climate.—Tibet lies so high that its climatic relations are very peculiar. The Himalaya captures most of the rainfall of the summer monsoon, but a little gets through the passes and is captured by the trans-Himalaya, beyond which the climate is

extremely dry and we are in the region of internal drainage.

In July the Tarim basin has average temperatures varying from 68° to as high as 90° F. in different places. On the Tibetan highland figures are lower and are correlated with elevation; thus, at an elevation of 3,000 metres the temperature in July in north Tibet is known for one or two stations and is about 59°, for a station at 4,000 metres it is less than 50°, and for the general area of Chang-t'ang, with a height of 5,000 metres, it is probably about 40°, or even less But the daily variations are extreme.

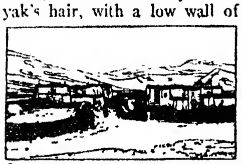
There is more snow in the winter, towards the west, and more rain, in the summer, towards the south-east The total fall of rain and snow over most of Tibet, except the south-east and patches of the trans-Himalaya, is about 8in per annum.

Vegetation.—The severe conditions of Chang-t'ang limit its plants to some high-steppe grasses in the valleys, with a few bushes here and there up to the 15,000ft. contour. Towards the western Kuenlun, on the one hand, and towards the Chinese border on the other, there is more woodland Prjevalsky, the pioneer collector, and Thistleton-Dyer class the flora as Arctic-Alpine and ancient, with many endemic species. It is chiefly composed of immigrants from the Himalaya and Mongolia. The river valleys between the Himalaya and trans-Himalaya, are warmer, and peaches, apricots, apples, plums, grapes, water-melons, and even pomegranates are raised, while trees include plane, poplar, maple, walnut, oak, cypress and a variety of conifers. Barley and buckwheat are the chief cereals.

Animals.—Herds of yak, wild ass (kiang) musk deer, Tibetan antelope (*Pantholops*), wild sheep (*bharal* of the Himalayas) and wild goats roam the high wastes, while bears, leopards, wolves, foxes, marmots, squirrels, monkeys, cats and dogs also occur. The sloth-bear (*Aeluropus*) and the so-called unicorn-antelope (*Budorcas*) are Indo-Malayan forms that reach up into Tibet. Several water-fowl breed in Tibet, notably the bar-headed goose (*Anser indicus*) and towards the eastern borders there occur several rare and handsome varieties of pheasant

Population and Economic Life.—The people of Tibet, like its plants, must be considered as post-glacial immigrants, Tibet having apparently been an ice desert during the phases of great extension of the ice-sheets. Indeed, it is doubtful whether mankind could spread up into these wastes until long after the last ice-maximum had passed away This helps to interpret the further fact that the majority of the inhabitants is related in physical type to the peoples of the steppes and deserts farther to the north The Tibetans have high power of resistance to cold and hunger if they can obtain buttered tea, which they drink at frequent intervals. The country can support only a small population, and estimates are mostly below 3,000,000, a large number of these being celibates in monasteries. (*See* LAMAISM) Polyandry is practised to a certain extent, the brothers in a family, in such a case, having a wife in common

The herdsmen, tent-dwellers, among them are usually called Drok-pa, and their tents are of yak's hair, with a low wall of dung or stones around the tent-base. The tents are moved at intervals. and once a year the herdsmen make their way down-hill to market, mostly at Lhasa. Their food is mainly composed of products of yak's milk The peasant-cultivator inhabits chiefly the valleys of the south and south-east, and is mostly tied to the soil, partly, no doubt, because men are so scarce The crop rotation may give the sequence. barley, fallow, barley, peas, wheat, and the plough is drawn by oxen or yaks.



A TIBETAN VILLAGE ON THE PLAIN OF THE THREE BROTHERS, 14,700 FT. ABOVE SEA-LEVEL

In addition to herding and agriculture a certain amount of wool-spinning, weaving and knitting is fairly widely-distributed in Tibet, but the immense importance of religious matters in this country makes the production of images and cult-objects a more important matter.

Tibet is so difficult a country that the steppe-conquerors of various periods have usually avoided it completely, and it has practical autonomy, in spite of varying relations, chiefly diplomatic, with China, and to some extent with Britain, through India, and even at times with Russia. Its central position and the longitudinal valleys of the Brahmaputra (Sanpo), the Sutlej and the Indus—the passes from the last across into the Tarim basin—and the communications via the valleys of the two last and other Himalayan streams with Kashmir and India, have made Tibet of importance in the caravan trade across Asia.

Batung (Ba'an-fu) and Chamdo in Kham (Chwanben) are among the stations on the ways up from China, the former connecting more especially with Szechuan and Yunnan, the latter with Szechuan, Kansu and Mongolia. To the west, in Tibet proper, the valley between the Himalaya and the trans-Himalaya provides the main line of communication, and portions of the Brahmaputra are navigable. Lhasa is the chief station. From Lhasa it is possible to go south, via Gyantse, to the passes between high peaks that lead to Sikkim and India. Ya-tung in the Chumbi valley, was created a mart for Indo-Tibetan trade by the regulations appended (1893) to the Sikkim-Tibet convention of 1890, but it was not successful, and in 1904 an additional mart was fixed at Gyantse Westward from Lhasa the trade route goes to Shigatse and on past the sacred lakes, Manasarowar and Rakas-tal, reaching the Indus system near Gartok, another mart for Indo-Tibetan trade fixed by the 1904 convention. Gartok has ways leading through the Himalaya south to Almora, and a less important one west to Simla; it stands more than 14,000ft above sea-level. From Gartok the trade route goes on down the Indus to the mart at Leh, the capital of Ladakh, whence there are routes to Kashmir and to the Tarim basin The main route through Tibet here described is known as the Janglam. The high wilderness of the Chang-t'ang is of less importance for transit purposes, but a route from Lhasa goes north via Nag-chu-ka, farther east, to Urga, in Mongolia. Camels are left at Nag-chu-ka on the way to Lhasa, and the caravans assemble twice a year at Kuku-nor (lake), reaching Lhasa in August and in January. Mules are much used, as also are yaks Musk, wool and woollen materials, furs, rhubarb, yak's tails, cult-objects, medicinal herbs, etc., are carried especially to China, and tea, rice, porcelain, horses, cereals, silks are imported thence. The trade with India is mainly an exchange of Tibetan wool for manufactured goods Postal transport may, with good fortune, cover as much as 75m. a day, and there is a telegraph line from Lhasa to Gyantse

Government.—The ruler is the Dalai Lama, who lives in a palace near Lhasa and is nominally supreme both in civil and in religious affairs. He is supposed to be chosen by the heads of the three chief Buddhist monasteries of Lhasa (Ganden, Sera and Drepung) with the help of the State oracle at Lhasa and the oracle at Sam-ye. The second lama of the Tibetan Church is the head of the monastery of Tashi-lhunpo, near Shigatse, and this Dalai Lama is held by some Tibetans to have a spiritual authority higher than that of the Dalai Lama The renown of Tashi-lhünpo is chiefly a matter of the last three centuries, and at various times it has sought to undermine the power of the Dalai Lama, who keeps agents to watch matters at Shigatse. Until 1912, the amban, or representative of China, had a share in government and in the selection of a Dalai Lama, but in that year the amban, whose power had long been waning, was expelled. The Dalai Lama has a chief secretary who may have great power; he is supposed to act with a greater and a lesser council and a national assembly, and these bodies have an official who may be called a prime minister, but the Dalai Lama and his secretary have been known to set aside the authority of prime minister and council. A lord chamberlain is the head of the country's ecclesiastical officials, under the Dalai Lama. There is naturally a good deal of local autonomy in outlying areas of a region with such difficulties of communication, but the personal authority and prestige of the Dalai Lama have often been very marked. It arises partly from the fact that the occupiers of this great position have on several occasions proved themselves to be strong-minded men, and partly from the fact that the supreme head is held to be one who has won the right to Nirvana but has consented to rebirth for the sake of his fellow men. As such he is venerated, not only in

Tibet, but, in varying degrees wherever, in Asia, Buddhist ideas have penetrated and maintained themselves.

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ETHNOLOGY

I. GENERAL

The Mongolian plateau is the origin of a considerable part of the population, in which other elements have been discovered, including a type with fairly long heads, wavy, even curly hair, as well as lightish hair

The people may be roughly divided into four main classes, namely, the nobility, the traders, the peasants, and the herdsmen Many of the nobility reside in Lhasa They have also their country residences scattered over the country. Next in the social scale come the traders These are usually laymen, though many also among the monks trade on behalf of their monasteries The traders move about into all parts of the country, spending perhaps a portion of the year in the north to obtain salt from the lakes, in the east, trading in tea with China, and in the south selling wool, yak-tails, hides, etc, in India, and bringing thence cotton goods and the varied utilities of western civilization.

There is no strong middle-class in Tibet The peasant farms generally on a small scale He works in the fields of the local nobleman, monastery or other landlord, as well as tending his own small plot of land The herdsmen seek pastures for their flocks mainly in the uplands, at altitudes of over 14,000ft, and frequently move their camps to new ground Among other members of the social organization are the beggars and the brigands.

BY COURTESY OF THE UNITED CHRISTIAN MISSIONARY SOCIETY

A TIBETAN NOMAD CHIEF CARRYING A CHARM BOX UNDER HIS LEFT ARM

Bodily Traits.—The males are short, often not more than 5ft. 5in. in height, except in eastern Tibet, where 5ft 9in is a general height; the females are appreciably shorter. The head is mesaticephalic, verging on brachycephalic in the case of many of the hereditary herdsmen, the hair is black and somewhat wavy; the eyes are usually of a clear brown, in some cases even hazel; the cheek-bones are high, the nose is thick, sometimes depressed at the root, in other cases prominent, even aquiline, though the nostrils are broad The teeth are strong but irregular; the ears, with tolerably large lobes, stand out from the head The mouth is broad, the lips not full, and, among the people of the lower altitudes, decidedly thin. The beard is sparse, and is often plucked out with tweezers. Moustaches are worn occasionally.

The shoulders are broad, the arms round. The legs are moderately developed in the people of the central and more settled parts of the country. But the eastern Tibetans and the Bhutanese branch of the Tibetan race, being all hardy denizens of steep and lofty mountains, have not only well-developed legs but are in general physical build fine specimens of the human race. The foot is somewhat small but broad, the hand coarse The waist is much less pronounced than among many nations, as is quickly recognized by Europeans and Americans who don Tibetan attire The colour of the skin is a light brown, sometimes so light as to show ruddy cheeks in children, though where exposed to the weather it becomes dark brown.

Dwellings.—The landed proprietors live in houses, solidly built around a rectangular courtyard. On three sides of this courtyard are stables and storehouses; on the fourth, opposite the gate, is the mansion itself, one or two storeys higher than the other three sides, and sometimes as much as five storeys in height. The walls are constructed of flat stones bound together with mud In the smaller buildings, and especially in the upper layers, the stones are replaced by sun-dried bricks The roof is flat, and is formed like the earth floor, but is not polished Windows are plentiful, but glass is rare Its place is taken by waxcloth or other similar material, strong wooden shutters protecting this from rough usage The houses of the peasants are, as a rule, solid and substantial Here, too, the walls are of stone or sun-dried bricks, though occasionally of clods of earth Flat roofs of beaten earth are the rule throughout the interior of the country, but in the Chumbi valley and other rainy districts they are laid on a gentle slope Where pine trees grow, the roofs are constructed of pine shingles, kept in position by heavy stones The shepherds and herdsmen dwell in tents of yak-hair These tents are rectangular in shape, often some 12ft in length, but sometimes up to 50 feet. An aperture, about two feet in width along the middle of the roof, lets out the smoke

Food and Drink.—The staple diet of the ordinary Tibetan is yak's meat, mutton, barley flour, cheese and tea The rich, and those who dwell in the lower altitudes, also eat fruit and vegetables in small quantities The climate is so cold that Tibetans are compelled to eat meat, although as Buddhists they should abstain from doing so, and the production of grain, vegetables or fruit at great altitudes is very difficult Rice cannot be grown in the cold uplands, and is thus a luxury for the wealthy only The chief Tibetan grain food is barley

The main beverage is tea Brick tea from China is used, and is boiled up in water flavoured with soda When thoroughly boiled, the mixture is taken out with a ladle and poured through a strainer into a churn Butter and salt are added and the whole churned until it is well mixed. It looks then like *café au lait*. The consumption of this beverage among Tibetans is enormous, for they drink on an average from 30 to 50 cups of tea a day They eschew tea as known in Europe and America, finding it indigestible and lacking in nutriment The other chief beverage is beer It is brewed from barley, and being but mildly intoxicating, a good deal can be drunk with impunity

Religion.—Religion occupies a predominant position in the life of the Tibetan people Their religion is the form of Buddhism (*see* Mahayana and Lamaism), which was introduced into Tibet in the 7th century A D under King Song-tsen Gam-po. It includes a widespread belief in reincarnation An incarnation may be born into any family, however humble; for example, the Dalai Lama, the religious and secular ruler of the whole country, has often reincarnated in the family of a peasant Hermits are found here and there throughout the land, in houses, in caves, in cliff-side dwellings. Oracles are in daily use, furnishing prophecies for the State and for the village, as well as for individuals.

Pilgrims are ubiquitous A traveller in Tibet or on the borderland is sure to meet them on their way to holy temples, to snow mountains inhabited by spirits, to the foot-prints of departed saints stamped on the rocks, and other sacred objects. Some will cover every yard of the way with their prostrate bodies. Lying on his face, the pilgrim makes a mark with his fingers a little beyond his head. Rising, he brings his feet to this point, and again, muttering a prayer, prostrates himself. Such a pilgrimage may well take two or three years. It would, perhaps, be safe to say that, judging by the amount of their time and their money which they devote to religion, the Tibetans are one of the most —if not the most—religious people in the world. A huge number, estimated by some at a seventh, by others as high as a

fourth, of the entire male population, enters the priesthood. Great monasteries, often housing more than a thousand monks, are scattered over the countryside, as well as hermitages and smaller collections of priests.

The priesthood is divided into two main divisions. There is the original establishment known as *Nying-ma*, dating from the 7th century of the Christian era, when Buddhism first made real headway in Tibet. And there is the reformed sect, known as *Ge-luk*, which dates from the 14th century of the same era The *Nying-ma* is divided into a number of sects, among whom the *Ka-gyü* have numerous adherents, especially in Bhutan The different sects abstain from open dispute with each other, so that the religion is not torn by sectarian disputes, but presents a united front to the outside world

A TIBETAN WOMAN WEARING NATIVE HEAD-DRESS AND CHARM BOX ON THE THROAT

National Characteristics.—The Tibetans are a cheerful, pleasure-loving people. Their chief forms of recreation include gambling, horse-racing, picnics (held especially in the parks which surround such few large towns as there are) and theatrical entertainments. They are particularly fond of the last, which often form part of their religious festivals. Another very marked characteristic is their insistence on ceremonial and etiquette. The form of address used towards a social superior, equal or inferior, the presentation of ceremonial scarves, and many other details of daily intercourse rest on rules which are observed by high and low.

II. DETAILS OF SOCIAL ORGANIZATION

The Nobles.—The nobility are a class apart. The Tibetan nobleman traces his descent to one of three sources It may be that an ancestor was ennobled for good work done for the country. The founder of the Pa-lha family, for example, was a Bhutanese ex-priest of the 17th century, whose work in the service of the Lhasa Government was rewarded by a place on the supreme council and the gift of an estate near Gyantse containing 130 farms. Secondly, the family in which a Dalai Lama or a Tashi Lama takes re-birth, however lowly it may be, is *ipso facto* ennobled and receives large estates from the Government. Some of the leading Lhasa nobles are descended from the brothers of previous Dalai Lamas. The third section of the aristocracy is the oldest and smallest of all. They trace their ancestry right back to the early monarchs who ruled Tibet before the 10th century of the Christian era. The houses of Lha-gyal-ri and Ra-ka-shar both claim unbroken descent from these early rulers, who are known as the "Religious Kings." Thus the heads of these two families are even now greeted by their tenants with the forms of obeisance that are accorded only to Lamas.

The nobility of Tibet are wealthy by comparison with their fellow-subjects. For instance, on the Pa-lha estates there are at least 1,400 farms, as well as 13 grazing grounds, each of the latter supporting 15 to 20 families of graziers. The tenantry pay rent in service, grain and cash. Out of this the nobleman pays a considerable proportion to the Government, both in cash and in grain He also passes on to the Government some of the service of his peasants, to provide transport animals, etc., for travellers armed with a governmental authorization for the same. In addition to taxes, the nobleman's family is bound to supply one or two members to work as Government officials at nominal salaries.

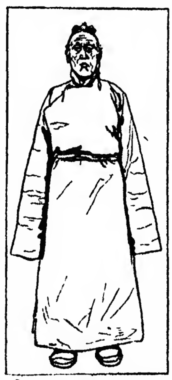
The laws of inheritance vary in different parts of the country. In central Tibet, when the father dies the sons usually remain in joint possession. When there are sons, daughters receive no portion of the land, but are given a small share when they marry. If, however, a nobleman dies leaving a daughter but no son, this daughter inherits the property. When she marries she adopts her husband into her family. She does not take his name; he takes hers. She is entitled to the deciding voice in the management of the property. There have been innumerable instances of such adoption among the high families of Lhasa. As a general rule the daughter succeeds in preference to a nephew. Throughout the greater part of Tibet there are families of noble stock. In the Tsang provinces are eight or nine who stand above the others. Eastern Tibet has its chiefs, styled *Gyal-po, De-ba*, etc. Ladakh has a remnant of the royal line, and Sikkim, till recently part of Tibet, has its ruler descended from an eastern Tibetan chief.

The names of the leading Lhasa families are as follows:—*Chang-lo-chen, Do-ring, Hor-kang, Lha-ding, Lha-lu, Nam-se-ling, Pa-lha, Pün-kang, Ra-ka-shar, Ram-pa, Sam-trup Po-trang, Se-chung, Sha-tra, Sur-kang, Tom-pa, Trum-pa, Yap-shi Sar-pa,* (*i.e.*, "The New Patrimony"), the name by which the family of an existing Dalai Lama is known. When the latter dies, his family take another name. The family of *Lha-gyal-ri* does not belong to Lhasa.

The Traders.—Tibetan society falls almost entirely into two classes, the landed gentry on the one side, and the peasantry and shepherds on the other. Such middle-class as there is, however, is provided by the traders. The chief articles of export are wool, yak-tails, hides, the soft underwool of the shawl-wool goat, borax, salt, musk and medicinal herbs. The chief imports are tea and cotton goods; and, in a smaller degree, woollen goods, hardware, corals, precious stones, tobacco, dried fruits, sugar, molasses and matches, needles, soap, etc. (*See* also INDUSTRY) The trading instinct is deeply embedded in the Tibetan character. Nobles and monks alike engage in trade, as well as the ordinary class of professional traders. The large monasteries trade widely, and are able to do so because each has its administrative department. Even the robber tribes issue from their haunts and go to other districts to trade.

Women often manage the shops and the general retail trade Especially is this the case in Lhasa; men take charge of the commercial dealings which necessitate long journeys, and in any case in which the issue is a large one the decision as a rule rests with them The wealthiest traders may be seen together with the poorest, exposing their goods for sale in the market-places

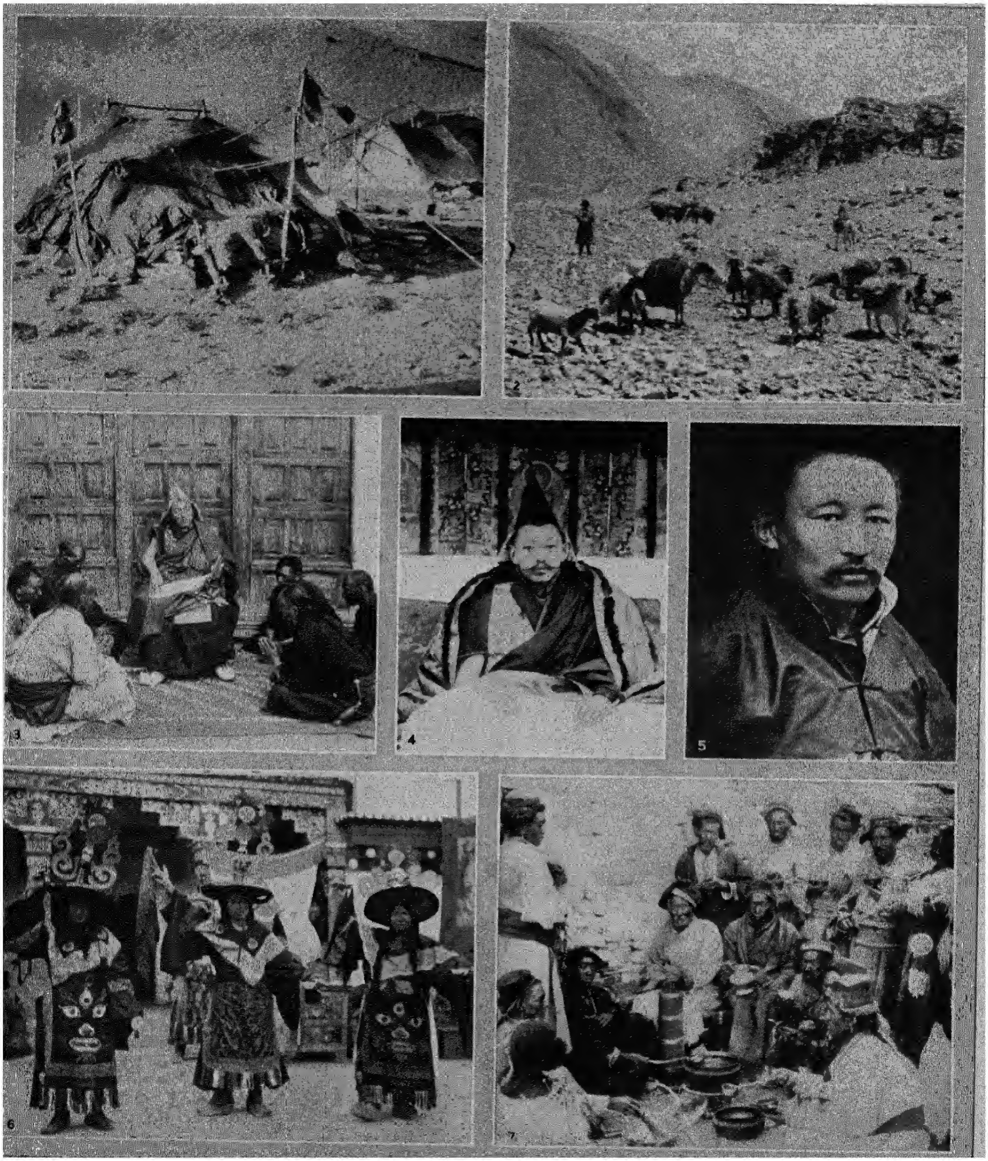
The Peasants.—On plains and in valleys that lie below an elevation of 14,000ft above sea-level there is much land that is fit for the plough But, owing to the steadily decreasing population, largely a result of the overwhelming proportion of celibate monks, the problem of obtaining sufficient man-power to carry on the every-day duties of life is a very real one; and in no department is it more acute than in that of the cultivation of the soil. Tibet does not lack land for cultivation, but she lacks the men to till it. This is emphasized by the fact that a peasant is not allowed to quit his home without first obtaining the landlord's permission. If he wishes to go away, he must ask for leave, or, as the Tibetan phrase runs, "petition for man-separation." He must also pay a large sum if the request is allowed, but such permission is usually refused.



A TIBETAN NOBLEMAN Showing characteristic costume and official ear-ring

There is a great gulf fixed between the peasant and his landlord. The former must use a different vocabulary when addressing the latter and bow low before him But there is mutual fellowship between the two, and the tenantry usually take a pride in the standing and traditions of the master, whom they surround and serve. The larger landed proprietors have, after feudal fashion, large staffs of servants, of whom many are employed during the winter, when the land is icebound, in spinning wool and weaving it into cloth. This is utilized in part for the servants' clothes; the balance is sold to traders or to neighbours.

Slavery is not common in Tibet, and where it occurs the slaves are often treated better than the paid servants or tenants. They are allowed to move about freely, and, when not at work, they



BY COURTESY OF (4) SIR CHARLES BELL, "TIBET, PAST AND PRESENT" (OXFORD UNIVERSITY PRESS), (5) BASIL CRUMP; PHOTOGRAPHS, (1, 3, 7) EWING GALLOWAY, (2, 6) COWLING FROM EWING GALLOWAY

TIBETAN VIEWS

1. A Tibetan sheep herder's camp in the high hills of western Tibet. Tents are made of heavy woven rugs on account of the cold nights. 2. Pack caravan resting on one of the perilous trails crossing the Himalayan mountains. Sheep are largely used for pack animals on account of their sure-footedness. 3. A Yellow-Hat Lama reading scriptures to a group of followers. The Yellow Hat order was founded by Tsong Kha-pa in the 14th century. Members are forbidden to marry or drink wine. They have a very strict code of morals. 4. The Dalai Lama, religious and secular ruler of Tibet; religious head of Mongols and of many Buddhists in China and Russia. 5. Tashi Lama of the monastery of Tashilhunpo near Shigatse, inferior to the Dalai Lama in secular authority. 6. Lama dance. The performance is built around Buddhist symbolism and enacted for the purpose of glorifying Tibetan Buddhism. Dancers are elaborately costumed. 7. Meal time in Tibet. Tea is made in iron pot then put in churn-like container, where butter and spices are added. Some of the Tibetans mix barley flour with it, making both food and drink

have only to attend a roll-call in the morning and in the evening. The theatrical troupes that tour Tibet are mainly recruited from the peasants. When their tour is finished the actors return to their crops and their cattle.

Dress.—The dress of both sexes and of all classes in Tibet may conveniently be described here. It consists of a very full gown with a high collar and long sleeves. In the summer this is usually of the ordinary Tibetan cloth among the peasantry, and of silk among the wealthier classes. The winter gown is sometimes of sheepskin, sometimes of cloth lined with lambskin or wadded cotton. Tied tightly round the waist with a woollen or cotton band, it is puffed out above, and in the capacious pocket thus formed are carried drinking cups and other odds and ends. For laymen the robe reaches to the knee, for priests and women to the ankle. In central Tibet, and in parts of eastern Tibet, the women wear aprons, woven in varied colours, and often so broad that they nearly meet at the back. Shirts are of cotton or silk; trousers differ greatly in shape from the European pattern, and are of silk or cloth. The boot is of cloth, felt or leather, and of various colours. It rises to the knee, with a slit behind the knee, and is tied with gay-coloured woollen garters 3ft. or 4ft. long.

BY COURTESY OF THE UNITED CHRISTIAN MISSIONARY SOCIETY

A TIBETAN WOMAN IN EVERYDAY COSTUME

Men's hats are of various kinds, but are usually fur-trimmed in winter. The women of Tibet, especially those who rank among the upper classes, make no small display of dress and ornaments. The chief ornament is the head-dress; those of the upper classes are bedecked with pearls, turquoises and corals on a wooden frame Men, and particularly shepherds and herdsmen, adorn their hair with rings of silver and ivory. It is only in a few districts that men wear necklaces Ear-rings are very common, and among the official classes universal The official ear-ring is of a standard pattern. Long and narrow, it hangs from a gold ring with a pearl in the middle attached to the left ear. For the rest it is a string of turquoises, except that an inflexible rule requires the elongated lower end to be not a true turquoise, but an imitation. In the right ear a rough turquoise is worn, and this by all classes, official and unofficial, rich and poor.

Shepherds and Herdsmen.—The shepherd and grazier class are hardy and independent. Those in the uplands (and many shepherds live at high altitudes) descend to lower levels once a year to sell their products and buy barley, wheat, tea, turnips and woollen cloth, such necessities as cannot be obtained away from cultivated regions The shepherd, like the cultivator, is frequently in the employ of, or under contract to, one of the nobility or landed gentry. The Pa-lha household, for instance, owns some 20,000 sheep altogether, which are grazed in scattered grazing grounds within 50m. of Gyantse.

The butter of sheep and goats is consumed by poor people only. The gentry and the richer people generally eat only the butter from the *dri,* or female yak, and the cross-breeds between the yak and the ordinary cattle. The women take their share of the work. In addition to the milking and buttermaking, they grind the barley and perform the varied duties round the tents. The children help them in this, some going out with the sheep and goats, but not much with the yaks till they are 12 or 13 years old.

The Women.—The position of women in Tibet deserves special mention. Compared with those of other eastern races, they hold, and have always held, a remarkably high status. In olden days when the country was split up into a number of principalities, each ruled by its own chief, the ruler was occasionally a woman. Even in modern days, chiefs, ministers and officials of all grades consult their wives in their official work. In religious doings, however, the position of women is lower. For instance, of the three forms of blessing accorded by the Dalai Lama to different suppliants (touching the head with both his hands, with one hand, and merely with a tassel) the last and lowest form is the one used for all women, excepting only one. This solitary exception is Dor-je Pa-mo, the sole female incarnation in Tibet. She is one of the highest of all the incarnations, and is the head of a monastary (not a nunnery) at Sam-ding on the Yam-dro lake.

Tibetan women are physically strong. They perform heavy manual tasks. When not tanned by exposure to the elements, they are often fair, and those of the upper classes take great care of their complexions. Throughout Tibet it is a general custom for women to smear caoutchouc on their faces. Rough pads of felt which have been soaked in a red colouring matter are used. In addition to the head-dress, which has been described above, numerous ornaments are worn, rings, ear-rings, necklaces and girdles. The women lay charm boxes on the chest immediately below the throat. These usually contain a small image of a deity and a talisman specially written for the wearer by a Lama

Marriage.—Although the Tibetan woman enjoys a great measure of independence, she usually has little or no share in the choice of her husband A son is consulted by his father as to the bride proposed for him, but the parents consult a daughter hardly at all. The preliminaries attaching to a wedding, and the wedding ceremony, vary somewhat according to the district and the rank of the bride and bridegroom. The horoscopes of the pair must agree, and an auspicious day be fixed for the exchange of presents to take place as well as for the actual ceremony. The ceremony itself is attended by prayers, blessings, the exchange of ceremonial scarves, and feasting The priests of the unreformed, *i e.,* Red Hat, sect are permitted to marry. A Lama's wife, however, is not known by the same designation as the wife of a layman, but as "proprietress." Thus is the idea conveyed that the Lama and his belongings are in her charge, so that he is free to devote himself to religion.

Monogamy, polygamy and polyandry are all common in Tibet, especially the first Polygamy is practised among those whose wealth suffices to support more than one wife. Polyandry is found among the herdsmen and the farmers. Where it holds, the husbands are brothers Having married one of the brothers in a family the wife marries also all the other brothers who are younger, but not any that are older than he

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HISTORY

Legendary.—Prior to the seventh century of the Christian era, Tibetan history is wrapt in myth and legend, helped out from time to time by sidelights from contemporary Chinese history According to native tradition the Tibetan race was descended from a monkey into whose body had entered the Compassionate Spirit, known as *Chen-re-si* in Tibet and *Avalokitesvara* in India. This spirit, with a she-devil, produced the first Tibetan offspring.

The early legendary kings of this country commence with Nya-tri Tsen-po, said to have been the fifth son of the Indian King Prasenajit of Kosala. He fled north of the Himalaya into Tibet, where he was elected king by the twelve chiefs of the tribes of southern and central Tibet. He took up his residence in the Yar-lung country south of Lhasa The first king and his six successors are known as the seven celestial *ti;* the next series consists of six kings known as the earthly *lek;* and they are followed by eight terrestrial *dé.* This threefold succession is apparently an imitation of the ancient legend of heavenly, earthly and human rulers, which was carried into Persia and China, and from the latter country into Japan and Tibet. The kings were followed by four rulers simply called *tsen, i.e.,* "mighty."

The king next in order was Lha-to To-ri Nyan-tsen. It was during his reign that the first Buddhist objects are reputed to have reached Tibet, probably from Nepal. They are said to have fallen from heaven into his palace during his eightieth year. The fourth of his successors was Nam-ri Song-tsen, who died in 630. During his reign the Tibetans obtained their first knowledge of arithmetic and medicine from China; the prosperity and pastoral wealth of

the country were so great that "the king built his palace with cement moistened with the milk of the cow and the yak"

The Early Kings.—With his illustrious son Song-tsen Gam-po the real Tibetan history commences He came to the throne when but thirteen years old, and reigned for many years He pushed forward the Buddhist influence in Tibet, and introduced an alphabet, basing it mainly on the Indian alphabet then used in Kashmir.

As a conqueror he extended his sway from the still unsubdued Kiang tribes of the north to Ladak in the west, and in the south he carried his power through Nepal to the Indian side of the Himalaya. How far southward this dominion at first extended is not known; but in 703 Nepal and the country of the Brahmans rebelled, and the Tibetan king, the third successor of Song-tsen Gam-po, was killed while attempting to restore his power It is noteworthy that nothing is said of this Tibetan rule in India, except in the Chinese annals, where it is mentioned until the end of the monarchy in the 10th century, as extending over Bengal to the sea—the Bay of Bengal being called the Tibetan Sea.

Mang-song Mang-tsen, the second son and successor of Song-tsen Gam-po, continuing the conquests of his father, subdued the Tatars around the Koko Nor (*Nor* is Mongol for *Lake*) in 663, and attacked the Chinese. After some adverse fortune the latter took their revenge and penetrated as far as Lhasa, where they burnt the royal palace Tsuk-tsen, the grandson of Mang-song and second in succession from him, promoted the spread of Buddhism. Tsuk-tsen married a Chinese princess who gave birth in 730 to Ti-song De-tsen, one of the three most illustrious monarchs of his country, partly on account of his conquests and partly because of the strenuous efforts he made in favour of Buddhism during his reign of forty-six years (743–789)

His son and successor Mu-ni Tsen-po enacted that there should be no distinction between humble and great After the third experiment the king's mother poisoned her son

Nothing of importance occurred during the following reigns, until that of Ral-pa-chen, who won glory by his care for the translations of the Buddhist scriptures which he caused to be completed, and rewritten more accurately In this reign a severe struggle took place with China, peace being concluded in 821. The line of kings ending with Ral-pa-chen is known as the "Religious Kings" (Chö-gyal), because they promoted Buddhism and were believed to be Incarnations of Chen-re-si, the patron deity of Tibet. And the greatest of them were Song-tsen Gam-po, Ti-song De-tsen, and Ral-pa-chen.

The proselytizing zeal of King Ral-pa-chen was too vigorous for many of his people When forty-eight years of age (A D 838) he was assassinated at the instigation of his own brother Lang-dar-ma, who was at the head of the anti-Buddhist party And now, as the chroniclers tell us, "The religious law broke like a rotten rope. The peace of Tibet became as a lamp without oil Evil arose like a storm; the good intentions were forgotten as a dream"

Lang-dar-ma was himself assassinated after a reign of only three years by a priest of the persecuted religion, who gained admittance to the King's presence under the pretext of showing him a new dance. The dance is represented in Tibetan religious plays to this day, in memory of this priestly retribution.

The Kingdom Divided.—Meanwhile, the kingdom was divided into eastern and western between Lang-dar-ma's two sons, the nation was disunited, and its glory among foreign nations waned. In 928 no one could be found at the Court of China who could read a Tibetan letter, which had been brought there by four priests.

The second western king, Pal Kor Tsen, left two sons, the latter of whom, Kyi-dé Nyi-ma-gon, went to Nga-ri, of which he made himself master and founded the capital, Pu-rang. He left three sons, of whom the eldest declared himself king of Mang-yül, the second seized Pu-rang, and the youngest Dé-tsuk-gön, became king of the province of Shang-shung.

The revival of Buddhism began with the two sons of the last-named, the elder of whom became a monk. The younger, Kor-ré, inherited his father's throne, and was followed in his authority by twenty successors. Ta-shi Tsek-pa, the elder of Pal Kor Tsen's sons, had three sons, Pal-dé, O-dé and Kyi-dé, each of whom with their descendants, made themselves masters of different districts. Thus the process of decentralization spread The kingdom was split up among a number of chieftains (some of them women), who built forts on hills and ridges overlooking their subjects on the plains below. And thus came into use the Tibetan saying:—

The fort on the hill,
The fields on the plain.

The fort protected the villagers and the villagers fed the fort.

Indian Religious Teachers.—Meanwhile, Buddhism was slowly reviving In A D 1013, the Indian pundit Dharmapala came to Tibet with several of his disciples. In 1042, a still greater came, Atisha, who left his monastery, Vikrama Sila, when 59 years of age, and came to Tibet, where he died fourteen years later He founded the Kar-ma-pa sect of Tibetan Buddhism, and wrote a number of works. He translated many other works, relating principally to Tantrik theories and practices Atisha is known in Tibet as "the Precious Lord" (Cho-wo Rim-po-ché)

Mongol and Chinese Influence.—The priests steadily increased their power during the twelfth and thirteenth centuries. One of the chief among them was the high priest of the large monastery of Sa-kya, south-west of Shi-ga-tse in central Tibet The grandson of the great Mongol conqueror, Jenghiz, invited the prelate of Sa-kya, known as the Sa-kya Pandita, to his court (1247) Five years later Kublai Khan, who had conquered the east of Tibet, and ascended the throne of China, invited to his court the Pandita's nephew, Pak-pa Gyal-tsen He remained twelve years with the emperor, and at his request framed for the Mongol language an alphabet imitated from the Tibetan, which, however, did not prove satisfactory, and disappeared after eighty-five years without having been very largely used In return for his services, Kublai invested Pak-pa with sovereign powers over (1) Tibet proper, comprising the thirteen districts of Ü and Tsang, (2) south-eastern Tibet (Kam) and (3) Am-do, a province in north-eastern Tibet From this time the Sa-kya-pa Lamas became the rulers of Tibet, and remained so, at least nominally, under 21 successive Lamas during seventy years (1270–1340)

When the power of Sa-kya began to wane, that of the rival monasteries of Dri-kung, Pak-dup and Tsal increased largely It was at this troubled epoch that Chang-chup Gyal-tsen, better known as Pak-mo-du from the name of his native town, appeared on the scene He subdued Tibet proper and eastern Tibet, and established a dynasty which furnished twelve rulers in succession, lasting till 1635, when the king of the Tsang province brought it to an end The latter was subdued a few years later by Gushi Khan, the chief of the Eleut Mongols. Th s dynasty of Pak-mo-du, known also as the Si-tya dynasty, brought prosperity

Rise of the Yellow Hats.—An admixture of Buddhism and Animism, and the lax priestly discipline that resulted, failed to satisfy the minds of its more ardent followers Reform came from within. In A D. 1358 there was born in Am-do one who was destined to play a large part in the national life of Tibet He was known as Tsong Ka-pa, "The Man from the Land of Onions." His disciples, known as the Yellow Hats and thus distinguished from the Red Hats of the existing priesthood, were forbidden to marry or drink wine, and a stricter code of morals was instituted He founded the large monasteries at Gan-den and Se-ra, which with Dre-pung are the three strongest religious bodies in Tibet.

Tsong Ka-pa's successor was Gan-den Trup-pa, who founded the great monastery of Tashi-Lhümpo, which in the seventeenth century became the residence of a Grand Lama—known to Europeans and Americans as the Tashi Lama—the second Grand Lama of the Yellow Church

Gan-den Trup-pa died in 1474, but his spirit was believed to have entered the body of a baby boy born two years later. This child became his successor, and thus there came into force the system of priestly incarnation There are nowadays some seven or eight hundred incarnate Lamas.

The second incarnation, and thus the third in the list, was Sö-nam Gya-tso, who spread the faith through Mongolia. From a Mongol chieftain he received the title of *Dalai Lama Vajradhara*, "The All-embracing Lama, the Holder of the Thunderbolt." And thus the title, Dalai Lama, came into use, and continues to-day.

THE RULE OF THE DALAI LAMAS

The fifth was Lob-sang Gya-tso, who in his contest with the older Church, received help from the Eleut Mongols to such good effect that he was established in 1641 as the Ruler over the whole of Tibet.

The Potala Palace, emblem of sovereignty, had been built by the great king, Song-tsen Gam-po, but destroyed during subsequent wars. The fifth Dalai Lama's chief Minister built the great stone palace on a larger scale, which with but few additions, stands to this day It is nine hundred feet in length, and higher than St. Paul's Cathedral in London, but harmonious in line and colour.

The fifth Dalai Lama visited the Emperor of China at Peking. He was received as an independent sovereign, for the Lama's position, backed by Mongol support, and his religious authority among both Mongols and Manchus ensured for him the highest treatment at the hands of the Manchu Emperor and Court.

It was during the early life of this Priest King that the first European entered Tibet. His name was Antonio de Andrada, a native of Portugal. He did not reach Lhasa or Shigatse. The first Europeans to enter Lhasa were two Jesuit fathers, Grueber, an Austrian and D'Orville, a Belgian, who left Peking in 1661, travelled by the Koko Nor to Lhasa, stayed there a month, and then came to Nepal In Lhasa they witnessed the rule of the fifth Dalai Lama, whom Grueber styles "the devilish God-the-Father who puts to death such as refuse to adore him" But among Tibetans the fifth is accounted as the greatest of all their Dalai Lamas. The present day administration of Tibet dates in large measure from his reign, and stories are told not only of his ability but also of his benevolence.

The Great Fifth, as he is generally known, died in 1680, but Sang-gye Gya-tso was unwilling to desist from his task He concealed the death and ruled in his master's name. In due course, however, a successor, who had received the name of Tsang-yang Gya-tso, succeeded to the headship of Tibet.

The new Dalai was entirely unorthodox. He wrote light verse too which remains popular to this day among Tibetans.

But his own contemporaries did not view Tsang-yang Gya-tso in that light Many Tibetans, Mongols and Chinese doubted whether he could be a real incarnation of the divine spirit of Chen-re-si which dwelt in all true Dalai Lamas. The Chinese and Mongols removed him from Lhasa on the understanding that he was to visit Peking and put him to death at Nag-chu-ka, ten days' journey north of Lhasa Dissensions among the people followed, and the Chinese were able to increase their hold over Tibet, always to China a matter of prime importance by reason of the religious authority exercised by the Dalai Lama in Tibet, Mongolia and Manchuria.

During the early years of the eighteenth century the Chinese established a representative known as Amban, and later on two such representatives, in Lhasa. These intervened in Tibetan administration. In 1750, the Ambans killed the Tibetan Regent. The people in their turn massacred the Chinese in Lhasa. The Emperor Chien-lung dispatched an army, restored Chinese authority, and strengthened the power of the Ambans. But Lhasa is so far from the Chinese frontier that it was an uphill fight.

Gurkha Invasion.—In 1788 the Gurkhas, who had recently gained the ascendancy throughout Nepal, occupied some Tibetan districts near the Nepal frontier Three years later they captured Shi-ga-tse. The Chinese Government, now thoroughly aroused, dispatched an army, composed partly of Chinese and partly of Tibetans, under Chinese leadership. This army marched through Tibet in the arctic cold of winter, defeated the Gurkhas decisively during the spring of 1792, and dictated terms of peace within a short distance of Katmandu, the Gurkha capital. Suspecting also that the British, who were by then established in India, had helped the Gurkhas, the Chinese closed Tibet as far as possible to foreign influence. It was decreed that all foreign questions should be dealt with by the Ambans, not by the Tibetan Government.

In 1841, a force of 5,000 Dogras, mountaineers from Kashmir, invaded western Tibet, but were defeated by the Tibetans and almost exterminated. A battle was fought at 15,000 feet above sea level in the depths of winter, and the great cold contributed largely to the defeat of the Dogras.

Another Gurkha invasion occurred in 1855, and this was more successful. The resulting treaty empowered the Gurkhas to establish an Agency in Lhasa and other centres, gave them an annual subsidy of ten thousand rupees, the right of free trade in Tibet, and the right of extra-territoriality In return the Gurkha Government undertook to aid Tibet if the latter were attacked by another nation

EXPLORATION

There is no gradual blending of the climates and physical conditions of India and Tibet, such as would tend to promote intercourse between the inhabitants of these neighbouring regions On the contrary, there are sharp lines of demarcation, both in the mountain barrier which is scalable at comparatively few points, and also in the social aspects and conditions of life on either side. No great armies have ever crossed Tibet to invade India

Jesuit and Capuchin Visitors.—It was no easy matter for the early European travellers to explore Tibet. Friar Odoric of Pordenone is supposed to have reached Lhasa *c.* 1328, but this visit is doubtful The Jesuit Antonio de Andrada, a native of Portugal (1580–1634), travelling from India, appears to have entered Tibet on the west, in the Manasarowar Lake region In 1661 Grueber and D'Orville, as mentioned before, reached Lhasa The extracts from Grueber's narrative, given by Athanasius Kircher in his *China illustrata* (Amsterdam, 1667), are accompanied by a good drawing of the Potala During the first half of the 18th century various Capuchin friars appear to have passed freely between Calcutta and Lhasa (1708), by way of Nepal. They even founded a mission in Lhasa, which, after failing at first, was more firmly established in 1715

In 1716 two Jesuits, P Ipolito Desideri, of Pistoia, and P. Freyre, a Portuguese, reached Lhasa by way of Kashmir. The long journey from Kashmir was taken by Lake Manasarowar and the valley of the Tsango-po Desideri remained at Lhasa till April 1721, witnessing the capture of Lhasa successively by Dzungar and Chinese Of the moderation of the latter, and their abstinence from all outrage or plunder, he speaks highly He left a large MS volume of his observations The next European visitor was Samuel Van de Putte, of Flushing, an LL D. of Leiden, whose thirst for travel carried him through India to Lhasa (1730), where he is said to have resided a long time.

In 1745 the Capuchin mission finally collapsed after a revival had been attempted in 1741 by a party under Orazio della Penna. The collapse appears to have been due to lack of funds rather than Tibetan opposition We possess some of the results collected by this mission in an excellent short treatise on Tibet by P. Orazio himself, as well as in the *Alphabetum Tibetanum* of the Augustine monk A. Georgi (Rome, 1762). Some fifty volumes, the relics of the mission library, were in 1847 recovered from Lhasa by Brian Hodgson, through the courtesy of the Dalai Lama himself, and were transmitted as an offering to Pope Pius IX.

First English Visitation.—The first Englishman to enter Tibet was George Bogle, a writer of the East India Company, in 1774, on an embassy from Warren Hastings to the Tashi Lama. In 1783 Lieut Samuel Turner was despatched on a mission similar to that of Bogle, and reached Shigatse In 1811–1812, an English traveller, Thomas Manning, reached Lhasa. Having resided some years at Canton, Manning went to Calcutta, bent on reaching the interior of China through Tibet, since from the seaboard it was sealed After reaching Lhasa he stayed there about five months, and had several interviews with the Dalai Lama, but was compelled to return to India. He never published anything regarding this journey, but some years after his death extracts from his scanty and eccentric private diary were published. These, however, do not yield much information.

The Abbé Huc states that William Moorcroft, an Englishman who made a journey into Tibet in the neighbourhood of Lake Manasarowar in 1812, and another into Kashgar in 1824, lived in Lhasa for twelve years disguised as a Muslim.

Exclusion of Europeans.—During the 19th century Europeans were systematically prevented from entering the country, or speedily expelled if found in it. In 1844–1846, however, the

French missionaries, Evariste Régis Huc and Joseph Gabet, made their way to Lhasa from China. They travelled via Siningfu, and arrived in Lhasa on the 29th of January 1846. On the 15th of March they were sent off under escort by the rugged road to Szechuen Huc's book, *Souvenirs d'un voyage*, etc, is a most delightful book of travel. The brothers Henry and Richard Strachey visited Manasarowar Lake in 1846 and 1848 respectively. In 1866 the Abbé Desgodins travelled through portions of eastern Tibet and reached Cham-do (in Kam)

Indian Explorers.—From 1863 onwards a number of Indian explorers were sent by the Government of India into Tibet, for the purpose of surveying the country and collecting information about its inhabitants They carried prayer wheels, but instead of prayers these contained rolls of blank paper on which observations were noted. They carried also Tibetan rosaries by the beads of which each hundred paces were counted. The work was dangerous and difficult, but the results were on the whole remarkably accurate. The best known of these men were Pandit Nain Singh, Pandit Krishna, originally known as A-K (from the first and last letters of his name transposed) and U-gyen Gya-tso, or U-G. Nain Singh reached Lhasa in the course of two remarkable journeys. In the first, after an ineffectual attempt by Nepal, he travelled by the Manasarowar Lake, and the road thence eastward, parallel to the course of the Tsangpo, reaching Lhasa on the 10th of January 1866, and leaving it on the 21st of April 1867 On the second journey (1874) he started from Ladak, crossing the vast and elevated plateau by the Tengri Nor and other great lakes, and again reaching Lhasa on the 18th of November

In 1878 A-K. also visited Lhasa, stayed a year, and afterwards continued into Tsaidam, not returning to India till 1882. U-gyen Gya-tso, a Tibetan of Sikkim, who was originally a teacher of Tibetan in a Darjeeling School, secured permission in 1879 from the Tashi-lhunpo authorities for Sarat Chandra Das, Bengali schoolmaster at Darjeeling, to visit that monastery, where his name was entered as a student. This was the opportunity for a series of valuable exploratory journeys through the Tibetan provinces adjoining the Indian and Nepalese frontiers. Sarat also brought back from his journeys a large number of interesting books in Tibetan and Sanskrit, some of which were edited and published by him, with the assistance of U-gyen Gya-tso and other Tibetans But these explorations, and particularly those of Sarat, when discovered by the Tibetans, incensed them still further, and deepened their distrust of the strong Power that came nearer and nearer and now explored their country in secret

The Russian explorer Prjevalsky, although he did not penetrate far into Tibet, did much towards determining the conformation of its north-eastern and eastern mountain systems His fourth journey, between November 1883 and October 1885, covered part of northern Tibet, and established the true character of Tsaidam.

Recent Exploration.—Between 1889 and 1892, W. W. Rockhill, an American possessing great qualifications for Tibetan exploration by reason of a fair knowledge of the language and history of the country, coupled with the instincts and training of a scientific explorer, made two journeys through the north-eastern and eastern districts of Tibet. His record of these has added to the world's knowledge both of the country and its people.

In 1889 Prince Henri d'Orleans and M. Bonvalot; in 1891 two Englishmen, Capt Bower and Dr. Thorold; the following year Miss Taylor, a solitary Englishwoman who came to within 150 miles of Lhasa, and in 1893, two other Frenchmen, MM. Dutreuil de Rhins and Fernand Granard, all entered Tibet They were followed by Mr. and Mrs. Littledale, accompanied by Mr. Fletcher, in 1895; by Capt. Deasy a year later, by Capt. Welby and Lieut Malcolm in the same year, and by Rijnhart, a Dutch missionary, in 1898 and by Sir Aurel Stein. These all explored different tracts in the great unexplored regions, and many brought back knowledge of the flora and fauna. All, or nearly all, endeavoured to reach Lhasa, but none succeeded, so thorough were the precautions taken by the Tibetans to guard against such an event. The Littledales came the nearest, being stopped 80 miles north of the Forbidden City. De Rhins and Rijnhart lost their lives, being murdered, as is believed, by the people of the country.

Dr. Sven Hedin, a Swede, has made three important journeys in Tibet and has traversed the country, north, south and west, surveying a great deal of unexplored country. His attempt to reach Lhasa, as that of all Europeans during these days of Tibetan hostility, was frustrated by Tibetan watchfulness But his careful and detailed maps and lake soundings, and his scientific observations, hydrographic, geological and meteorological, have placed him in the forefront of modern explorers. (X.)

MODERN HISTORY

In 1774 and 1783 Warren Hastings, the far-sighted Governor-General of India, had established transient connection with the Tashi Lama. From 1872 onwards the Government of India made attempts to open up relations with the central Tibetan Government. But the latter declined, for they feared and distrusted the Power whose strength and influence were steadily extending in the territories on their southern frontier. A treaty made in 1890 between India and China was repudiated by the Tibetans

In 1903, as a result of continued disputes, and in particular from the fear of Russian penetration, the Indian Government despatched a mission with an armed escort to Tibet The Tibetans, however, refused to negotiate, and the Chinese were powerless In 1904 the mission advanced further into the country. It was opposed, and fresh troops were sent, so that it became a military expedition It withstood the rigours of the climate, dispersed without much difficulty the Tibetan levies, who were untrained and poorly armed, and succeeded in reaching Lhasa Lt-Col (now Sir Francis) Younghusband, the political representative with this force, effected a treaty there in September 1904 with the Tibetan delegates, the Dalai Lama and his entourage having fled to Mongolia After modification by a Convention with China in 1906, the main terms of the Lhasa treaty were —

(a) The opening of two fresh marts to foreign trade, one at Gyantse between India and Lhasa, and one at Gartok in western Tibet.

(b) The abolition of trade dues between Tibet and India

(c) Tibetan territory not to be ceded, leased, etc, to any Foreign Power.

(d) An indemnity of two-and-a-half million rupees (£166,000)

Chinese Suzerainty.—The Anglo-Russian Convention of 1907 recognized Chinese suzerainty over Tibet, and stipulated that neither Russia nor Britain should interfere in the internal administration of Tibet, seek concessions there, take any part of the revenue, or depute representatives to Lhasa But, as a result of the Russian Revolution, this Convention is believed to be no longer in force

The Chinese Government were alarmed by the British Expedition to Lhasa in 1904, fearing a repetition and the establishment of British power there. The Peking Convention of 1906 and the Anglo-Russian of 1907 placed them in a strong position Tibet was enfeebled by the British attack, and perhaps somewhat mazed by the crowd of events. So China organized a military Expedition of her own, which eventually, in February 1910, reached Lhasa

The Dalai Lama and his Government fled again, this time to Darjeeling in India. Here the British Government treated them hospitably, and being on Indian soil, they were safe from personal attacks by the Chinese, who contented themselves with consolidating their position in Tibet While observing strict neutrality as regards Tibet, Britain took occasion to inform China that she would tolerate no interference with the Himalayan States, Nepal, Sikkim and Bhutan.

Recent Developments.—Tibet's deliverance, however, was near at hand. In 1911 the Chinese Revolution broke out, disorder among the Chinese troops ensued, and the Tibetans were able to drive them out of Lhasa, and to recapture most of their country. The Dalai Lama and his Ministers returned to Lhasa. They were now hostile to China, and friendly to Britain. In 1917 the Chinese attacked again, but were defeated, and the Tibetans pushed them back more or less to the positions which had been held since 1720.

During 1912 Russia, by a treaty with Mongolia, gained further influence in that country. The following year a conference was

held in India by Britain, China and Tibet to discuss the political status of Tibet, but achieved no decisive result.

Then followed the World War. The Tibetan Government offered a thousand soldiers to fight on the British side, a striking change from their former attitude of hostility.

Towards the end of 1920 Mr. (afterwards Sir Charles) Bell, the British representative in Tibet, was deputed to Lhasa at the request of the Tibetan Government, the first white man to be invited to Lhasa by the Tibetans themselves As a result of his visit, which lasted for about a year, the growing friendliness between the two nations was still further strengthened, and a line of policy consonant with that attitude was marked out In 1922, following the repeated requests of the Tibetan authorities, the Forbidden City of Lhasa was linked with India by telegraph.

Mount Everest.—Permission was obtained for the Royal Geographical Society of England to despatch a climbing expedition to Mount Everest through Tibetan territory Three such expeditions followed, in 1921, 1922 and 1924 respectively The last attained to within 800 feet of the summit. Mallory and Irvine, two of the climbers, lost their lives in the last attempt. Since 1912, Tibet has been politically independent of China

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TIBETAN ART. Tibetan art is to a large extent a continuation of the mediaeval Buddhist art of Behar and Orissa, the dominions of the Pala kings, which were the strongholds of Indian Buddhism during the 11th and 12th centuries. The conservatism which is so marked a feature of Tibetan art is due to the peculiar character of that rude and uncultivated country, which Buddhism reached, late and in a very decadent form, in the 7th century A D. The barbarians beyond the mountains were all the more willing to receive the pious images, so accurately representative of the religious spirit, which the missionaries brought from India, because they had no local artistic tradition to set up against them All that they could do was to have copies made of the original models, which were deeply venerated, and then in turn to copy them for themselves. Of all the copies thus made, the most servile were the reproductions of paintings This was due to purely technical reasons; the copies were executed by anonymous artisans by means of transfers It is thus extremely difficult for the historian of art to decide the date of paintings of this kind. The bronzes are less puzzling, since many of them are cast by the method *à cire perdue,* and consequently have more originality and indeed individuality. Architecture, although to a large extent determined by the climate and the nature of the soil, shows Indian and Chinese influences. Though situated between these two countries of ancient and highly developed civilisation, and subjected to their influence, Tibet, as the great refuge of Indian Buddhism, enjoyed so great a religious prestige that it exported certain aspects of its religious art to the China of the Ming and Tsing emperors.

Temple Banners (thang-Ka).—These paintings are for the most part reproduced by means of transfers, a method used in embroidery. The transfers are applied on a piece of cotton, canvas, or more rarely silk, which has first been treated with a coating made of a mixture of glue and chalk-dust, completely smoothed by rubbing with the polished part of a sea shell Thin silks which will not take a coating of this kind are given to experienced craftsmen who copy direct from the model without using a transfer.

Attempt at Chronological Classification.—It will be seen from the description of technical processes given above that it is an extremely difficult matter to date a Tibetan painting, unless the subject of the picture gives some chronological indication. The main interest of a study of Tibetan paintings thus resides in a just appreciation of the antiquity of the subject represented rather than of that of the painting. One of the most ancient subjects is that treated by the somewhat rare paintings which represent the Bodhisat Siddharta, the future Buddha Śâkya-muni, in the form of a young man. This is probably a pictorial representation of the celebrated statue which Sarat Chandra Das saw in the principal temple of Lhasa, this statue will be dealt with later in the section dealing with sculpture There are certain pictures representing the life of the Buddha Śâkya-muni, some of the many reproductions of which are to be seen in various European museums, which are derived from Indian originals of the 9th and 10th centuries. Some of the pictures representing the birth of the Bodhisat are strongly reminiscent of Indian models The compositions based on ancient originals deal only with the principal episodes in the life of the Buddha Taking their inspiration from these models, Tibetan artists of about the middle of the 18th century composed an abundantly illustrated life based on a biography dating from 1734 In these more modern pictures, however, the scenes, of which there is an infinite variety, are all represented round a central figure of the Buddha. In short, Tibetan illustrations of the life of the Buddha may be traced to two sources, the first very ancient (9th to 10th centuries), the second composed entirely by a Tibetan lama of the 18th century. The paintings of the second series show elements derived from Chinese landscape painters in the representations of scenery, rocks are rendered by the superposition of uniform coats of blue and green, separated by gold lines Other compositions unmistakably go back to Indian originals Among these are the representations of the 84 great sorcerers, whose cult had been spread by means of Lamaism beyond the borders of Tibet itself The method of representing the eighty-four sorcerers was already fixed in the 13th century, for M P. Pelliot has discovered pictures representing them in a cave of Tuen-Huang (province of Kan-su in Western China) which was decorated during the Mongol period The Tibetan representations of these great magicians (Musée Guimet) are clearly derived from the great Indian tradition

The representations of the Bodhisats are directly reminiscent of the artistic traditions which were prevalent in Orissa in the time of the Pala kings, who were the last champions and patrons of Indian Buddhism A Tibetan painting discovered at Tuen-Huang by Sir Aurel Stein, which is probably the most ancient extant Tibetan picture (*c.* 10th century) represents Avalokiteśvara, whose mission it is to liberate humanity from the Eight Great Perils This painting, which is now in the British Museum, shows a definite affinity with an Avalokiteśvara in the Fine Arts Museum of Boston which A K. Coomaraswamy believes to be an Indian work of the Pala or Sena period (12th century). So great is the conservatism of Tibetan artists that very little difference can be observed between the 10th century painting discovered by Sir Aurel Stein and a similar composition of modern date which was brought from Tibet by Jacques Bacot and is now in the Musée Guimet. (*See* INDIAN AND SINHALESE ART AND ARCHAEOLOGY)

The influence of the Indian tradition—it is possible to go further and say of the Ajantâ tradition—is particularly marked in a painting in the Musée Guimet representing the Bodhisats Avalokiteśvara and Kshitigarbha seated in an attitude of royal ease

Tibetan artists never introduced any innovations in the representation of the fierce, terrible and threatening deities which derive from Śiva (*Mahākâla*). Divinities of this kind are not to be found in the most ancient compositions which depict episodes from the life of the Buddha Śâkya-muni, the most that appears from time to time is a genius (*yaksha*) subduing heretics All other paintings, whether their subjects are Bodhisats or saints, include representations of fierce deities, often accompanied by their female counterparts. Pictures of this kind already existed in India, but the Tibetans greatly developed the cult of these deities of Saivite origin. The Manchu Emperors who ruled over China in the 18th century appear to have had a special taste for pictures of this kind, and Tibetan Buddhic art had great vogue at Peking at the end of that century. Paintings ordered by the Emperor Chien-lung and executed at Peking under direction of the Grand Lama of Peking are extant. One of them represents the fierce goddess Sridevî (*Lha-mo*); it is carried out in the purest Tibetan style

except that there are certain details of execution which are clearly Chinese, especially in the treatment of the mule on which the goddess is mounted and the emblems with which the frame of the picture is adorned This is a good example of Lamaist painting dated 1777, which, though executed in China, shows, with the exception of certain details, all the characteristics of Lamaist works of art. An inscription in four languages, Chinese, Mongol, Manchu and Tibetan, says: "In the forty-second year of Chien-lung, an Imperial decree was issued ordering the lchang-skya-hu-tog-thu (Grand Lama of Peking) to draw holy images, following the text of the sacred books, in order to do homage to the auspicious goddess Śrîmatî (Śrîdevî) . ." A considerable number of religious pictures were executed during the reign of the Emperor Chien-lung by Tibetan lamas at Pekin, and special mention should be made of the paintings showing definite Tibetan characteristics which represent the divinities of Confucianism and Taoism.

To return to the normal work of Tibetan artists, it is necessary to mention a number of paintings representing the saints of Indian Buddhism and Lamaism The clearly marked Indian influence visible in the pictures of the group of the great sorcerers has already been mentioned; the same influence, becoming gradually attenuated, may be seen in the series of pictures showing the life of some great saint, such as the famous Atiśa, who died in A D. 1058 (Pl. II, fig 1.), or the lchang-skya Rol-pa'i rdo-ye (Lalitavasjra) (1736–95), the same who had the picture of the goddess Śrîdevî painted at the order of the Emperor Chien-lung The latter is not an ancient composition; both the subject and the painting itself are modern, and show the characteristic Tibetan architecture of the monasteries of Dgah-ldan and Bra-śis lhun-po (Tachilhunpo), placed on rocks treated in a way which shows Chinese influence (*see* at the top and in the middle the monastery of Brag-dkar [White Stone]) The saint, who is seated in the European fashion in the middle of the picture on the right, carries the book and sword, the attributes of his patron the celebrated reformer Tsong Kha-pa (A.D 1355–1417). These attributes are also those of Manjuśri, the Bodhisat of transcendental wisdom, who inspired Tsong Kha-pa It is for this reason that a magic representation of Manjuśri appears in the centre of the painting under the aspect of the fierce Yamântaka with the head of a bull Maitreya, the future Buddha, is shown in a medallion placed in the upper part of the picture on the left The saint himself appears, after his death (at the top of the picture on the right) in the trifoliate niche of a *stupâ;* he is being mourned by his disciples, and divinities are rising from the clouds to receive him. The painting showing the learned Atiśa (11th century) is less elaborate, and is clearly derived from a more ancient original.

Tibetan artists sometimes use a technique similar to that of wax painting; some remarkable examples of this method are to be seen in R. Pfister's collection It is a highly successful attempt to find relief from the monotony of the flat tones of tempera painting; the faces stand out remarkably clearly, and the floral decorations show great originality in the choice of colours The painting is unfortunately damaged by the imprints of the hands and feet of the Grand Lama of Bra-śis lhun-po (Tachilhunpo). The painting represented in Plate II, fig 3, shows the fifth Dalai-Lama Ngag-dbang Blo-bzang-rgya-mcho (1617–80); special note should be taken of the delicacy of the floral decoration

The Tibetans also have a special fondness for paintings representing particularly venerated places One of these pictures shows, in a sort of rough perspective, the principal religious edifices of Lhasa; in the centre the Potala, in the lower part the great temple (Jo Khang), in the upper part the monasteries of Sera and Depong, which are two miles away from Lhasa, and a number of small shrines treated in the minutest detail.

Bon-po Paintings.—Before leaving the subject of Tibetan painting, it is fitting to mention the paintings which appear in the temples of the Bon-po, the followers of the pre-Buddhic religion of Tibet. The rare specimens of Bon-po painting which we have had an opportunity of studying are, as far as the legends represented are concerned, nothing more than imitations of Lamaist paintings. The trained eye can, however, clearly distinguish between Bon-po and Buddhist paintings Bon-po paintings scarcely ever contain a large-scale figure of the hero of the legend the episodes of which are represented by the picture Thus the paintings illustrating the legend of the Bon-po prophet Gśen-rab-mi-bo (Ollone collection) consist only of a series of miniature scenes.

Buddhic Sculpture.—According to legend, the most ancient Buddhic sculpture which was imported into Tibet came from Magadhâ, but it is said to have reached Tibet through China, having been brought by the princess of Wen-tcheng, who was related to the Emperor Tang Tai-tsong and married the 1st Buddhist king of Tibet, Srong bcan sgam-po (7th century A.D.). This statue still exists in the Jo-Khang of Lhasa, and forms, together with another statue of the monastery of Kum-bum and the famous image of the Santal temple at Peking, one of a triad celebrated in the Buddhist world. The Lhasa statue is probably of the same type as that which is preserved in the temple of Seiryo in Japan. A distinguishing feature of that work of art is the characteristic drapery with its close folds. A statuette in the Musée Guimet, though a comparatively modern work (18th century) (Pl. I., fig. 6) recalls these ancient originals Most of the Tibetan statues to be seen in Europe are modern, but it is possible to trace back their origin, through a number of modifications, to Indian sculptures executed at the time of the Pala kings of Bengal (11th to 12th centuries A D) The traces of Chinese influence which may here and there be noted are to be attributed to the Tang or even the Sung period. These statuettes, most of which are cast by the process known as *à cire perdue,* represent only a portion of the whole production of the skilled Tibetan metal-workers There are also a number of bronze statues 10 or 12 metres high representing the Bodhisat Avalokiteśvara with 11 heads Occasional examples are found which have no counterpart in the Buddhic world, such as the Bodhisat who is shown making a mystic gesture which is nowhere else represented (Pl I, fig 8) Of three representations of the same divinity, one may show Chinese and one Indian influence, while the third is purely Tibetan This applies to three representations of Manjuśri which are preserved in the Musée Guimet; the first figure, which is brandishing a sword, is in the classical Indian style, the second, which is loaded with ornaments and is heavy of aspect, is Tibetan, while the third is a young Chinese prince, carelessly seated in an attitude of royal ease, his hand resting on a book. The statuettes of saints are in some cases actual portraits (Pl I, fig. 3).

Wood-carving.—The finest examples of Tibetan craftsmanship are the bronzes and brasses, but there are also some fine statues carved in wood. The wood-carvers, however, excel most of all in the execution of low reliefs adorning the rectangular pieces of wood which are used to cover the sacred books. These reliefs show extraordinary technical skill

Bon-po Sculptures.—Very few Bon-po sculptures have as yet been studied. They are very bad specimens, and are influenced by late Chinese statuary

Iron Work; Gold- and Silversmiths' Work.—Some of the Tibetan metal workers are magnificent artists Some of the designs of iron work are as delicate as lace; dragons, volutes and geometrical patterns are mingled in detailed and balanced designs ornamenting saddles, pen-cases, quivers and clasps for reliquaries (central motif: daśâkâro vaśî). Some of the reliquaries are carried out in beautiful repoussé work in silver and sometimes, also in gold. Beautiful brass vases and censers are also executed in repoussé work. The designs on these vases are sometimes Indian and sometimes Chinese in character Damascene work is very much used for the decoration of pen-cases. Tibetan jewellery, heavily set with turquoises, includes earrings, necklaces and bracelets (*See* SILVERSMITHS' AND GOLDSMITHS' WORK.)

Architecture.—The available information concerning Tibetan architecture is very incomplete. No complete studies of monasteries with plans have been made except in the case of Kum-bum.

Stûpas of the Tibetan type have a characteristic form of their own; the base is raised to such a height that it sometimes shelters a little shrine, the bulb-shaped dome is sometimes very small, and the discs of the parasols, which are very close together, form a cone surmounted by the crescent and the disc. The base and the disc are of masonry, and the upper part of gilded copper. The

EXAMPLES OF TIBETAN ART

1. Religious vessel of gold, silver and copper used only by holy Lamas. 2. Samantabhadra Bodhisattva, Genius of Goodness, on her vehicle, the elephant. Made of bronze and gilded. 3. Statuette of Padma Sambhava, the Buddhist pandit who came to Tibet from India in the 8th century, and translated parts of the Buddhist scriptures into the Tibetan language. 4. Another view of Samantabhadra Bodhisattva on her elephant. 5. A religious vessel of gold, silver and copper inlaid with turquoise and showing Chinese influence. 6. Figure of the Lama Jigs-med-rgya-mcho. 7. Figure of Bodhisattva wearing a diadem of five Dhyani-Buddhas. 8. The Bodhisattva Siddhārtha (Gotama Buddha), founder of Buddhism, in characteristic teaching attitude. 9. Figure of Lha-mo. 10. Delicately carved gateway. Tibetan design. 11. The Bronhyd Lotus, the perfect eight-leaved lotus flower with silver urn in centre. The lotus represents the heart of beings and the urn holds the source of organic life. 12. Bronze statuette of Nepalese lion (inscribed under neck). 13. The lotus shown Fig. 11., with all petals closed. 14. A Buddhist incense burner with pierced cover

TIBETAN ART

BY COURTESY OF (1, 2) O. BURCHARD, (3) M. R. PFISTER

TIBETAN FAINTINGS

1. Painting of the learned Atisa. Figure of naked heretic near the halo, together with the figures of a sorcerer and his disciples, is reminiscent of Indian art. Numerous visits of this saint are represented by miniature scenes. At the top of picture (to the right of the aureole) he is seen acting as mediator between two armies about to fight

2. Representation of lchang-skya Rol-pa' i rdo-ye. Chinese influence shown by architecture of the monasteries in painting. The saint carries a book and sword, attributes of his patron, the celebrated reformer, Tsong Kha-pa

3. Painting of the fifth Dalai-Lama Ngagdbang Blo-bzang-rgya-mcho. He carries the thunderbolt and bell of the Buddha Vajradhara. Disciples and seven jewels are picturesquely grouped at bottom of picture

temples (*cf.* plan of Jo Khang in Waddell's *Lhasa and its Mysteries*) are frequently built on a rectangular ground plan with a sort of ambulatory between the outside wall and the chapels opening on the main temple. The main temple altar is at the end opposite to the entrance, and the principal temple is roofed with Chinese pavilions. The monotony of the massive structure of the palaces and castles is relieved by plaster-work of violent colours such as deep vermilion; large tapestries representing religious subjects are hung out on solemn occasions (*See* also INDIAN ARCHITECTURE.)

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TIBETAN LANGUAGE. The language of Tibet is known as "the speech of Bod or Tibet" namely *Bod-skad* (pronounced Bhö-kà), while the vernacular is called *P'al-skad* or "vulgar speech," in contradistinction to the *rje-sa* or "polite respectful speech" of the educated classes, and the *ch'os-skad* or "book-language," the literary style in which the scriptures and other classical works are written

It comprises several dialects classed into three groups, (1) the central or the dialects of Lhasa and the central provinces of Ü and Tsang (including Spiti) which is the *lingua franca* of the whole country, (2) the western dialects of Ladak, Lahul, Baltistan and Purig, and (3) the eastern dialects of the province of Khams. Many sub-dialects of Tibetan are spoken in the frontier Himalayan districts and states outside Tibet The Takpa of Tawang in the eastern Assam Himalayas appears to form a transition between the central and the Sifan group of dialects on the Chinese frontier, which includes the Minyak, Sungpan, Lifan and Tochu dialects. On the north bordering on Turkestan the dialect of the nomadic Hor-pa tribes is much mixed with Turkic ingredients

Tibetan is allied to the Burmese languages, and forms with the latter the "Tibeto-Burman" family

Writing.—Notched sticks (*shing-chram*) and knotted cords were in current use On the eastern frontier the medicine-men or *tomba* of the Moso have a peculiar pictorial writing, which is known in Europe from J Bacot's work, *Les Mo-So* (Leyden, 1913). It undoubtedly contains survivals of a former extensive system superseded by the alphabetic writing introduced from India The close resemblance of the Tibetan characters "with heads" to the Gupta inscriptions of Allahabad shows them to have been derived from the monumental writing of the period; and the other Tibetan letters came from the same Indian character in the style in which it was used in common life. The Tibetan half-cursive was further developed into the more current "headless" (*u-med*) characters, of which there are several styles. The ancient manuscripts discovered by Sir Aurel Stein in Khotan include very early Tibetan documents.

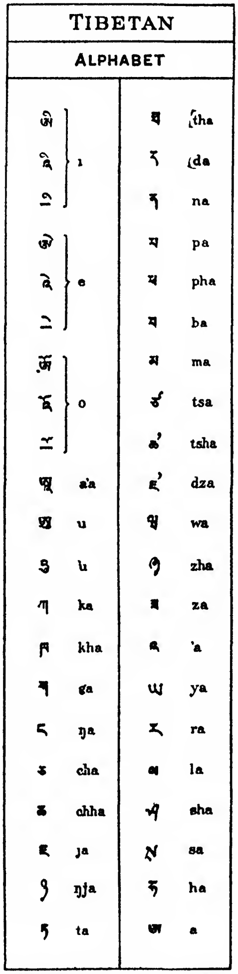
The language was first reduced to writing with the assistance of Indian Buddhist monks in the middle of the 7th century A D. by Thonmi, a Tibetan layman. The letters, which are a form of the Indian Sanskrit characters of that period, follow the same arrangement as their Sanskritic prototype. The consonants, 30 in number, which are deemed to possess an inherent sound *a*, are the following: *ka, k'a, ga, nga, ča, č'a, ja, nya, ta, t'a, da, na, pa, p'a, ba, ma, tsa, ts'a, dza, wa, z'a, za, 'ha, ya, ra, la, s'a, sa, ha, a;* the so-called Sanskrit cerebrals are represented by the letters *ta, t'a, da, na, s'a,* turned the other way. *Ya,* when combined as a second consonant with *k-, p-, m-,* is written under the first letter. *Ra,* when combined as second letter with *k-, t-, p-,* is written under the first, and when combined with another consonant as first letter over the second. The vowels are *a, i, u, e, o,* which are not distinguished as long or short in writing, except in loan words transcribed from the Sanskrit, etc., though they are so in the vernaculars in the case of words altered by phonetic detrition. By adding to the bases form-words as prefixes, suffixes or infixes, the Tibetan language has developed a considerable grammatical system. Agglomerations of consonants are often met with as initials, giving the appearance of telescoped words—an appearance which historical etymology often confirms. Many of these initial consonants are silent in the dialects of the central provinces, or have been resolved into a simpler one of another character. The language is much ruled by laws of euphony. Among the initials, five, viz., *g, d, b, m, 'h,* are regarded as prefixes, and are called so for all purposes, though they belong sometimes to the stem As a rule none of these letters can be placed before any of the same organic class. Post-positions, *pa* or *ba* and *ma,* are required by the noun (substantive or adjective) that is to be singled out; *po* or *bo* (masc) and *mo* (fem.) are used for distinction of gender or for emphasis. The cases of nouns are indicated by suffixes, which vary their initials according to the final of the nouns. The plural is denoted when required by adding one of the several words of plurality. When several words are connected in a sentence they seldom require more than one case element, and that comes last There are personal, demonstrative, interrogative and reflexive pronouns, as well as an indefinite article, which is also the numeral for "one" The personal pronouns are replaced by various terms of respect when speaking to or before superiors and there are many words which are only employed in ceremonial language. The verb, properly a kind of noun or participle, has no element of person, and denotes the conditions of tense and mood by an external inflection, or the addition of auxiliary verbs and suffixes when the stem is not susceptible of inflection, so that instead of saying "I go" a Tibetan says "my going." The chief differences between the classical language of the Tibetan translators of the 9th century and the vernacular, as well as the language of native words, existed in vocabulary, phraseology and grammatical structure, and arose from the influence of the translated texts

Tones.—Tones in Tibetan have developed on the same lines as in Chinese Thus intransitive bases seem to have begun only with soft consonants, and it is doubtful whether the parent tongue possessed hard consonants at all, while transitive bases were formed by hardening of the initial consonants and at the same time pronouncing the words in a higher tone, and these two latter changes are supposed to have been indicated by a prefix to the base-word Many of these old soft initial consonants which are now hardened in the modern dialects are preserved in classical Tibetan, *i e.*, in Tibetan of the 7th to the 9th century A D.

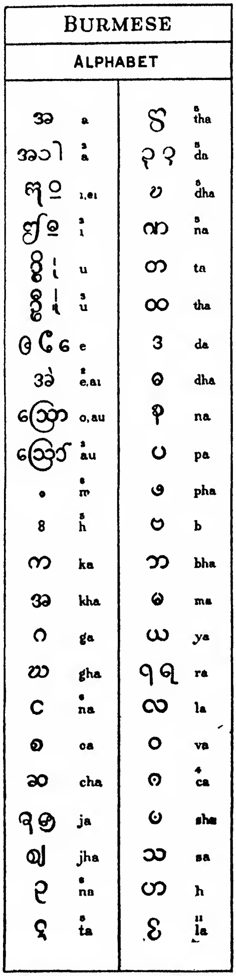
See Sarat Chandra Das' *Tibetan English Dictionary with Sanskrit synonyms* (1902), V. C Henderson, *Tibetan Manual* (1903); and Sir C. A. Bell, *Grammar of Colloquial Tibetan* (Calcutta, 1919), and *English-Tibetan Colloquial Dictionary* (1920); also vol iii of the *Linguistic Survey of India* (1908). As separate publications there are several vocabularies of Chinese and Tibetan, Mongol and Tibetan, Chinese, Manchu, Mongol, Oelot, Tibetan and Turkish, Tibetan, Sanskrit, Manchu, Mongol and Chinese

TIBETO-BURMAN LANGUAGES. The Tibeto-Burman family comprises dialects spoken from Tibet in the north to Burma in the south, and from the Ladákh wazárat of Kashmir in the west to the Chinese provinces of Sze-ch'uen and Yünnan in the east. In the first place we have the various Tibetan dialects, spoken all over Tibet and in the neighbouring districts of India and China The Himalayan dialects are spoken in the southern Himalayas, from Lahul in the west to Bhutan in the east East of Bhutan, to the north of the Assam valley, a third small group, the North Assam group, consists of three dialects A fourth group, the Bodo group, comprises a series of dialects from Bhutan in the north to the Tippera state in the south, which at one time extended over most of Assam west of Manipur and the Nāgā hills, and even far into Bengal proper. To the west of the Bodos, and in the neighbourhood of the Nāgā hills is a fifth group, the so-called Nāgā group It comprises dialects of very different kinds Some of them approach Tibetan and the dialect of the North Assam group. Others lead over to the Bodo languages, and others again connect the Nāgā dialects with their Tibeto-Burman neighbours to the south and east To the south of the Nāgā hills, in the long chain of hills extending southwards, is a sixth group, the Kuki-Chin dialects. The old Meitei language of Manipur lies midway between this group and the easternmost branch of the Tibeto-Burman family, the Kachin group, in the tract of country to the east of Assam and to the north of Upper Burma, including the headwaters of the Chindwin and the Irrawaddy. The Kachin and the Kuki-Chin gradually and finally merge into Burmese, the language of the ancient kingdom of Burma.

The dialects spoken in the Himalayas and in Assam can be viewed as a double chain connecting Tibetan with Burmese, the two principal languages of the family. In the first place the Kachin group runs from the easternmost Tibetan dialects in Sze-ch'uen down to the Burmese of Upper Burma. The second chain has a double beginning in the north, one line through the North Assam group, the Nāgā, Bodo and Kuki-Chin groups, another line proceeding from Tibetan through the Himalayan and Bodo groups into Kuki-Chin, finally merging into Burmese.



THE SYMBOLS OF THE TIBETAN ALPHABET



THE SYMBOLS OF THE BURMESE ALPHABET

The Tibeto-Burman languages are closely related to Chinese and Tai, more closely to the former than to the latter. The agreement is apparent in the phonetical system, in vocabulary and in grammar. The principal point in which they differ is the order of words. The Tibeto-Burman family arranges the words of a sentence in the order of subject, object, verb, while the order in Chinese and Tai is subject, verb, object Together all these languages form one great family, now called Sino-Tibetan.

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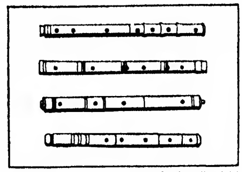
TIBIA, a pipe played by means of a reed mouthpiece, extensively used in classic Rome. The tibia, often mistranslated "flute," was identical with the aulos (*q.v.*) of the Greeks, and it may be regarded as the prototype of our clarinet or oboe (*qq.v*).



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

THE TIBIA, A REED INSTRUMENT OF ANCIENT ROME

TIBULLUS, ALBIUS (*c* 54–19 B.C.), Latin elegiac poet The information which we possess about him is extremely meagre. Besides the poems themselves—that is to say, the first and second books—we have only a few references in later writers and a short *Life* of doubtful authority. We do not know his praenomen; his gentile name has been questioned; nor is his birthplace ascertained His station was not improbably that of a Roman knight (so the *Life* affirms); and he had inherited a very considerable estate. But, like Virgil, Horace and Propertius, he seems to have lost the greater part of it in 41 amongst the confiscations which Antony and Octavian found expedient to satisfy the rapacity of their victorious soldiery Tibullus's chief friend and patron was M. Valerius Messalla Corvinus, himself an orator and poet as well as a statesman and a commander Messalla, like Maecenas, was the centre of a literary circle in Rome, but the bond between its members was that of literature alone. They stood in no relations to the court; and the name of Augustus is not once to be found in the writings of Tibullus. About 30 B C. Messalla was despatched by Augustus to Gaul to quell a rising in Aquitania and restore order in the country, and Tibullus may have been in his retinue. On a later occasion, probably in 28, he would have accompanied his friend who had been sent on a mission to the East, but he fell sick and had to stay behind in Corcyra Tibullus had no liking for war, and though his life seems to have been divided between Rome and his country estate, his own preferences were wholly for the country life His first love, the subject of book i, is called Delia in the poems, but we learn from Apuleius (*Apol* 10) that her real name was Plania. Delia seems to have been a woman of middle station. It is impossible to give an exact account of the intimacy. The poems which refer to her are arranged in no chronological order. Now she appears as single, now as married, but we do not hear anything either of her marriage or of her husband's death. It is clear, however, that it was the absence of her husband on military service in Cilicia which gave Tibullus the opportunity of making or renewing the acquaintance. It was not dropped when he returned. It was not difficult to deceive the simple soldier; and Delia was an apt pupil in deception—too apt, as Tibullus saw with dismay when he found that he was not the only lover. His entreaties and appeals were of no avail; and after the first book we hear no more of Delia. In the second book the place of Delia is taken by Nemesis, which is also a fictitious name. Nemesis (like the Cynthia of Propertius) was a courtesan of the higher class; and she had other admirers besides Tibullus. He complains bitterly of his bondage, and of her rapacity and hardheartedness. In spite of all, however, she seems to have retained her hold on him until his death. Tibullus died prematurely, probably in 19, and almost immediately after Virgil. His death made a deep impression in Rome, as we

learn from his contemporary Domitius Marsus and from the elegy in which Ovid (*Amores*, iii. 19) has enshrined the memory of his predecessor.

The character of Tibullus is reflected in his poems. Though not an admirable it is certainly an amiable one. He was a man of generous impulses and a gentle unselfish disposition. He was loyal to his friends to the verge of self-sacrifice, as is shown by his leaving Delia to accompany Messalla to Asia, and constant to his mistresses with a constancy but ill deserved. His tenderness towards them is enhanced by a refinement and delicacy which are rare among the ancients. Horace and the rest taunt the cruel fair with the retribution which is coming with the years. If Tibullus refers to such a fate, he does it by way of warning and not in any petty spirit of triumph or revenge. Cruelly though he may have been treated by his love, he does not invoke curses upon her head He goes to her little sister's grave, hung so often with his garlands and wet with his tears, and bemoans his fate to the dumb ashes there. Tibullus has no leanings to an active life. his ideal is a quiet retirement in the country with the loved one at his side He has no ambition and not even the poet's yearning for immortality As Tibullus loved country life, so he clung to its faiths, and in an age of crude materialism and the grossest superstition, he was religious in the old Roman way As a poet he reminds us of Collins and Longfellow His clear, finished and yet unaffected style made him a great favourite with his countrymen and placed him, in the judgment of Quintilian, at the head of their elegiac writers And certainly within his own range he has no Roman rival For natural grace and tenderness, for exquisiteness of feeling and expression, he stands alone He has far fewer faults than Propertius, and in particular he rarely overloads his lines with Alexandrian learning. But, for all that, his range is limited; and in power and compass of imagination, in vigour and originality of conception, in richness and variety of poetical treatment, he is much his rival's inferior. The same differences are perceptible in the way the two poets handle their metre Tibullus is smoother and more musical, but liable to become monotonous, Propertius, with occasional harshness, is more vigorous and varied It may be added that in many of Tibullus's poems a symmetrical composition can be traced, although the symmetry must never be forced into a fixed and inelastic scheme

The third book, which contains 290 verses, is by a much inferior hand The writer calls himself Lygdamus and the fair that he sings of Neaera He was born in the same year as Ovid, but there is nothing Ovidian about his work He has a good many reminiscences and imitations of Tibullus and Propertius; and they are not always happy. The separation of the fourth book from the third has no ancient authority It dates from the revival of letters, and is due to the Italian scholars of the 15th century The fourth book consists of poems of very different quality. The first is a composition in 211 hexameters on the achievements of Messalla, and is very poor. The author was certainly not Tibullus.

The value of the short *Vita Tibulli*, found at the end of the Ambrosian, Vatican and inferior mss, has been much discussed There is little in it that we could not at once infer from Tibullus himself and from what Horace says about Albius, though it is possible that its compiler may have taken some of his statements from Suetonius's book *De poetis*. It is another moot question of some importance whether our poet should be identified with the Albius of Horace (*Od* i. 33; *Epist.* i. 4), as is done by the Horatian commentator Porphyrio (A D. 200–250) in his *Scholia* Porphyrio's view has been examined by Postgate (*Selections from Tibullus*, appendix A). If it is rejected the authority of the *Life* is considerably impaired. Delia's name (from δῆλος) is a translation of Plania. As regards her station, it should be noticed that she was not entitled to wear the *stola*, the dress of Roman matrons (i. 6, 68). Her husband is mentioned as absent (i. 2, 67 *seq*) Lygdamus is probably the real name of the author of the first six elegies in book iii., but little further is known about him His elegies and the other poems in the third book ("third" and "fourth" books) appear to have been known to Ovid. There are agreements much too close to be accidental. Most scholars since Lachmann have condemned the "Panegyric on Messalla." It is an inflated and at the same time tasteless declamation, entirely devoid of poetical merit. The language is often absurdly exaggerated, *e g.*, 190 *seq* The author himself seems to be conscious of his own deficiencies (1 *seq*, 177 *seq.*). Like so many of his contemporaries, he had been reduced to poverty by the loss of his estates (181 *seq.*). Sulpicia was the daughter of Servius Sulpicius (iii. 16; iv 10, 4), and she seems to have been under the tutelage of Messalla, her uncle by marriage (Haupt, *Opuscula*, iii. 502)

MANUSCRIPTS—The two best mss of Tibullus are the Ambrosianus (A), of date about 1374, and the Vaticanus (V), of the 15th century. Besides these we have a number of extracts from Tibullus in *Florilegium Parisinum*, an anthology from various Latin writers which probably goes back to the 11th century, and the *Excerpta frisingensia*, preserved in an 11th-century ms now at Munich, unfortunately very few in number Also excerpts from the lost *Fragmentum cuiacianum*, made by Scaliger, and now in the library at Leyden It only contained the part from iii. 4, 65 to the end. The *Codex cuiacianus*, a late ms containing Catullus, Tibullus and Propertius, is still extant

BIBLIOGRAPHY.—Tibullus was first printed with Catullus, Propertius, and the *Silvae* of Statius by Vindelinus de Spira (Venice, 1472), and separately by Florentius de Argentina, probably in the same year. Amongst other editions we may mention those by Scaliger (with Catullus and Propertius, 1577, etc), Broukhusius (1708), Vulpius (1749), Heyne (1817, 4th ed by Wunderlich, with supplement by Dissen, 1819), Huschke (1819), Lachmann (1829), Dissen (1835). Among more recent texts Bahrens (1878, the first of the modern critical editions), L Muller (1880, with a useful introduction), Hiller (1885, with index verborum and in the *Corpus Poetarum Latinorum*, 1905), Postgate (1905). Of the commentaries Heyne's, Huschke's and Dissen's are still of value, *see* also Nemethy's (with Latin notes 1905–1906). The greater part of the poems are included in Postgate's *Selections* (with English notes, 1903). For further information *see* the accounts in Teuffel's *History of Roman Literature* (translated by Warr), Schanz's *Geschichte der romischen Literatur*, Marx's article *s v* "Albius," in Pauly-Wissowa's *Realencyclopadie*; A Cartault's *A propos du corpus Tibullianum* (1906); *see* also his *Tibulle et les auteurs du Corpus Tibullianum* (1909), and *Le Distique élégaique chez Tibulle* (1911); R. Burger, *Beitrage zur Elegantia Tibulls* (1911); and M Ponchont (ed), *Tibulle et les auteurs du Corpus Tibullianum* (1924) Cranstoun's translation (1872) is the only complete version of merit, but it is far inferior to those in C. A Elton's *Specimens of the Classical Poets* (1814). (J. P. P; X)

TIBUR (mod. Tivoli, *q v*), an ancient town of Latium, 18 m. E N E of Rome by the Via Tiburtina (*See* TIBURTINA, VIA.) It is finely situated at the point where the Anio forms its celebrated falls, it is protected on the east, north and north-west by the river and it commands the entrance to its upper course, with an extensive view over the Campagna below. The modern town is in part built upon the extensive terraces of the temple (itself a comparatively small building) of Hercules Victor, the chief deity of Tibur, of which some remains exist. Below it, on the cliffs above the Anio, is a large building round a colonnaded courtyard built over the Via Tiburtina (which passes under it in an arched passage), the meeting place of the Herculanei Augustales

Remains of two small temples of the late Republic—one circular, with Corinthian columns, the other rectangular with Ionic columns—stand at the north-east extremity of the town, above the waterfalls, traditionally, but wrongly, attributed to Vesta and the Sibyl of Tibur. The so-called Tempio della Tosse, an octagonal structure, is probably a tomb of the 4th century A D

Tibur was a favourite place of resort in Roman times, and both Augustus and Maecenas had villas here, and Horace also A house shown as being his in the time of Suetonius is identified with a villa of the Augustan period, over which is built the monastery of S. Antonio. In his poems he frequently mentions Tibur with enthusiasm Catullus and Statius, too, have rendered it famous. The abundance of water from aqueducts and springs and the falls of the Anio were among its chief attractions. The remains of villas in the district are numerous and important (*See* T Ashby in *Papers of the British School at Rome*, iii) The largest is that of Hadrian, situated in the low ground about 2 m. to the south-west of Tibur, and occupying an area of some 160 acres. A number of statues have been found in the villa, and costly foreign marbles and fine mosaic pavements, some of the last being preserved *in situ*. Excavations have gone on since the 16th century, and are now carried on by the Italian government. *See* H Winnefeld *Die Villa des Hadrian* (Berlin 1895); *Jahrbuch des k. d.*

arch. Instituts, Erganzungsheft iii.: R. Lanciani, *La villa Hadriana* (Rome 1906)

The ancient Tibur, though on the edge of the Sabine mountains, was a member of the Latin League There are remains of ancient roads and outlying forts in its territory dating from the period of its independence. It allied itself with the Gauls in 361 B.C., and in the war which followed the towns of Empulum and Saxula were destroyed and triumphs over Tibur were celebrated in 360 and 354 B C, and again in 338, when its forces were defeated, with those of Praeneste It, however, became an ally of Rome Syphax, king of Numidia, died in the territory of Tibur as a captive in 201 B.C., and in A.D 273 Zenobia, queen of Palmyra, was assigned a residence here by Aurelian Its prosperity during the imperial period was mainly due to the favour in which it stood as a summer resort During the siege of Rome by Narses, Belisarius occupied Tibur, it was afterwards treacherously surrendered to Totila, whose troops plundered it, but who rebuilt it in A D. 547 (T. A.)

TIBURTINA, VIA, an ancient road of Italy, leading E N E from Rome to Tibur (18 m). Though it afterwards became an important thoroughfare, the first portion of it always retained its original name (*See* VALERIA, VIA)

TICHBORNE CLAIMANT, THE. Roger Charles Tichborne (1829–1854), whose family name became a household word on account of an attempt made by an impostor in 1868 to personate him and obtain his heritage, was born at Paris on Jan 5, 1829, the eldest son of James Francis Doughty-Tichborne (who subsequently became 10th baronet and died in 1862) by Henriette Felicité, natural daughter of Henry Seymour of Knoyle, in Wiltshire He sailed in March 1853 from Havre for Valparaiso, whence he crossed the Andes, reaching Rio de Janeiro in 1854 In April of that year he sailed from Rio in the "Bella" and was lost at sea, the vessel foundering with all hands His insurance was paid and his will proved in July 1855 The baronetcy and estates passed in 1862 to Roger's younger brother, Sir Alfred Joseph Doughty-Tichborne, who died in 1866 The only person unconvinced of Roger's death was his mother the dowager Lady Tichborne, from whom every tramp-sailor found a welcome at Tichborne Park She advertised largely and injudiciously for the wanderer, and in November 1865 she learnt, through an agency in Sydney, that a man "answering to the description of her son" had been found in the guise of a small butcher at Wagga Wagga, in Queensland. Lady Tichborne "acknowledged" him as her son when he reached Paris in 1867. Other members of the family, however, obtained evidence that the claimant was identical with Arthur Orton (1834–1898), the son of a Wapping butcher, who had deserted a sailing vessel at Valparaiso in 1850, and had received much kindness at Melipilla in Chile from a family named Castro, whose name he had subsequently elected to bear during his sojourn in Australia An ejectment action against the trustees of the Tichborne estates (to which the heir was the 12th baronet, Sir Henry Alfred Joseph Doughty-Tichborne, then two years old) finally came before the court of common pleas on May 11, 1871 During a trial that lasted over one hundred days over a hundred persons swore to the claimant's identity, the majority of them—and they were drawn from every class—being evidently sincere in their belief in his cause But the evidence of the Tichbornes finally convinced the jury, who declared that they wanted no further evidence Orton was arrested on a charge of perjury and was brought to trial at bar before Chief Justice Cockburn in 1873. The indiscretion of his counsel, Edward Kenealy, the testimony of his former sweetheart, and Kenealy's refusal to put the Orton sisters in the box, proved conclusive to the jury, who, on the 188th day of the trial, found that the claimant was Arthur Orton. Found guilty of perjury on two counts, he was sentenced on Feb. 28, 1874 to fourteen years' penal servitude Orton died in obscure lodgings in Marylebone on April 2, 1898 (T. S)

See J. Brown, *The Tichborne Case compared with previous impostures* (1874).

TICINO, a wedge-shaped Swiss canton, driven into Italy. Its northern boundary runs along the Lepontine-Adula alps, and its southern tip reaches beyond Lago di Lugano almost to Como. Historically, it represents early Swiss conquests from the duchy of Milan (*see* SWITZERLAND, *History*) loosely amalgamated to form one of the six cantons admitted to the Confederation in 1803. It is inhabited by Italian-speaking Catholics (*see* below). Its dominant physical features are the three river systems occupying steep-sided valleys which extend from a mountain frontier and drain southwards to Lago Maggiore. The most important system is the river Ticino, which rises in the canton south-west of St. Gotthard, flows towards that mass through the Val Bedretto, and then swings round at Airolo to a south-east course through Valle Leventina; near Biasca it receives the left-bank Brenno from the Val Blenio; the combined stream flows through the wide, low valley—the Riviera—until slightly above Bellinzona, where it receives another large left-bank affluent which has drained the south-east slopes of the Adula group and reaches the Ticino via the Valle Mesolcina; the main stream curves again below the junction and enters the lake from the east. The Ticino receives no important right-bank tributaries, and the western part of the canton is drained largely by the Maggia and by its numerous right-bank tributaries, which receive torrent water from the western frontier. Between the Ticino and the Maggia, is the Valle Verzasca, which is practically a single stream system; the separate mouths of the three rivers lie close to one another at the head of the lake. The remainder of the canton lies south-south-east of this and consists of a triangular fragment of broken hill country, with a complicated drainage reaching the irregularly shaped Lago di Lugano

Its total area is 1,085 sq m, of which 74% are reckoned as "productive" (forests covering 277 9 sq m, and vineyards 7·1 sq m), while of the remainder 28 6 sq m consists of lakes, chiefly parts of Maggiore and Lugano; 13 sq m are occupied by glaciers The canton is fifth in point of size, but only the much larger Valais and Vaud exceed its vine-growing area The highest points are the Basódino (10,749ft), near the western border, south-east of the source of the Ticino, and the Rheinwaldhorn (11,175ft.) in the Adula alps The amount of lowland is small, and occurs only in the lower river valleys and near the lakes The lowest commune (669ft) is Vira (Locarno) on Lago Maggiore

The main St. Gotthard railway traverses the canton for about 75 m. from Airolo, at the southern mouth of the tunnel, *via* Valle Leventina, Bellinzona, Lugano to beyond Mendrisio. Locarno is connected with this line, another follows the eastern shore of Lago Maggiore, and light railways ascend Valle Maggia to Bignasco, Valle Blenio to Acquarossa, and Valle Mesolcina to Mesocco; the latter two are electric railways. Mountain railways for the ascent of Monte S Salvatore (3,002ft) from Lugano, and of Monte Generoso (5,581ft) from Capolago, have also been constructed in the extreme south of the canton

In 1920 the total population was 152,256, of whom 142,044 were Italian-speaking, 8,461 German-speaking and 1,034 French-speaking. The highest commune, Bosco-Vallem, near the western border and reached by the V. di Campo, had many German-speaking inhabitants, the result of an early movement eastward from Valais. There were in all 140,536 Catholics, 6,078 Protestants and 192 Jews.

In 1888 the diocese of Lugano (since joined to Basle) was created to replace the former purely Italian control over the canton by the dioceses of Milan and Como Bellinzona (pop. 11,800) has been the permanent political capital since 1881; formerly Lugano (13,950) and Locarno (5,050) alternated with it at six-year intervals. Mendrisio (3,600) is the only other large settlement.

The canton has 261 communes and eight administrative districts; its Constitution dates back to 1830, but the later political disturbances which characterize the canton, have caused, and still cause, considerable modifications. The legislature (*Gran consiglio*) is now composed of 65 members elected (since 1892) in the proportion of one to every 1,500 of the Swiss inhabitants. The executive (*Consiglio di stato*) of five members, is elected directly by the people. Both bodies hold office for four years Any 5,000 electors have the right (facultative referendum) of claiming a

popular vote as to bills passed by the legislature, while the same number of electors have the right of "initiative" in legislative matters, though 7,000 signatures are required in case of a proposal to revise the cantonal Constitution.

History.—The canton is made up of all the permanent conquests (with one or two trifling exceptions) made by different members of the Swiss Confederation south of the main chain of the Alps. From an historical point of view Italian Switzerland falls into three groups. (1) the Val Leventina conquered by Uri in 1440 (previously held from 1403 to 1422), (2) Bellinzona (previously held from 1419 to 1422); the Riviera and the Val Blenio, all won in 1500 from the duke of Milan by men from Uri, Schwyz and Nidwalden, and confirmed by Louis XII. of France in 1503; (3) Locarno, Val Maggia, Lugano and Mendrisio, seized in 1512 by the Confederates when fighting for the Holy League against France, ruled by the 12 members then in the league, and confirmed by Francis I in the treaty of 1516 These districts were governed by bailiffs holding office two years and purchasing it from the members of the League; each member of group 3 sent annually an envoy, who conjointly constituted the supreme appeal in all matters This Government was very harsh and is one of the darkest pages in Swiss history Yet only one open revolt is recorded—that of the Val Leventina against Uri in 1755. In 1803 all these districts were formed into one canton—Ticino—which became a full member of the Swiss Confederation. Since 1830 the local history of the canton was disturbed by friction between the Radical and Ultramontane parties

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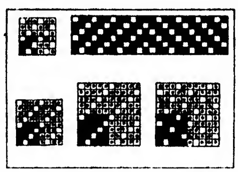
TICINO (Ger *Tessin*, anc *Ticinus*), a river of Switzerland and north Italy, which gives its name to the Swiss canton of Ticino (*q v*), and gave it in classical times to the town of Ticinum (Pavia). It rises at the foot of the Gries pass to the west of Airolo; from Airolo to the Lago Maggiore its valley bears the name of Val Leventina, and is followed as far as Bellinzona by the St Gotthard road and railway It flows through Lago Maggiore, leaving it at its south end at Sesto Calende, and thence flows S S.E. into the Po, which it joins a little way south of Pavia

TICINUM, an ancient city of Gallia Transpadana (mod. *Pavia, q v*), founded on the banks of the river of the same name (mod. *Ticino*) a little way above its confluence with the Padus (Po) Its importance in Roman times was due to the extension of the Via Aemilia from Ariminum to the Padus (187 B C.), which it crossed at Placentia and there forked, one branch going to Mediolanum and the other to Ticinum, and thence to Laumellum whence one branch went to Vercellae (and thence to Eporedia and Augusta Praetoria) and the other to Valentia (and thence to Augusta Taurinorum or to Pollentia) At Ticinum a triumphal arch was erected in honour of Augustus and his family; in the 4th century A D. there was a manufacture of bows there. It was pillaged by Attila in A D 452 and by Odoacer in 476, but rose to importance as a military centre in the Gothic period. At Dertona and here the grain stores of Liguria were placed, and Theodoric constructed a palace, baths and amphitheatre and new town walls. From this point, navigation on the Padus began. Narses recovered it for the Eastern Empire, but after a long siege, surrendered it to the Lombards in 572. The regular ground plan of the central portion of the modern town, a square of some 1,150 yd., betrays its Roman origin

TICKELL, THOMAS (1686–1740), English poet and man of letters, the son of a clergyman, was born at Bridekirk near Carlisle in 1686. In 1715 Tickell brought out a translation of the first book of the *Iliad* contemporaneously with Pope's version. Addison's reported description of Tickell's version as the "best that ever was in any language" roused the anger of Pope, who assumed that Addison himself was the author, or had at any rate the principal share in the work Addison gave Tickell instructions to collect his works, which were printed in 1721 under Tickell's editorship. In 1724 Tickell was appointed secretary to the lords justices of Ireland—a post which he retained until his death, which took place at Bath on April 23, 1740.

TICKER, a small printing machine operated by telegraph (*q.v.*), by means of which information is given from an exchange or trading centre as to the prices of securities and commodities Besides the "stock" ticker there are similar machines which furnish quotations upon various commodities such as grain, coffee and sugar Sometimes important news is sent over the machine (*See* TELEGRAPH) A man in the exchange sits at a keyboard, carrying upon it all the letters and forms used in quotations. As he reads the quotations he perforates a moving tape by striking the keys just as in operating a typewriter This tape passes through a transmitter which operates a large number of line relays and sends the signals to the local and distant points The instrument has been in use many years and was one of the first devices to receive the attention of Thomas A Edison

TICKET-OF-LEAVE, in the English penal system, a document or "pass" granted under the Penal Servitude Acts, and handed to a convict who has completed the second stage of his sentence and is about to enter the third and last, that of conditional liberation or semi-freedom, in which he goes at large to earn his own livelihood as a more or less independent member of the community The "ticket" or "licence" is the outward sign of "remission" gained by industry and good conduct in prison (*q v*), and it may be forfeited for disobedience or neglect of certain conditions endorsed upon the licence The term is not used in the U S. where it is replaced by the parole system



VARIOUS TYPES OF TICKING
Top left, ordinary three-leaf twill; top right, "Arrow head" twill; left bottom and centre, four- and five-thread straight twills; right bottom, five-thread steen twill

TICKING. A strong linen, cotton or union fabric usually woven in stripes of colour, blue and red with white being the most common The name is derived from a word "tick," common in various forms to many languages, signifying a case or sheath Its original use was to enclose feathers, flocks or the like for beddings, but its use has been extended to include the covering for mattresses, and for awnings and tents In some qualities it is also used as a foundation for embroidery

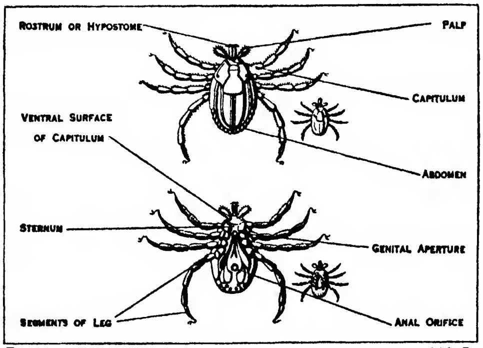
White, grey or brownish warp threads are usually flax, while the coloured threads are often cotton. The weft is flax or tow The warps of many of the cheaper kinds are made entirely of cotton, and jute is used for weft in the cheapest grades A feather tick should be made of fine flax yarns set closely, and there should also be a large number of weft threads per inch

TICKLE-GRASS (PANICUM CAPILLARE)
On the left is shown the free grain, and right, the grain is enclosed in the hardened fruiting scale

TICKLE-GRASS (*Agrostis hyemalis*), a North American grass, called also hair-grass, found widely throughout the continent and in various districts occurring in weed-like abundance It is a delicate plant of open grounds, bearing small flowering spikelets at the ends of the hair-like branches of a very diffuse panicle At maturity the fruiting panicle breaks away from the plant and is blown about as a tumble-weed (*q.v.*).

TICKS, the name for Acari, of the order Arachnida (*q v*), of the families Ixodidae and Argasidae They have on the head

a median probe, armed with recurved teeth, which projects forwards. Ticks are of relatively large size, female specimens of some species measuring half an inch or more in length when distended after being gorged with blood. The mouth parts consist of two small retractile mandibles, a pair of short palpi and the toothed probe or hypostome By means of the hypostome ticks pierce the skin and adhere to the host whose blood they suck. In the Argasidae the palpi are simple; there is no sucker beneath the claws and there is only a slight difference between the sexes. In the Ixodidae the second and third segments of the palpi form a sheath for the hypostome; there is a sucker beneath the claws and the males have the dorsal integument continuously chitinized, whereas in the females only its anterior portion bears a chitinous plate.



THE TICK (HYALOMMA AEGYPTUM), SEEN FROM THE DORSAL (ABOVE) AND VENTRAL (BELOW) SIDES, SHOWING THE PIERCING MOUTH PARTS (ROSTRUM) AND HOOKED LIMBS BY WHICH IT GRASPS ITS HOST

Both families contain pathogenic species *Ornithodoros moubata,* belonging to the Argasidae, is widely distributed in tropical Africa from Uganda in the north to the Transvaal in the south. It is the carrier of the Spirochaete of relapsing fever in man An allied species, *O. turicata,* occurs in Mexico and Texas, where it is a pest to mankind and to poultry. *Argas miniatus* is the carrier of the Spirochaete causing spirillosis in fowls in Rio de Janeiro and New South Wales Amongst the Ixodidae several forms are injurious to man and domestic animals. *Dermacentor venustus* is the carrier of the human disease known as Rocky Mountain Spotted Fever. *Dermacentor reticulatus,* widely distributed in Europe, Asia and America, infects dogs with the Haematozoon causing "biliary fever." The same disease results in South Africa from the bite of *Haemaphysalis leachi Amblyomma hebraeum,* the bont tick of the Cape Colonists, infects sheep with the Sporozoon causing "heart-water" sickness, and in Europe sheep are inoculated with the same disease by *Rhipicephalus bursa.* The "coast fever" in cattle in South Africa is conveyed by *Rhipicephalus appendiculatus* and *R. simus. Margaropus annulatus* is the carrier of the germ causing the cattle-disease known as "Texas" or "red-water" fever in America, South Africa and Australia. With one or two exceptions, no species of tick is confined to a particular host, and reptiles are infested as well as mammals.

TICONDEROGA, a village in the township of Ticonderoga, Essex county, New York, U.S A., on the outlet of Lake George, 100 m. by rail N by E. of Albany. Pop (1925), 3,858 Ticonderoga is served by the Delaware and Hudson and the Rutland railways. The water from Lake George falls here about 30 ft, providing water-power, and among the manufactures are paper pulp, paper-making machinery and lumber. Commanding a portage on the line of water communication between Canada and the English colonies, Ticonderoga was a place of considerable strategic importance during the Seven Years' War. On an eminence overlooking the present village and Lake Champlain the French began building a fort of earth and timber in 1755 and called it Fort Carillon; later it was named Fort Ticonderoga. Sir William Johnson led an expedition in the same year against this fort and Crown Point; though he failed to capture the forts he defeated Baron Ludwig August Diesku in the battle of Lake George and erected at the head of the lake Fort William Henry, which was captured by the marquis de Montcalm in 1757. On July 8, 1758, less than 4,000 Frenchmen were confronted at Fort Carillon by about 6,000 British regulars and 10,000 provincials under Lieut-General James Abercrombie and Brigadier-General George A Howe, but Howe, the controlling spirit of the British force, had been killed on July 6, and Abercrombie retreated, after an ineffective attack which cost him nearly 2,000 men killed or wounded. In 1758, however, when Montcalm had gone to Quebec to oppose Wolfe and a force of only 400 men was left at Ticonderoga, Lord Amherst with 11,000 men invested it, and on July 26 the garrison blew up and abandoned the fortifications. At the beginning of the Revolutionary War, on May 10, 1775, a small expedition under Ethan Allen, a backwoods strategist untrammelled by military pedantry, captured the fort by ruse instead of costly assault. When the American expedition against Canada was driven back from Quebec they garrisoned Ticonderoga so strongly that the British commander, Carleton, shrank from attacking it In 1777, however, Burgoyne's counter invasion from Canada arrived before the fort and occupied the precipitous Sugar Loaf Hill which commanded the fort The garrison, already reduced in numbers and supplies, felt compelled to evacuate it and on July 6 the British occupied it. Burgoyne, pressing onwards to the Hudson, was driven to surrender at Saratoga in October; Ticonderoga was abandoned by the British immediately after this disaster, but was reoccupied by them in 1780 After the close of the war it was allowed to fall into ruins. In 1909, on the occasion of the tercentenary celebration of the discovery of Lake Champlain, the restoration of the fort was begun under the direction of the owner of the site. The settlement of this region was begun soon after the close of the Seven Years' War, and the township of Ticonderoga was set apart from the township of Crown Point in 1804 The village of Ticonderoga was incorporated in 1889. The name "Ticonderoga" is a corruption of an Indian word said to mean "sounding waters"

TICUNAN, a small group of tribes of South American Indians, constituting an independent linguistic stock The Ticunas and their related tribes lived in western Brazil, on the lower Yavary river and on the main Amazon for some distance below the junction of the two streams.

TIDAL POWER. The idea of utilizing the rise and fall of the tides for power purposes has long attracted the attention of inventors, and many ingenious schemes have been suggested. So far, however, the only practicable method is based on the use of one or more tidal basins, separated from the sea by dams or barrages, and of hydraulic turbines through which the water is passed on its way between basin and sea or between one basin and another.

Types of Schemes.—Briefly outlined the more promising of the schemes of tidal power development are as follows:—

(*a*) A single tidal basin is used, divided from the sea by a dam in which are placed the turbines The basin is filled through sluices during the rising tide. At high tide these are closed. When the tide has fallen through about one-half its range, the turbine gates are opened and the turbines operate on a more or less constant head until low tide or slightly after. If A be the surface area of the basin in square feet; if H ft. be the tidal range; if a constant working head of h ft. be adopted; and if the turbines operate until low tide; the volume of water used during the falling tide will be $A\ (H-h)$ cu ft, and the energy available in the water will be

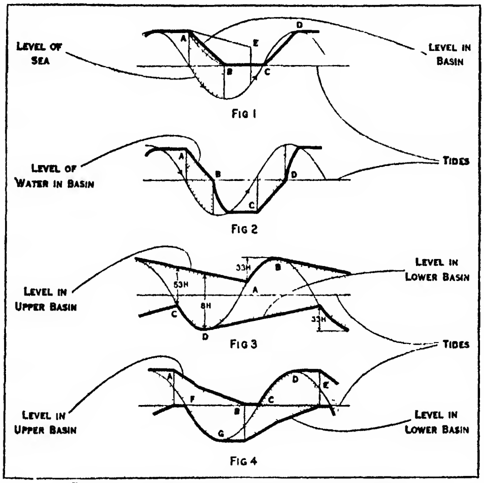
$$64A\ (H-h)\times h,\ \text{ft lb. per tide.}$$

This expression is a maximum when $h=H\div 2$, that is, when the working head is one-half the tidal range, and then equals $16\ AH^2$ foot-pounds.

If A is in square miles, and if the efficiency of the turbines is 75%, the output in h-p.-hours per tide is given by

$$\frac{0\cdot75\times64(5280)^2AH^2}{4\times33000\times60}=169AH^2.$$

The cycle of operations is shown in fig. 1 where AB denotes the working period and CD the period of replenishment of the basin. The sine curve represents the level of the sea outside the basin. Owing to the great variation in the rate of efflux of the water, in this constant-head method of operation, the power output varies very largely during the falling tide. This variation may be reduced considerably by allowing the turbines to operate on a more or less constant fall of level in the basin as shown by the straight full line AB. By this method of operation the necessary turbine capacity for a given output may be greatly reduced By extending the working period beyond low tide, as indicated by the light line AE, a greater amount of energy may be developed per tide and the idle period is diminished, but at the expense of an appreciably greater variation in head The most efficient combination of working period and of working heads can only be determined by detailed examination of the particular site, and with a knowledge of the exact form of the tidal curve.



PLAN OF SCHEMES FOR TIDAL POWER DEVELOPMENT

Fig. 1.—Single tidal basin, divided from sea by a dam containing turbines operating only during ebb tide. Fig 2.—Single tidal basin, with turbines operating on rising and falling tides. Fig. 3 —Two tidal basins with turbines in dividing walls. Fig. 4.—Two tidal basins with turbines installed in walls dividing sea from each basin The heavy lines show the water level in the basin at any instant, and the light lines show the sea level at the same instant. The shaded areas represent the working heads when the turbines operate

(*b*) A single tidal basin is used, with the turbines operating on both rising and falling tides The cycle of operations is indicated in fig 2. The working period per complete tide now extends from A to B and from C to D. Slightly before low water, at B, the basin is emptied through sluice gates, and at D, a little before high water, the basin is filled through the sluice gates. With a working head equal to one-half the tidal range, the period of operation is approximately 60% greater than in system (*a*) with operation down to low tide, and the work done is some 60% greater

(*c*) Two basins of approximately equal areas are used, with turbines in the dividing wall. Each basin communicates with the sea through suitable sluice gates. In one of these basins called the upper, the water level is never allowed to fall below one-third of the tidal range, while in the lower basin the level is not allowed to rise above one-third of the tidal range. The working head then varies from 0·53 H to 0·80 H, with a mean of approximately 0·66 H, and operation is continuous as indicated in fig. 3 which shows the cycle of operations. Between A and B, the upper basin is filled from the sea through appropriate sluice gates, and the lower basin discharges into the sea from C to D. For a given total basin area and a given tidal range the output is only about one-half that obtained in system (*a*) and one-third that obtained in system (*b*), so that except where the physical configuration of the site is particularly favourable the cost per h.p. is likely to prove very high.

(*d*) Two tidal basins of approximately equal areas are used. Turbines are installed in the walls dividing the sea from each basin. Fig. 4 shows the cycle of operations From A to B the upper basin discharges through its turbines into the sea. From B to E the sea enters the lower basin through its turbines. The upper basin is filled from the sea through its sluice gates between C and D, and the lower basin is emptied through its sluice gates from F to G. The head varies from 0·25 H to 0·62 H, and the output is some 25% greater than in system (*c*) but the number of turbines required is much greater.

It is possible to arrange in each of these systems that the head shall be maintained constant during any one working period, but since this means that the working head is then limited to the minimum obtaining during that period, a loss of energy is involved, with a great additional cost of construction and complication in manipulation and with little compensating advantage. For any scheme of development involving the use of a tidal estuary of such types as are found in the Severn or Dee, the cost of any of the multiple basin systems would appear to put them definitely out of court A scheme involving operation only on a falling tide has the disadvantage that the output is only about 60% of the output theoretically possible with double-way operation. On the other hand the output per unit of turbine capacity is sensibly the same, while it enables a much more efficient type of turbine setting to be used, and halves the number of sluice gates.

The Severn Scheme.—Up to 1928 no tidal scheme of any magnitude had been constructed The possibilities of such an installation on the estuary of the Severn are, however, now under consideration by a committee appointed by the British Government This would consist of a single tidal basin of about 25sq m. in area formed by a barrage probably in the neighbourhood of Sudbury, along with a storage reservoir some 500ft above sea-level and about 5m away above the Wye valley. It is estimated that the scheme would be capable of developing some 500,000h p. over a 10-hour working day throughout the year.

Fundy Bay Scheme.—Two schemes, each of the two-basin type, have been suggested for utilizing the tides in the Bay of Fundy (*q v*). From one of these, at Passamaquoddy Bay, where the average spring tidal range is 23·2 ft , it is estimated that from 500,000 to 700,000 h p can be generated The other, which is a smaller but relatively less costly scheme, is at Hopewell at the head of Shepody Bay, and utilizes the estuaries of the Petitcodiac and Memramcook rivers as the two tidal basins. Here the spring tidal range is 45 5 ft and the available power about 200,000 h p Both schemes have been before the New Brunswick Government.

Aber-Vrach Scheme.—A combined tidal and river-power scheme to which the French Government is giving financial assistance is projected at Aber-Vrach on the coast of Brittany For the tidal station a barrage 490ft. long is to be constructed in the estuary. Four turbines connected to synchronous generators are to be installed, each capable of developing 1,200h p , under the maximum head available at spring tides The turbines are to operate both on the ebb and flow tides This station will work in conjunction with an auxiliary water-power station some 4m. away on the river Diouris. The river is to be dammed at this point, forming a fresh water reservoir from which turbines having a maximum capacity of 2,700h p. are to be supplied. Electrically driven centrifugal pumps of a capacity of 3,200h p will also be installed

Bibliography —A. M A Struben, *Tidal Power* (1921); A H. Gibson, *Hydro-Electric Engineering*, vol II (1922) , N Davey, *Studies in Tidal Power* (1923) ; W. R. Turnbull, *Proposed Tidal Hydroelectric Power Development of the Petitcodiac and Memramcook* (1925).

(A. H. G.)

TIDES. 1. The word "tide" refers to those alternating relative motions of the matter of the planet, satellite or star, which are due to the gravitational actions of external bodies Two terrestrial examples besides the tides of our oceans and seas are

earth-tides and atmospheric tides. They consist in the alternating slight change of shape due to the gravitational action of the moon and sun. There is, however, a still wider use of the word which has some convenience. It is based on descriptive and kinematical, instead of on causal and astronomical ideas, and takes for criterion that the motions in question shall have certain features in common with ocean-tides. This extension includes those "long" waves of the sea which are sometimes caused by earthquakes, the effects on the sea of variable atmospheric pressure, as well as the oscillations of the water of lakes known as "seiches."

Ordinary Tides.—2 At most seaside places the water reaches its highest level approximately twice a day, the average interval between two successive high waters being 12 hr. 25 min, but the interval varies considerably during the course of a week, while at certain places in the China sea the interval is often over 24 hours. At places on the shores of the oceans the time taken by the tide in rising is about equal to the time taken in falling on the same day, but in estuaries the tide usually rises quicker than it falls At certain places, such as Southampton, England, the high waters are often doubled, *i.e.*, the water reaches a maximum height, falls a little and then rises to a maximum again. At other places, the low waters are often doubled As we go along any stretch of coast the time of high water changes progressively, while as we go up an estuary from the sea the time of high water always becomes progressively later.

At most places, on the average, a high water is about as much above the mean level of the sea as the succeeding low water is below it The difference in level between successive high and low waters is called the *range* of tide At most places it reaches a maximum once a fortnight, and a minimum midway between two successive maxima At the head of the Bay of Fundy the range of tide reaches 50 ft, while at certain islands of the Pacific and over most of the Mediterranean the range never exceeds 2 ft. At many places outside the Atlantic the heights of two successive high or low waters are markedly different, a phenomenon known as *diurnal inequality.*

At a place in a strait or narrow sea the tidal current usually flows for about 6 hr 12 min. in each direction At the reversal of the current we have the state of rest usually called *slack water.* At a place in the open sea the direction of the current often takes all points of the compass, making the complete revolution in the tidal period. During this period there are usually two times of maximum, and two intermediate times of minimum current, separated by about half the tidal period In general there is no fixed relation between the time of high water and the time of maximum current; but if the current flows directly in and out of a bay it will reach its inward maximum about a quarter period before high water at the head of the bay, so that slack water is simultaneous with high water On the other hand in an estuary the upstream maximum will occur at a much shorter interval before high water, so that the current continues to flow upstream for some time after high water and to run down stream after low water. When the current is directed towards land or up an estuary, it is called the *flood* current; when it runs away from the land it is called the *ebb.*

The speeds of tidal currents vary greatly from place to place; *e.g.,* in the Mersey at Liverpool the maximum current reaches 7 knots, while in the North sea it rarely exceeds 1 knot. At some distance up certain rivers the rising water spreads over the flat sands in a roaring surf and travels up the river almost like a wall of water. This phenomenon is called a *bore.* Near a headland separating two bays there is sometimes a very swift current, termed a *race.*

HISTORY OF THE STUDY OF TIDES

3. The theories of tides advanced by the early Chinese, Arabic and Icelandic authors, are fantastic The Greeks and Romans lived on the shores of an almost tideless sea and therefore seldom referred to tides. Nevertheless Strabo quoted from Posidonius a clear account of the tides on the Atlantic coast of Spain, and connected them correctly with the motion of the moon He also gave the laws of the tide and diurnal inequality in the Indian ocean as observed by Seleucus the Babylonian. Kepler (*q.v.*) recognized the tendency of the water of the ocean to move towards the sun and moon, but produced a theory which appeared to reintroduce the occult qualities of the ancient philosophers. Galileo (*q.v.*) referred the phenomenon to the rotation and orbital motions of the earth, and he considered that it afforded a principal proof of the Copernican system.

Foundation of Modern Theory.—It was Newton (*q v.*) who, in his *Principia* of 1687, laid the foundation of the theory of the tides when he brought his generalization of universal gravitation to bear on the subject He used an artifice of imaginary wells of water reaching to the centre of the earth where the pressure-intensities would be equal He accounted for many of the general properties of the tides, such as the phenomenon of springs and neaps, priming and lagging, diurnal and elliptic inequalities The only important factor which he did not mention is the dynamical effect of the earth's rotation. He attempted to calculate the magnitude of the lunar equilibrium-tide from data provided by the actual tides

In 1738 the Academy of Sciences of Paris offered as a subject for a prize the theory of the tides The authors of four essays received prizes, viz, Bernoulli, L Euler, C Maclaurin (*qq v*) and A Cavalleri The first three adopted not only the theory of gravitation but also Newton's method of the superposition of two ellipsoids. Laplace (*q v*) gave an account and critique of the essays of Bernoulli and Euler in his *Mécanique Céleste* In 1746 J. le R D'Alembert wrote a paper on atmospheric tides

The theory of the tidal movements of an ocean was almost untouched when, in 1774, Laplace first undertook the subject He formulated the equation of continuity and the dynamical equations (*See* his *Mécanique Céleste*) He also established the principle of forced oscillations, often known by his name, viz, "The state of oscillation of a system of bodies in which the primitive conditions of movement have disappeared through friction is co-periodic with the forces acting on the system" The tidal application of this is the foundation of the harmonic method

The connection between the tides and the movements of the moon and sun is so obvious that tidal predictions founded on empirical methods were regularly made and published long before mathematicians had devoted their attention to them. The best example of this kind of tide-table was afforded by Holden's tables for Liverpool The use of automatic tide-gauges appears to have been begun about 1830, two of the earliest machines being those of H. R. Palmer (*Phil Trans*, 1831) and J. G. Bunt (*Phil. Trans*, 1838).

Co-ordination of Observations and Harmonic Analysis.—4 The work of Lubbock and Whewell is chiefly remarkable for the co-ordination and analysis of data at various ports, and the construction of tide-tables. In 1838 Whewell produced his "Essay towards a first approximation to a map of co-tidal lines." (*Phil. Trans.*) He was led to perceive the existence of the amphidromic point (§ 15) in the Flemish bight, and this led to the observational verification by W. Hewett (*Brit. Ass. Report,* 1841) of the small range near the point. Airy, in his *Tides and Waves* of 1842, contributed an important review of the whole tidal theory and studied profoundly the theory of tidal motions in canals. The results given in §§ 17, 18, 22 for canals and gulfs of uniform section are only a few of his many achievements in this connection. In 1847 and 1857 F. W. Beechy published (*Phil. Trans.*) the results of a survey of tidal currents over the Irish sea, the English channel and North sea.

About 1863 W. Thomson (afterwards Lord Kelvin, *q.v.*) became interested in the problems presented by earth-tides. In 1866 he took up the analysis of ordinary tidal observations and introduced the methods of harmonic analysis which quickly developed. Kelvin's other contributions to tidal theory are also of profound importance. He established (*Phil. Mag.* 1875) the correctness of Laplace's procedure in discussing the dynamical theory of the tides of an ocean covering the whole earth. He introduced (*Proc. Roy. Soc.* Edinburgh, 1879) the rotation of the

earth into the tidal dynamics of small seas, and thus accounted for the transverse surface-gradients across narrow seas. He produced the exact solution of the dynamical equations for a channel of uniform depth when there is no transverse component of current, and indicated the characteristics of tidal motion in a circular basin of uniform depth (§ 19). In 1872 he designed the tide-predicting machine (§ 26).

In 1874 W. Ferrel of the U.S. Coast and Geodetic Survey published his *Tidal Researches* which included a harmonic development of the generating potential; in the same year A W. Baird of the Survey of India organized a service of observation and harmonic analysis for Indian tides (*See* his *Manual of Tidal Observations*); and in 1882 G. H Darwin produced memoirs (*Brit. Ass. Reports,* 1883, '84, '85, '86) which formed the standard manual on the subject. They contained an elaborate analysis of the generating potential and a complete treatment of the methods of analysing hourly heights He afterwards developed methods of analysing observations of high and low water and designed his "tidal abacus" (*Proc Roy Soc.* 1892).

About this time J. E. Pillsbury of the U S Coast Survey began the observations with current meters In 1885 C Börgen introduced new ideas into the methods of harmonic analysis, and these have since been developed in Germany (*See* K Hessen, *Ann der Hydrog* 1920) Between 1870 and 1890 F. A Forel (see *Le Leman*) made illuminating studies of the seiches (§ 17) of Lake Geneva About 1890 M. Margules (*Sitz. Ber. Akad. Wiss. Wien.* 1892–93) investigated the dynamics of atmospheric tides

5. In 1895 H Lamb published the second edition of his *Hydrodynamics* which gave a mathematical account of the dynamical theory His most important original contributions were on the theory of steady motions and free oscillations of the second class, but he also developed the theory of circular basins (§ 19) In 1896 the two memoirs of H Poincaré "Sur l'équilibre et les movements des mers" appeared (*Journ de Math*); and in 1897 S S Hongh produced his two memoirs "On the applications of harmonic analysis to the dynamical theory of the tides," in which he greatly augmented the treatment for an ideal ocean covering the whole earth (§ 19)

From 1894 to 1907 R A Harris of the U S Coast Survey published his *Manual of Tides;* the work contained much on the dynamical theory and charts showing co-tidal lines for the whole world and based on hypotheses, the leading feature of which was the principle of resonance It was assumed that in each ocean there exist regions capable of free oscillation with a period near one of the principal tidal periods, and that the nature of these free oscillations may be calculated approximately He developed the theory of amphidromic points, gave satisfactory general explanations of the tides in a number of narrow seas and considered features of local coastal origin In 1904 and 1905 G. Chrystal (*Roy. Soc. Edinburgh, Proc* and *Trans.*) published his mathematical work on the longitudinal seiches of lakes. About this time a number of Scandinavian oceanographers, notably V. W. Ekman, O Pattersson and J. P. Jacobsen invented current meters, and the records taken with these have been subjected to harmonic analysis. A few years later L. Favé observed tidal elevations in the open sea by means of his self-registering instrument

Recent Research on Water-tides.—6. In 1910 H Poincaré published his *Théorie des Marées.* This theory was further developed by G. Bertrand in 1923 (*Ann. Ecole Normale*). In 1912 A. Blondel (*Ann. Fac. Toulouse*) applied the narrow sea theory, through the principle of least action, to the tides of the Red sea. From 1913 to 1920 R. Steineck (*Acad. Wiss. Wien., Sitz. Ber* and *Denk.*) and A. Defant (*Ann. der Hydrog*) developed the narrow sea theory, as sketched in § 16, with special reference to the Adriatic sea, Defant (*Akad. Wiss. Wien, Denk.* and *Sitz. Ber.*) applied this theory to the Red sea, the Persian gulf, the English channel and the Irish sea (parts of fig. 4 are based on his work), and Steineck (*Sitz. Ber. Akad. Wiss. Wien.* and *Ann. der Hydrog.*) applied extensions to the theory of the tides of the Mediterranean and Black seas. In 1914 J. Proudman gave a direct mathematical process for integrating Chrystal's differential equation without approximating to the normal curve in Chrystal's manner This method was applied to Lake Geneva by A. T. Doodson, R M Carey and R Baldwin in 1920 (§ 15) In 1914 G R Goldsbrough worked out the details for polar and zonal oceans of uniform depth (§ 19) In 1917 J Proudman (*Proc. Lond. Math. Soc*) specified the tidal state of an ocean by means of an infinite number of co-ordinates of the Lagrangian type, and then transformed the differential equations into an infinite set of linear equations.

In 1918 G J Taylor (*Phil Trans. A.*) made a numerical estimate of the rate of dissipation of tidal energy in the Irish sea, and H Jeffreys made the estimate of total dissipation referred to in § 21. In 1920 G J Taylor gave the solution of the dynamical equations for the reflection of a Kelvin wave at the head of a rectangular gulf and for a rectangular basin, the problems mentioned in §20 E Fichot (*Comptes Rendus*) has written several papers on amphidromic regions In 1923 A Defant (*Ann der Hydrog*) produced a co-tidal chart of the North sea derived from a knowledge of the currents by means of the equation of continuity. In the following year J. Proudman gave the method of calculating elevations from currents (§ 15), and A. J. Doodson produced the co-tidal chart for the North sea (*see* references in *Phil. Trans* A) In 1925 J Proudman gave the theory of tides in a channel of non-uniform depth (*Phil Mag*) sketched in § 19, and a mathematical discussion of the effects of capes, bays and islands on local tides (*Mon Not R A S Geoph. Supp.*) In 1927 G R Goldsbrough produced the dynamical theory of tides in an ocean bounded by two meridians referred to in § 20, and A T Doodson described his methods of analysis of observations

TIDAL OBSERVATION

7 Complete investigation of the laws of tidal oscillation demands that the height of the water should be measured at times other than those of high and low water The simplest sort of observation is to note the height of the water on a graduated staff fixed in the sea, with such allowance for wave motion as may be possible; but when extensive observations are to be made an automatic and continuous *tide-gauge* is generally used A well or tank is built on the shore, communicating by a pipe with the sea at some depth below lowest low water mark A float rests on the surface of the water in the well and hangs by a high wire or chain This wire is wrapped round a wheel and imparts to it a rotation proportional to the rise and fall of the tide, which by means of a simple gearing, moves a pencil to and fro against a slowly revolving drum thereby tracing the tide-curve A number of attempts have also been made to construct a self-registering gauge which, when placed on the bottom of the sea, will give a continuous record of the pressure of the water above it.

Tidal currents have mostly been measured by noting the distance moved by a floating log in a definite interval of time, but series of observations at frequent intervals, especially of currents below the surface are usually made by *current-meters* One of the commonest of these, the Ekman meter, registers the mean speed and direction of the current, the former by means of a small propeller actuating a revolution-counting apparatus, and the latter by a vane attached to an apparatus dropping shot into sectorial boxes on a compass card

Astronomical Correlation.—8 The times of high water are found to bear an intimate relation to the positions of the moon and sun The period of 12 hr 25 min is half that of the moon's apparent revolution round the earth The length of time between the moon's crossing of the meridian of a place and the next high water at that place is known as the *lunitidal interval* for the place. The interval takes its average value a day or so after new and full moon and after the first and third quarters The average value of the lunitidal interval on the days of new and full moon is known as the *establishment of the port.*

The range of tide may be similarly correlated. In British waters it reaches its maximum a day or so after full moon and its minimum a day or so after the quarters. In these circumstances the maximum tides are known as *spring tides,* and the minimum tides as *neap tides.* About the time of the equinoxes spring tides are generally larger, and about the time of the solstices generally

smaller than usual. The average interval between new or full moon and the next following spring tides is known as the *age of the tide*. At certain places in Canadian waters the chief variation in the range of tide is associated with the varying distance of the moon from the earth, while at others it is associated with the varying declination of the moon. The diurnal inequality is always associated with the declination of the moon or sun. The most complete correlation between the tides and astronomical variable is provided by the harmonic methods (§ 13).

TIDE-GENERATING FORCES

9 By the law of gravitation the force directed towards the moon's centre on any particle is jointly proportional to the masses of the particle and of the moon, and inversely proportional to the square of the distance between the particle and the moon's centre. If we imagine the earth and ocean sub-divided into a number of small portions or particles of equal mass, then the *average*, both as to direction and intensity, of the forces acting on these particles is equal to the force acting on that particle which is at the earth's centre. For, if we divide the earth into two portions by an imaginary spherical surface passing through the earth's centre and having its centre at the centre of the moon, the portion remote from the moon is a little larger than that towards the moon, but the nearer portion is under the action of slightly stronger forces, so the resultant effects on the two portions are equal It is departure of the force acting on any particle from the *average* which constitutes the tide-generating force. On the side of the earth towards the moon the departure from the average is a small force directed towards the moon; and on the side of the earth away from the moon the departure is a small force directed away from the moon The tidal forces tend to pull the water towards and away from the moon, and to depress the water at right-angles to that direction (*See* fig 1.) The relative magnitudes of the forces are given by the numbers on the figure, and are calculated as indicated in § 11 M is in the direction of the moon, V is the point of the earth nearest the moon, DD are the sides of the earth where the tidal force is directed towards the earth's centre.

The separate attractions of the moon at the earth's centre and at a point on the earth's surface are each inversely proportional to the square of the moon's distance, so that the difference between the two, which gives the tide-generating force, is approximately inversely proportional to the cube of the moon's distance The *vertical* component of the tide-generating force coincides in direction with the gravitational force of the earth itself and thus acts as a very slight modification of weight; this component does

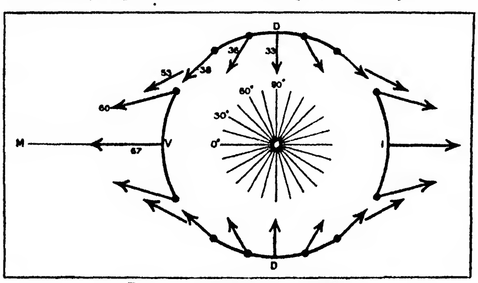


FIG 1—TIDE-GENERATING FORCE

not tend to alter the position of equilibrium which the water would take up in the absence of any disturbance from an extra-terrestrial body. The effective tide-generating forces, therefore, are the *horizontal* components of those indicated in fig. 1, and midway between V and I these are zero.

Equilibrium-form of Tide.—10. For many purposes it is convenient to specify the distribution of tide-generating forces at any instant by reference to a fictitious tide in an ocean covering the whole earth If the earth carried such an ocean and were to remain at rest, and if the tide-generating forces were to remain constant, there would be an invariable elevation of water at each point of the ocean-surface and no tidal currents. If the distribution of forces were the same as that of the actual tide-generating forces at any definite instant, then we might use the consequential elevation of water as a specification of these forces. This distribution of fictitious tidal elevation is known as the *equilibrium-form of the tides*. In this equilibrium-form the inclination to the horizontal of the surface of the water would be always such that the consequential differences of pressure produced horizontal forces balancing the tide-generating forces. It is therefore clear that the surface of the water would slope upwards from DD towards the points V and I, the water being raised by a maximum amount at V and I and depressed by a maximum amount along the great circle through DD perpendicular to the line joining the earth and moon. The surface of the water would be that of a nearly spherical surface of revolution Owing to the motion of the moon relative to the earth, this surface of revolution moves over the earth so that V is always directly opposite, while owing to the varying distance of the moon the surface of revolution changes slightly in shape

The tide-generating forces due to the sun's gravitation may be similarly specified From a consideration of the relative masses and distances of the sun and moon, at corresponding points of the two spheroids representing the lunar and solar equilibrium-forms respectively, the tidal elevations on the average will be in the ratio of 2 17 to 1

Harmonic Constituents of Tide-generating Forces.—At any point of the earth's surface we must represent the sum of the two varying elevations, due to the two moving equilibrium-spheroids, as the sum of a number of constituents that are harmonic functions of the time, *i.e*, terms of form ($H_0 \cos n\ (t-\tau_0)$), where t denotes the time, n is an angular speed, H_0 a length and τ_0 constant The quantity n is the *speed* of the corresponding constituent, it is the same for all points of the earth's surface. The length H_0 is called the amplitude of the constituent at the place in question; H_0 and τ_0 are constant at any one place, but vary over the earth's surface The angle $n(t-\tau_0)$ is called the *phase* of the constituent at time t

If the moon moved with constant angular speed in the plane of the earth's equator and at a constant distance from the earth we should have, at any place, equilibrium high water occurring regularly at intervals of time equal to 12 hr 25 min, with a maximum range of elevation at the equator and a zero range at the two poles Let γ denote the angular speed of the earth's rotation and σ the mean motion of the moon Then the rise and fall of the water would be approximately harmonic, with a speed of $2(\gamma-\sigma)$, so that the equilibrium tide would be represented very approximately by a single harmonic constituent. The fact that the moon does not move as here supposed causes many modifications, the chief of which takes into account the elliptic inequality of her distance giving rise to two new harmonic constituents of speeds $2\gamma-3\sigma+\omega$ and $2\gamma-\sigma-\omega$. The moon's motion also varies in her elliptic orbit, and thus causes the first of these two constituents to be greater than the second.

The moon's movement in a parallel of latitude other than the equator introduces a further new constituent, of speed $(\gamma-\sigma)$, with an amplitude vanishing at the equator. Also, the amplitude of the original constituent, of speed $2(\gamma-\sigma)$, would be less than when the moon was in the equator. Since the declination of the moon changes, this new constituent requires modification. If its amplitude could be regarded as changing harmonically with speed σ, it would be replaced by two harmonic constituents of speeds $\gamma-\sigma\pm\sigma$ Owing to the fact that this is not quite so, the amplitude of the constituent of speed $\gamma-2\sigma$ is greater than that of speed γ. The changing declination of the moon also causes the amplitudes of the semi-diurnal constituents to vary, therefore the speed and range of tide increase or decrease together, and we get yet another new constituent of speed $2(\gamma-\sigma)+2\sigma$. The daily mean level in the equilibrium-form depends upon the particular curve of the spheroid which passes over the place; on this account the changing declination of the moon introduces a constituent of speed 2σ.

The amplitudes of all the constituents depending on the inclination of the moon's orbit to the equator vary with the position of the node on the ecliptic. As the monthly mean level at any place also depends on the inclination of the moon's orbit to the equator, we have a small constituent with a speed $\dot{N}$ equal to that of revolution of the moon's nodes. The speeds of the constituents of solar origin may be similarly determined

Species.—The constituents fall into three species; a *semi-diurnal* species containing the constituents of speeds approximately equal to 2γ, a *diurnal species* containing those constituents of speeds approximately equal to γ, and a *long period species* containing constituents of speeds small compared with γ. Each constituent has a recognized symbol and name.

Symbol	Name	Speed	Coefficient
	Semi-diurnal Species		
M_2	Principal lunar	$2(\gamma-\sigma)$	·454
S_2	Principal solar	$2(\gamma-\eta)$	211
N_2	Larger lunar elliptic	$2\gamma-3\sigma+\omega$	·088
K_2	Luni-solar	2γ	·058
	Diurnal Species		
K_1	Luni-solar	γ	·265
O_1	Larger lunar	$\gamma-2\sigma$	·189
P_1	Larger solar	$\gamma-2\eta$	·088
	Long Period Species		
M_f	Lunar fortnightly	2σ	·078
S_{sa}	Solar semi annual	2η	·036
	Nineteen yearly	$\dot{N}$	·033

In this table η denotes the mean motion of the sun and the coefficients have been calculated as will be explained in § 11

Imagine an equilibrium surface corresponding to each separate harmonic constituent For the semi-diurnal species there will be two maximum and two minimum elevations on the equator, and the elevation will steadily decrease away from the equator reaching zero values at the poles For the diurnal species the elevation will be zero along the equator and at the two poles, but along any other parallel of latitude there will be one maximum and one minimum At any one time all the maxima and minima will lie on two meridians, a maximum changing into a minimum and *vice versa* on crossing the equator For both species the motion of the surface relative to the earth will be one of uniform rotation round the earth's axis with the speed given in the table For a constituent of the long period species, the corresponding surface at any one time will be symmetrical about the earth's axis, and its motion will be a harmonic pulsation with the speed given in the table

11. For the dynamical theory we require a mathematical expression of the geographical distribution of the equilibrium-form in each species of constituent, and for the theory of earth-tides we require the distribution of the generating forces inside the earth as well as over its surface For this purpose we use the *potential* of the forces. A uniform distribution of the average force of the moon's attraction over the whole body of the earth has a potential

$$\frac{\Gamma M}{D^2} r\cos\delta, \tag{1}$$

where Γ = gravitational constant, D = distance from moon C to earth O, M = mass of moon, r = distance of the point P at which potential is evaluated from the centre of the earth, δ = angle COP. The complete potential at P due to the moon's attraction is $\Gamma M/R$, and to get the potential V of the tide-generating forces we have to subtract (1); therefore

$$V=\Gamma M\left(\frac{1}{R}-\frac{r}{D^2}\cos\delta\right)=\frac{\Gamma M}{D^3}r^2(\tfrac{3}{2}\cos^2\delta-\tfrac{1}{2}). \tag{2}$$

on dropping the term $\Gamma M/D$, since it contributed nothing to the forces. If E denotes the mass of the earth, a its radius and g the acceleration of its gravity, we have $g=\Gamma E/a^2$, so that (2) may be written as

$$V=\tfrac{3}{2}g\frac{M}{E}\frac{a^2}{D^3}r^2(\cos^2\delta-\tfrac{1}{3}). \tag{3}$$

Fig. 1 has been constructed from the expression (3). This expression, when $\cos\delta$ is defined in terms of the latitude λ and longitude ϕ of P and the declination Δ and hour-angle α of the moon, gives rise to the semi-diurnal, diurnal and long period species. To find these we must substitute for D and Δ as functions of the time The constituents of the three species then take the respective forms:

$$g\mathbf{H}C\frac{r^2}{a^2}\cos^2\lambda\cos(nt+2\phi-\epsilon),$$

$$g\mathbf{H}C\frac{r^2}{a^2}\sin 2\lambda\cos(nt+\phi-\epsilon),$$

$$g\mathbf{H}C\frac{r^2}{a^2}\tfrac{3}{2}(\sin^2\lambda-\tfrac{1}{3})\cos(nt-\epsilon),$$

where $$\mathbf{H}=\frac{3}{2}\frac{M}{E}\frac{a^4}{D^3}=1\cdot 8\text{ ft.},$$

D_0 being the mean value of D, ϵ denoting a constant for each constituent, and C the numerical coefficient whose value is given in the table of constituents. (G H Darwin, *Brit. Ass. Report*, 1883, A. T Doodson, *Proc Roy Soc* A, 1921) A similar analysis applies to the solar constituents, and the value of **H** will be 460 × 1 8 ft , but in the table of constituents the solar coefficients have been multiplied by ·460 so as to make the coefficients themselves give the relative order of magnitude of both lunar and solar constituents. In certain circumstances the equilibrium-form of tide may provide an approximation to the actual tide, if the "correction for continents" (H H Turner, *Proc. Roy. Soc.* 40) and the modification due to the elevated water itself producing a disturbance in the earth's gravitational field are made (W. Thomson and P G Tait, *Natural Philosophy*, Arts 815, 817; 1879–93)

Equations of Motion.—12 We shall now denote position on the surface of the earth by the co-latitude θ and east longitude ϕ (where $\theta=\frac{\pi}{2}-\lambda$) Let h denote the depth of the ocean at any point so that h is a function of θ, ϕ Also let ζ denote the elevation of the free surface at any point above its mean level, and u, v the southward and eastward components of tidal current, so that these quantities are functions of θ, ϕ as well as of time t. Then the equation of continuity may be written in the form

$$\frac{1}{a\sin\theta}\left\{\frac{\partial}{\partial\theta}(h\sin\theta u)+\frac{\partial}{\partial\phi}(hv)\right\}+\frac{\partial\zeta}{\partial t}=0 \tag{4}$$

In cartesian co-ordinates the equation of continuity takes the form

$$\frac{\partial}{\partial x}(hu)+\frac{\partial}{\partial y}(hv)+\frac{\partial\zeta}{\partial t}=0, \tag{4·1}$$

but, if the elevation is more than a small fraction of the depth of the sea, this equation must be replaced by

$$\frac{\partial}{\partial x}\{(h+\zeta)u\}+\frac{\partial}{\partial y}\{(h+\zeta)v\}+\frac{\partial\zeta}{\partial t}=0. \tag{4·2}$$

Along a *coastline* the equation

$$(\text{depth})\times(\text{current normal to coast})=0 \tag{5}$$

will be satisfied

The *acceleration* of a particle of water will consist of two parts, one due to the rate change of the current relative to the earth and the other to the earth's rotation Except in shallow water and near land the cartesian components of acceleration takes the form

$$\frac{\partial u}{\partial t}-2\omega v,\quad \frac{\partial v}{\partial t}+2\omega u.$$

Dynamical Equations.—It is the kinematical characteristic of tidal motion that vertical accelerations are relatively small, and it is a dynamical consequence of this that the pressure-

intensity at any point depends only on the depth. We therefore see that the southerly and easterly horizontal pressure-gradient at any place will be given by the formulae

$$g\rho\frac{1}{a}\frac{\partial\zeta}{\partial\theta},\ g\rho\frac{1}{a\sin\theta}\frac{\partial\zeta}{\partial\phi},$$

and this at whatever depth these gradients may be required. If we denote by $g\bar{\zeta}$ the potential V of the tide generating forces, then the southerly and easterly horizontal components of these forces will be

$$g\frac{1}{a}\frac{\partial\bar{\zeta}}{\partial\theta},\quad g\frac{1}{a\sin\theta}\frac{\partial\bar{\zeta}}{\partial\phi}$$

per unit mass. The southerly and easterly components of total force per unit mass of water are therefore

$$\frac{g}{a}\frac{\partial}{\partial\theta}(\zeta-\bar{\zeta}),\ \frac{g}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta-\bar{\zeta}),$$

and the dynamical equations may be written

$$\left.\begin{aligned}\frac{\partial u}{\partial t}-2\Omega\cos\theta v&=-\frac{g}{a}\frac{\partial}{\partial\theta}(\zeta-\bar{\zeta})\\ \frac{\partial v}{\partial t}+2\Omega+\cos\theta u&=-\frac{g}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta-\bar{\zeta})\end{aligned}\right\}\quad(6)$$

In cartesian co-ordinates the equations take the form

$$\left.\begin{aligned}\frac{\partial u}{\partial t}-2\omega v&=-g\frac{\partial}{\partial x}(\zeta-\bar{\zeta})\\ \frac{\partial v}{\partial t}+2\omega u&=-g\frac{\partial}{\partial y}(\zeta-\bar{\zeta})\end{aligned}\right\}\quad(6{\cdot}1)$$

The form of these equations shows that for the oscillatory motion of the tides the current-components u, v will be the same at all depths

In this argument a number of factors have been left out of account These include the frictional forces at the sea-floor, which itself may be subject to a small variable elevation due to earth-tides.

HARMONIC CONSTITUENTS OF OCEAN TIDES

13 Suppose now that

$$\bar{\zeta}=H_0\cos n(t-\tau_0)$$

as in a single harmonic constituent, H_0, τ_0 being functions of θ, ϕ but not of t Then the solution of the equations (4) (5) and (6) will be of the form

$$\zeta=H\cos n(t-\tau_0),$$

$$u=U\cos n(t-\tau_1),\quad v=V\cos n(t-\tau_2),$$

where H, U, V, τ_1, τ_2, τ_3 are all functions of θ, ϕ, but are independent of t These expressions represent a harmonic constituent of the tides themselves, as distinct from one of the equilibrium-form. At any place the elevation and current-components will vary harmonically with the same speed as the equilibrium-form, though the functions H and τ will in general be quite different from H_0 and τ_0, so that the actual tidal elevation will be quite different from the equilibrium-elevation. Any number of independent solutions of the equations (4), (5) and (6) may be superposed by simple addition, and it follows that for any constituent in the equilibrium-form there will be a constituent of equal speed in the actual tides These constituents are known by the symbols and names already given for the equilibrium-form, and they may be disentangled from the observations of elevations and currents taken at any one place. The dynamical theory here sketched forms the basis of the ***harmonic analysis*** of tidal observations, a process which has been carried out for the elevations at over a thousand stations scattered round the coasts of all the oceans and seas, and for the elevations and currents at a few stations away from the shore in certain shallow seas.

For most places the constituent of largest amplitude is the principal lunar semi-diurnal constituent M_2, as would be expected from the equilibrium-form. When this is the case we may regard the M_2-elevation as the average tidal elevation at the place in question and the other constituents as producing inequalities. Where S_2 is the predominating constituent the average interval between successive high waters will be 12 hours. When M_2 is the largest constituent and S_2 comes next, as in British waters, we have the phenomenon of *spring* tides and *neap* tides. Spring tides occur when the phases of M_2 and S_2 are the same, so that S_2 reinforces M_2; and neap tides occur when these phases differ by 180°, so that S_2 counterbalances M_2 as far as it can. The phase of S_2 gains on that of M_2 at the rate of $2(\sigma\text{-}\eta)$, so that the interval between successive spring tides is half a *synodic month* While S_2 reinforces M_2 the period of the resultant tide is less than the average and we have the phenomenon known as *priming*, whereas while S_2 partly counterbalances M_2 the period of the resultant tide is longer than the average and we have the phenomenon known as *lagging* In the equilibrium-form it is easily seen that spring tides occur at new and full moon and neap tides at the quarters, but in the actual tides these phenomena usually occur a day or two later

When M_2 is the largest constituent and N_2 comes next, as in certain Canadian waters, we have a phenomenon similar to springs and neaps except that it depends on the distance of the moon from the earth Since the phase of M_2 gains on that of N_2 at the rate $\sigma\text{-}\omega$, the period from one reinforcement to the next is an *anomalistic month.* In the equilibrium-form the reinforcement occurs at the time of lunar perigee, but this is not usually the case in the actual tides When M_2 is the largest constituent and K_2 comes next we have a similar phenomenon depending on the declination of the moon The presence of the diurnal constituents gives rise to the diurnal inequality, and when the combined diurnal constituents exceed the combined semi-diurnal constituents we may have only one high water in the day

Geographical Distribution of M_2 Constituent.—14 We shall now indicate the distribution of the principal lunar semi-diurnal constituent M_2 as it has been revealed by harmonic analysis. Along the coasts of the Atlantic, there is a steady progression past the places from South Africa to Nova Scotia, this is rapid in the Gulf of Guinea, slower round Cape Verde and again rapid from Ireland to Iceland Over much of the eastern coast of the United States the M_2 constituent is almost simultaneous, and then along the coast of South America the progression is again northwards. The amplitude is greatest on the coasts of Europe and least in the West Indies. Considering next certain associated seas, on both sides of the English channel and south Irish sea, there is a progression away from the Atlantic, with amplitudes which reach values greater than at places on the open Atlantic. Round the North sea there is a progression southwards along the coasts of Scotland and England, and northwards along the Continental coasts, the amplitude being very small at the south-west corner of Norway. Up the St Lawrence there is a progression away from the Atlantic

Considering next the Indian ocean we exclude the Bay of Bengal and the Arabian sea There is then a progression from Madagascar round by Somaliland, Ceylon, Sumatra and Java to Australia, the amplitudes being small

Along the east coast of the Pacific there is a progression both northwards and southwards away from Lower California, the southerly progression being very rapid round the Central American bay. Following the northerly progression round the northern and western boundaries of the ocean, we come across a number of stretches along each of which the constituent is nearly simultaneous. One is along the Kurile islands and another from the south of Japan to the north-west of New Guinea; another is from the south-east of New Guinea to the north of New Zealand. Along the east coast of Japan there is a relatively slow southerly progression, and along the east coast of New Zealand there is a relatively slow northerly progression. Over the southern ocean the amplitudes are small.

Distribution of Elevation Away from Shore.—15. A convenient method of describing the distribution of the elevation

in a harmonic constituent over an area of the sea is to give on a map the *co-tidal* and *co-range* lines. A *co-tidal* line is one through all points of the sea with the same value of τ, and a co-range line is one through all points with the same value of H. The records from accurate observations of elevations away from the shore, however, are so scanty that they do not form a sufficient basis for a description of the distribution of a harmonic constituent. To give such a description we must have recourse to theory, and when the currents have been well observed this theory is supplied by the fundamental dynamical equations These equations connect the elevation-gradients with the currents and the external forces including those of friction From a knowledge of the currents and a law for the frictional forces the elevation-gradients can be calculated When the elevation is also known at a particular point the directions of the co-tidal and co-range lines and also the distance apart of neighbouring members of these lines can be calculated. Such conditions are fulfilled for many coasts. If the elevation-gradients can be calculated along a line which passes through one or more points at which the elevation is known, methods can be devised by which the elevation can be calculated all along the line. In this way the distribution over the North sea and northern part of the Irish sea as shown in fig 2 have been determined

Tides in small seas open to the ocean are usually such that the actual elevation-gradients are large compared with those of the equilibrium-form, for the equilibrium-range of M_2 only changes by 1·6 ft from the equator to the poles. It follows that over such seas the direct effect of the generating forces is negligible, and this means that the tides of these seas are maintained by those of the oceans It is on the water of the great oceans that the gravitational forces of the moon and sun generate the greater part of the tides To simplify the argument we shall neglect frictional forces; although often important near land, these forces are not as a rule predominant

In the first place we note that the co-tidal line through a point gives the surface contour-line a quarter period (3 lunar hours for M_2) before high water at the point, for at this time the water is at its mean level and the surface contour line runs through points at simultaneous mean level and therefore of simultaneous high water Next we observe that the co-range lines are given by the surface contour lines at high water The dynamical equations then express that the direction of the acceleration is the same as that of the downward surface gradient, and this is perpendicular to the surface contour-line Now at the times of maximum and minimum current the acceleration will be perpendicular to the current. We therefore see that at these times the surface contour-lines will have the direction of the current. If high water occurs at maximum or at minimum current it follows that the co-tidal lines will have the direction of the current at the time of mean level, and that the co-range lines will have the direction of the current at high and low water. If also the maximum or minimum current is parallel to a coastline, one of the two sets of co-tidal and co-range lines will have the coastline for a member while the other will have its members striking the coastline at right angles Now those lines which are perpendicular to the coastline will converge towards a cape and diverge in a bay. An example is afforded by the northern part of the Irish sea Here the minimum currents are practically zero and high water occurs at slack water, so that the co-tidal lines are along the current lines and the co-range lines are perpendicular to the current lines

In a region where the current is non-rotatory, and the co-tidal lines radiate from a point and the co-range lines are similar and similarly situated ellipses with this point as centre, such a point is called an *amphidromic point*. Fig 2 provides two examples in the North sea

Friction.—The frictional resistance of the sea-floor will be directly opposite to the current, and its M_2 constituent will have a magnitude approximately proportional to the square of the magnitude of the M_2 current. When the current at any place reaches a maximum so that the acceleration in its direction is zero, the frictional forces must be balanced by a surface gradient sloping downwards in the direction of the current. For a given current, the magnitude of the slope will be inversely proportional to the depth of the sea. Suppose that the conditions are such that in the absence of friction the maximum current and zero elevation would be simultaneous, as occurs in the broadest part of the Irish sea. Then owing to friction there will be at the time of maximum current a downward gradient in the direction of the current. It follows that mean level will occur progressively later in the direction of the current, and therefore that there will be a progression of high water in this direction

Next suppose that the depth increases away from the shore and that the currents are parallel to the shore. Also suppose that the surface-gradients parallel to the shore are zero at the same time T along a line perpendicular to the shore, as occurs in the North sea between the Forth and the Humber Then in the absence of friction the currents would reach their maximum at the time T, but owing to friction they must have a backward acceleration at this time, and this acceleration will increase towards the shore. It follows that the currents will reach their maximum somewhat before the time T and that the effect will increase towards the shore We thus see that the inshore currents will turn earlier than those in the offing.

Dynamical Explanation of Actual Tides. 16 *The Narrow Sea Theory.*—Let us now consider a sea or ocean and imagine definite limiting vertical sections transverse to the channels which connect it with other seas or oceans Then the tides of this body of water are determined by the equations formulated in § 12 when either the elevations or the normal currents are known functions of time over the limiting sections In explaining the tides in any particular basin it is therefore necessary to assume, either from observation or from other theory, the tidal conditions over the limiting sections. The problem of determination is a purely mathematical one, but hitherto it has only been solved for those seas which are of elongated shape and fairly narrow, with the size and shape of transverse section varying gradually along the length The simplifying principle concerning the tides of such basins is that the transverse components of current are usually negligible, so that the actual currents are non-rotatory and parallel to the general direction of the basin

We will now illustrate this "narrow sea theory" by giving a general explanation of the M_2 constituent in the English channel. The direct action of the generating forces may be neglected, so that the tides of the channel are maintained by those of the Atlantic and North sea We shall leave out of account both the dynamical effects of the earth's rotation and the forces of friction Imagine a fixed material barrier *e* placed directly across the Strait of Dover so as to cut off the currents in that Strait Under these conditions the tides of the channel would consist of a longitudinal standing oscillation (a see-saw motion) maintained by the actual elevations at the Atlantic end and illustrated in fig 2, 8 hr and 11 hr. There would be a nodal line *m* from the neighbourhood of Bournemouth to that of Cherbourg along which there was never any tidal elevation Along a line *w* from Cornwall to Brittany there would be no currents, and we shall take the vertical section through this line to form the western limit of the channel The positions of the lines *m* and *w* are determined by the distribution of depth in relation to the period.

At 8 o'clock in lunar time the surface of the water would be everywhere level, with currents everywhere towards the east, these currents being zero at *e* and *w*, and reaching a maximum at *m*. Three lunar hours later, *i.e*, at 11 o'clock, there would be high water everywhere between *m* and *e* and low water everywhere between *m* and *w*. At 2 o'clock the conditions of 8 o'clock would be reversed, while at 5 o'clock the conditions of 11 o'clock would be reversed The range of tide would increase steadily from zero at *m* to maxima at *e* and *w*, that at *e* being greater than that at *w* on account of the convergence of the channel

Next let us treat the case in which there is no elevation along *w*, so that this line becomes a node With the barrier at *e* there would then be no tides at all, but now let us remove this barrier so that the tides will be entirely maintained by the actual currents in the Straits of Dover. Again they will consist of a longitudinal standing oscillation, but as illustrated in fig 2. 6 hr and

9 hr (two connected half see-saws). At 6 o'clock the surface will be level and the currents will be directed inwards towards *m* from both sides, being strongest in the Strait of Dover. Three lunar hours later, *i e*, at 9 o'clock, there would be high water all over the channel between *e* and *w*, the elevation reaching a maximum near *m* and being zero at *w* and near *e*. At 12 o'clock the conditions of 6 o'clock would be reversed, while at 3 o'clock

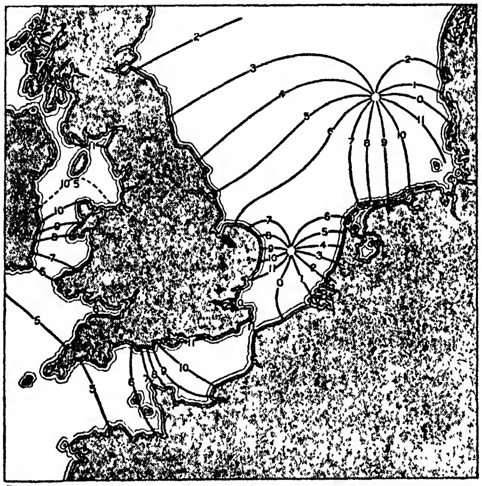


FIG 2.—COTIDAL LINES FOR M_2 CONSTITUENT IN BRITISH SEAS NUMBERS GIVE GREENWICH MEAN LUNAR TIME OF HIGH WATER

the conditions of 9 o'clock would be reversed This time the line *m* would be near a loop and *e* near a node. Now suppose that we superpose these two standing oscillations; we shall have the M_2 constituent of the channel-tides as it would be in the absence of the dynamical effects of the earth's rotation and the force of friction.

The effect of the earth's rotation is to cause an acceleration to the left of the current and proportional to the speed of the current, and when the current does not rotate this means that there must be a downward surface gradient to the left of the current and proportional to the speed of the current On allowing for this effect we arrive at the six diagrams of fig 3, the letter H indicating that the water is above mean level and the letter L that the water is below mean level. The lines drawn across the diagrams of fig 3 separate the regions of H from those of L, and are thus the contour lines at mean level Three lunar hours after the times indicated on each diagram these lines will be lines of either high or low water and therefore co-tidal lines On collecting these lines on to one diagram we have an arrangement of co-tidal lines approximating to those, shown in fig 2 for the English channel and southern Irish sea, which have been constructed from the mathematical form of the "narrow sea theory."

Seiches in Lakes.—This theory of the tides in narrow seas also embraces that of longitudinal seiches in elongated lakes (§ 17). There are many possible values for the periods of seiches, and there is a mathematical process for these values (J. Proudman, *Proc. London Math Soc* 14) which has been applied to the basin of Lake Geneva (A. T. Doodson, R. M. Carey and R Baldwin, *Trans. Roy. Soc. Edinburgh*, 1919), but it is of a complicated nature. Various types of approximation processes have been applied to a large number of lakes, notably to Loch Earn (G. Chrystal and E M. Wedderburn, *Trans Roy Soc Edinburgh*, 1905).

GEOMETRICALLY SIMPLE BASINS

17. In order to elucidate the general characteristics of tides, it is advisable to study the problems presented by the solution of their determining equations when the various conditions which govern them are ideally simple.

Narrow Channel.—We will begin by considering a channel of rectangular section, and neglect both the dynamical effects of the earth's rotation and the force of friction It can be shown mathematically that in these circumstances we reproduce very nearly the longitudinal equations of the narrow sea theory Various simple basins are regarded as particular cases of a channel, in order that the tides therein may be calculated from the narrow seas theory.

In the case of a *gulf* the basin is closed at one end and open to the sea at the other Three distinct types are illustrated in the following examples (a) In a short deep gulf the elevation will everywhere have the same phase as at the open end, and the inward current will have a phase which is $\pi/2$ in advance; also the amplitude of the elevation will increase from the sea to the closed end while the amplitude of the current will decrease from the sea to the end (b) In the Adriatic sea the elevation will have the same phase from the sea up to a certain line, called the *nodal line*, and then the directly opposite phase up to the end The phase of the current will be everywhere $\pi/2$ in advance of that of the elevation at the closed end The amplitude of the currents will increase steadily from the sea to a maximum at the nodal line, and then decrease steadily to zero at the end These relations illustrate to some extent the semi-diurnal constituents of the tides of the Adriatic sea (c) In the bay of Fundy we have the phenomenon of *resonance* which is responsible for the very large tides The case of resonance corresponds to the coincidence of the nodal line with the place at which a definite amplitude of elevation is prescribed

To illustrate *seiches in lakes* we suppose that the basin is closed at both ends. The various types of seiches are distinguished by the number of nodes characteristic of each. In *uni-nodal* seiches the node is in the middle of the basin, and the amplitude of the elevation reaches maxima at the two ends In the *bi-nodal*

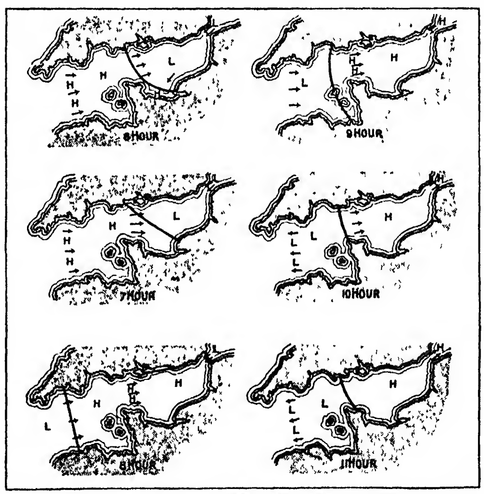


FIG 3.—M_2 CONSTITUENT OF TIDES OF ENGLISH CHANNEL. (H) INDICATES THAT SURFACE IS ABOVE MEAN LEVEL. (L) THAT SURFACE IS BELOW MEAN LEVEL. LINES SHOW SURFACE AT MEAN LEVEL. ARROWS SHOW CURRENTS

seiche the motion in each half of the lake is the same as that of a uni-nodal seiche in the whole lake, while in the *tri-nodal* seiche the motion in each third of the lake is the same as that of a uni-nodal seiche.

The distribution of tides over a gulf, maintained by those in the communicating sea, is similar to the distribution of seiches over part of a lake. The profile of the elevation for a particular time is a wave-form of decreasing amplitude, the greatest height

being at the closed end. The effect of decreasing depth towards the head of a gulf is to produce an increase in the range of tide at the head; the effect of decreasing breadth is of the same kind and more pronounced; but even when taken together the resulting multiplication is by a very moderate factor. The primary cause of the pronounced amplification observed in some gulfs and estuaries is resonance.

In the case of a basin of parabolic longitudinal section, the formula represents the slowest free oscillation, and the vanishing depth at either end of the basin causes no excessive multiplication of range.

Tides in a Lake.—Let us now consider the production of tides in a rectangular lake of uniform depth by the direct action of the generating forces of the moon or sun. There is a nodal line across the middle of the lake, and the distribution of elevation is skew-symmetrical on either side; also the currents reach their maximum on the nodal line. When resonance occurs the period of the disturbing forces is equal to that of a free oscillation or seiche, but such a relation would not hold for the ordinary tides in any actual lake. For certain lakes the equilibrium-form would provide a good approximation to the forced tides.

Long Canals.—18. We next consider a canal of uniform breadth lying *along a meridian* from pole to pole. We shall take the depth to be uniform and suppose the breadth to be sufficiently small for the transverse current off to be negligible. For a semi-diurnal constituent the phase of the elevation is everywhere the same or directly opposite to that of the corrected equilibrium-form; also that the elevation is symmetrical about the equator and that there is a node in latitude 45° N. or S. The maximum current is greatest under the nodes, and takes zero values at the poles and equator. The distribution on each side of the equator is similar to that of a uni-nodal seiche in a lake of uniform section.

Considering next a canal of uniform breadth encircling the earth *along the parallel of latitude,* take the depth to be uniform and again neglect the transverse component of current. For a semi-diurnal constituent the motion consists of a wave travelling round the earth with the same speed as the equilibrium-form, and in fact the phase of the elevation is everywhere either the same as or else directly opposite to that of the equilibrium-form At any place the west-going current reaches its maximum at the time of high water.

Small Seas.—19. Returning to seas over which we may neglect the curvature of the earth, let us take a *broad channel* whose section is uniform along its length, but whose depth may vary from side to side. A wave progressing along the channel with a zero transverse component of current can only exist if the depth be uniform. Such a wave we shall call a "Kelvin-wave" The narrow sea theory is never accurate when the depth is not uniform, but for such a channel it is possible to find an accurate solution representing a wave with straight transverse co-tidal lines Waves with straight transverse co-tidal lines are possible in spite of the variable depth. In them the principal axes of the current ellipses are parallel and perpendicular to the sides of the channel, and the time of the maximum longitudinal component of current coincides with that of high water at the same place. The solution gives the correction to the narrow sea theory for varying depth across the channel; in most actual cases this correction is not very important.

From a mathematical point of view the basin just considered is analogous to a *circular basin* in which the depth is either uniform or a function only of the distance from the centre. We have a wave progressing round the centre of the sea in either direction, or a standing oscillation. The principal axes of the current ellipses will be long and perpendicular to the radii. There is a definite infinite sequence of possible periods, with a longest period but with no shortest period (H. Lamb, *Hydrodynamics,* Art. 210, 1895). The corresponding oscillations are known as "free oscillations of the first class," and so long as the depth is uniform no other free oscillations are possible. When the depth is not uniform there may be in addition to an infinite sequence of oscillations of the first class, analogous to those just investigated, another infinite sequence called "oscillations of the second class." These have a definite shortest period but no longest period (*Ibid.* Art. 212).

Ideal Ocean.—The mathematical relationships of small seas still obtain for an ocean in which the depth is a function only of latitude and the coastlines, if any, lie along parallels of latitude. A special case has already been considered in the canal running round a parallel of latitude. For forced semi-diurnal constituents the motion consists of a wave travelling round the earth like the equilibrium-form. In fact, at any place the phase of the elevation is always either the same or else directly opposite to that of the equilibrium-form. The distribution of range of tide along a meridian, however, will in general be entirely different from that of the equilibrium-form. When the ocean covers the whole earth it is possible to allow for the mutual gravitation of the elevated water without seriously complicating the mathematical problem (S. S. Hough *Phil. Trans* A, 1897). At the poles the range of tide is zero as in the equilibrium-form, and sufficiently near the poles the elevation has the same phase as the equilibrium-form. For very great depths the tides everywhere approach the equilibrium-form.

When the depth is uniform and the ocean covers the whole earth the solution has been subject to much numerical evaluation. The first row in the accompanying table gives a series of depths in feet, and the figures below correspond respectively to oceans of

7,260	14,520	29,040	58,080
7·4	1·8	11·3	1·9
2·4	1·8	11·1	1·9
17 59	14 52	12 1	9 24
38 34	26 54	18 40	12 55

these depths. The second row gives the ratio of the range of the M_2 constituent on the equator to the corresponding range in the equilibrium-form when the mutual gravitation of the elevated water is neglected (H. Lamb, *Hydrodynamics,* Art. 221). The third row gives the same ratio when the mutual gravitation of the elevated water is allowed for. The fourth and fifth rows relate to free oscillations of the first class in the expressions (*cf* § 11) for which t and ϕ enter only through the factor cos $(nt+2\phi-\epsilon)$ and in the calculation of which the mutual gravitation of the elevated water has been taken into account. The fourth row gives in hours and minutes the longest periods of free waves travelling westward; while the fifth row gives in hours and minutes the longest periods of free waves travelling eastward. The shortest periods of the oscillations of the second class are all longer than a day Numerical evaluations of forced tides in a polar or zonal ocean indicate that the actual tides cannot be regarded as derived from tides generated primarily in the southern ocean (G R. Goldsbrough, *Proc. Lond. Math. Soc.* 1913, and *Proc. Roy. Soc* A, 1927).

Other Seas.—20. The above examples exhaust all the instances in which complete solutions of the dynamical equations may be obtained in a simple form when the effects of the earth's rotation are taken into account For seiches, however, of which the periods are small compared with a day, the effects of the earth's rotation are not important, and when these effects are neglected simple solutions are possible for certain other basins. The non-rotating *rectangular basin* of uniform depth, the *sectarial basin* whose depth is a function only of the distance from the apex, and in the case of free tides, an ocean bounded by meridians and parallels of latitude on a non-rotating earth when the depth is a function only of latitude (H. Lamb *Hydrodynamics,* Art 201) are all analogous. The solution for the forced tides in such an ocean has only been given in certain special cases (J. Proudman and A T. Doodson, *Mon. Not R A S, Geophys. Supp.* 1927). The *elliptic basin* of uniform depth possesses types of free motion which are analogous to those of the *circular basin* (H. Jeffreys, *Proc. Lond. Math. Soc.* 1923), the Bessel's functions and trigonometrical functions of the circular basin being replaced by Mathieu-functions.

Rotating Basins.—When the earth's rotation is taken into account the simplest problem not already mentioned is that of the reflection of a Kelvin-wave at the head of a *broad rectangular gulf* of uniform depth. For a given depth and period such a wave

can be reflected into one of the same type travelling in the opposite direction, if the breadth of the gulf is not greater than a certain amount The complete solution (G. J. Taylor, *Proc. Lond. Math. Soc.* 1920) then shows a wave progressing towards the head of the gulf on the one side, continuing round the head, and then away from the head on the other side There are a number of amphidromic points on medial line of the gulf. In the northern hemisphere the progression is such that the coast is always on the right. This arrangement may be compared with the co-tidal lines shown in fig 2 for the North sea The solution gives the correction to the narrow sea theory for a transverse barrier; at a distance from the barrier the correction becomes unimportant.

The solution for the rotating sectorial basin has only yet been given for the semi-circular case and for uniform depth (J. Proudman, *Mon. Not R.A.S. Geophys Supp.* 1926–28), while that for the rotating elliptic basin has only been published for special conditions (S. Goldstein, *Mon. Not., R A S, Geophys. Supp.* 1928). It can be proved, however, that for land-locked seas of small lateral extent, which are not too shallow, the forced tides follow very closely their equilibrium-forms. In these forms the centroid of the area is an amphidromic point

The only ocean on a rotating earth possessing coast lines other than parallels of latitude for which the dynamical equations have yet been solved is one whose depth is proportional to the square of the cosine of the latitude, and which is bounded by two meridians separated by 60° of longitude (G R Goldstein, *Proc. Roy Soc.* A, 1927) This basin has a much closer correspondence with those in which the actual tides are generated than any other for which a numerical solution has yet been given For the K_2 constituent in this basin it is found that the critical mean depth for resonance is 15,500 ft As the mean depth of the Atlantic is 12,700 ft., we have an indication of a considerable amount of resonance, and there can be little doubt that the Atlantic tides are largely generated in the Atlantic ocean itself

GENERAL DYNAMICAL QUESTIONS

21 The observed tides on many coasts of the world are very much larger than their equilibrium-forms, and this has usually been attributed to the magnifying effect of shallow seas Mere diminution of depth, however, even to vanishing point, is not in itself a necessary source of much magnification, so that some form of resonance is required. On the one hand, with mid-ocean tides of the equilibrium-order of magnitude, it is possible to have resonance on the continental shelf if its breadth and depth are suitably related. On the other hand, it is also possible to have a considerable degree of resonance in the main oceans themselves, as is shown by the last of the examples quoted above (§ 20).

All the examples of forced tides quoted above are such as to tend to their equilibrium-forms when their periods tend to become infinite This tendency is due to the special simplicity of the examples considered, and is not a general property of forced tides when the effects of the earth's rotation are taken into account but those of friction are neglected Steady currents are possible if there are any closed contour lines of the depth of the ocean measured parallel to the earth's axis, and the actual oceans do contain such contour lines. The problem of specifying the nature of the solution of the dynamical equations for the case of forced long-period tides is further complicated by the possibility of resonance with the free oscillations of the second class The effects of friction are sufficient to make any forced periodic tide conform to its equilibrium-form if its period is sufficiently long, but a criterion of this length has not yet been satisfactorily evolved. If tidal motion were everywhere non-turbulent, friction would have no appreciable influence on a constituent whose period was less than a year It is known, however, that the resultant motion in shallow seas is turbulent, and it is probable that even in mid-ocean the forces of friction are not less than those calculated on the hypothesis of turbulence.

The total rate of *dissipation* of energy by friction in the actual semi-diurnal tides has been estimated (H Jeffreys, *Phil. Trans.* A, 1920) at about 2×10^9 horse-power The chief contributory areas were found to be Bering sea, the Yellow sea, Malacca strait and the North-west passage, the dissipation in the great ocean basins being supposed negligible in comparison. The problem of estimating the length of time required to destroy the total energy in any constituent, at the rate at which energy is actually being dissipated in that constituent, turns largely on the amount of magnification of tides in shallow seas If, in mid-ocean, the semi-diurnal constituents were of their equilibrium-order of magnitude, then the time required would be only about two days (H Jeffreys, *Nature* 1923)

Compound Constituents.—22 So far in our discussion of tidal dynamics we have neglected certain terms in the dynamical equations The effect of this has been to make the differential equations linear, and it is the linearity of the equations which allows of the separation into independent harmonic constituents. Such a neglect, however, is not always admissible, especially in shallow water and near rugged coast lines. Suppose that over a region there is a predominant harmonic constituent, *e g.*, M_2 of speed n; then the effect of the retention of these terms will be that the time will enter in such a form that terms which contain the time-factor represent a constituent of double the speed of the primary constituent, while others represent a steady motion or displacement. The first of these is known as a *first overtide*, and when derived from M_2 is called M_4 Again, if the principal part of the tides comprises two harmonic constituents, then in addition to overtides we have terms which represent constituents of speeds n_1+n_2 and n_1-n_2 When the primary constituents are M_2 and S_2 they are denoted by MS_4 and MS_f respectively Since the force of friction at the sea-floor is not proportional to the speed of the current, there is also a frictional origin of compound constituents. Further approximations would give *second* and *third overtides*, etc

All the overtides travel up a canal, of uniform breadth and depth, indefinite length and communicating with the sea, at the same rate as the fundamental but they have double, treble, quadruple, etc, speeds If the canal shallows very gradually, the height of the overtide varies as (depth)[illegible]. Fig 4 read from left to right, exhibits the progressive change of shape. The steepness of the advancing crest shows that a shorter time elapses from low water to high water than inversely.

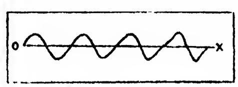


FIG 4 --PROFILE OF TIDE-WAVE IN CANAL

ATMOSPHERIC AND EARTH TIDES

Atmospheric Tides.—23. As air, like all other matter, is subject to gravitational influence, there will be tides in the atmosphere possessing many features of similarity with those in the ocean. One of the characteristics of these tides will be a very small oscillatory variation in the atmospheric pressure at any place, and this may be regarded as the superposition of harmonic constituents with the ordinary tidal periods. By the systematic analysis of long series of regular barometric records the principal lunar semi-diurnal constituent M_2 of the barometric variation has been determined for a number of places, and found to have an amplitude of the order ·001 inch. The dynamical theory of these tides has been the subject of considerable study. The derivation of the equations is not so simple as for ocean tides, one difficulty being that of taking account of the physical conditions in the upper regions. The equations which have been proposed are of the same general form as those for ocean tides, but the theory is still imperfect.

The results of analysis for the M_2 constituent show variations of phase from place to place and certain seasonal changes which are as yet unexplained. The results of analysis for the S_2 constituent show a much larger oscillation with an amplitude of barometric variation of the order ·03 inch. For this constituent, however, it is certain that thermal factors play a large part though the theory is far from complete (S. Chapman, *Quart. Journ. R Met. Soc.*, 1918–19–24).

Earth-tides.—24. The main body of the earth yields to tidal

forces, either with perfect or imperfect elasticity, and these minute tides of the solid earth have been measured. The measurement of earth-tides consists in determining the tilt of the earth's surface about its mean position in the earth's figure, and this has been carried out with apparatus of two kinds. One instrument, viz., the horizontal pendulum (O. Hecker, *Veroff K. Preussischen Geod. Inst.* 1907), is of a type also used in seismology. Its action is analogous to that of a door whose hinges are not exactly one above the other, so that it lies in a definite vertical plane depending on the position of its line of hinges. The other instrument consists of a horizontal tube, of length from 100 to 500 ft., acting as a water level and read by optical interferometer devices (A. A. Michelson, *Astrophys. Journ* 1914) It should also be possible to detect earth-tides by means of observations of ordinary water-tides, but in the absence of full observational knowledge of water-tides over a region we must have recourse to a certain amount of theory

Up to the present the method which has been adopted has utilized the ocean-tides of long period and in particular the lunar fortnightly constituent M_f. It has been assumed that this constituent follows the equilibrium law, and this is not certain, while in addition there is the fact that the complete equilibrium-form has not yet been numerically calculated There is a further serious difficulty in isolating the purely astronomical long-period constituents in analysis, and it may well be doubted whether reliable constants for the M_f constituent have ever yet been obtained from the records of observation

When we come to consider the dynamical theory of earth-tides we see that there are various factors involved. There is the direct response of the solid earth to the tide-generating forces of the moon and sun; there is the yielding produced by the varying pressure of the tidal load on the ocean-floor; there is also the yielding to the earth's varying gravitational field itself, as produced by the moving water and solid earth (A. E. H. Love, *Some Problems of Geodynamics*, 1911). These factors have not yet been completely disentangled from the results of observation. The period of the slowest free tidal oscillation of a homogeneous sphere, of the same radius and mass as the earth and as rigid as steel, is about one hour (H. Lamb, *Proc. Lond. Math Soc.* 1882). The corresponding period for a homogeneous fluid sphere, of the same size and mass, is about one and a half hours (W Thomson, *Phil. Trans.* 1863). It is, therefore, probably correct to assume that the periods of the free oscillations of the actual earth are all small compared with those of the chief constituents of the tides. This means that the earth tides will approximate closely to their equilibrium-forms, or, in other words, that they may be calculated on the principles of statics.

For an earth of uniform density and elasticity and with an ocean of uniform depth over the whole of it, a complete solution of the tidal problem, both ocean and earth, has been obtained (R O. Street, *Mon. Not R A S*, *Geophys. Suppl.* 1925). For the simpler case in which there is no ocean, if the mass be that of the actual earth and the assumed rigidity be that of steel, the earth-tide would be everywhere equal to $\frac{1}{3}$ of the equilibrium ocean-tide, while if the rigidity be that of glass the fraction would be $\frac{2}{5}$. Such determinations as have yet been made indicate that the effective rigidity of the earth as a whole is somewhat greater than that of steel (W. D. Lambert, *Bull. U.S. Nat. Research Council*, 1922).

ANALYSIS OF OBSERVATIONS AND PREDICTION

25. The tide-gauge furnishes us with a continuous graphical record of the level of the water above some known datum mark for every instant of time. The first operation performed on this record is the measurement of the height of water above the datum for every mean solar hour. In analysis it is necessary that these hourly heights be combined in such a way as to magnify one constituent relatively to all others, and in practice only linear combinations are used. The complete process of finding all the important constituents may be carried out in two stages, in the first of which simple linear combinations are made, and in the second, essentially a correction process, the results of all the linear combinations for all the constituents are used.

Process of Finding Constituents.—We will restrict our consideration to the problem of determining the principal solar series of constituents S_1, S_2, S_4, whose speeds are exactly 24, 12, 6, mean solar hours. At instants of time separated by 24 hours each constituent of this series will have the same value. If then we calculate the average of the heights at the same hour of each solar day, the corresponding value of each of these constituents will be unchanged. Any other constituent, however, will occur in a different phase each day, so that the algebraic additions will partially counterbalance, and if the number of days taken extend over a year the average value for a particular hour of a solar day will be very small. If such an averaging process be carried out for each of the 24 hours of the day we have a method of isolating the principal solar series. When this series has been isolated with sufficient completeness, the amplitudes and initial phases of its constituents may be determined in a number of ways (*see* HARMONIC ANALYSIS)

The process just sketched has been much followed in actual practice, especially in the early days of harmonic analysis of tidal observations. When applied to constituents other than those of the principal solar series it becomes less simple, as it is impossible to choose an interval of an exact number of mean solar hours which gives perfect repetition in the values of any other constituent. A common practice has been to treat the height at any mean solar hour as though it occurred at another time not differing by more than half an hour It is clear, however, that the effect on any constituent of any definite arithmetical process may be accurately determined, and this had led to important modifications in the processes of analysis In designing these modifications the criteria in mind have been: (1) the amount of labour involved, (2) the degree of elimination of all other constituents in the analysis for a particular constituent and (3) the completeness of the analysis (A. T. Doodson, *Phil. Trans.* A, 1927). Similar methods will serve for the analysis of a continuous record of a particular component of tidal current. Methods have also been devised for the harmonic analysis of observations of times and heights of high and low water only (G H. Darwin, *Proc Roy. Soc.* 1890), and even for the observations of times of slack water only

Even when the most complete methods are utilized on the most carefully made observations, there remains quite an appreciable fraction of the apparently periodic variation of sea-level which has not yet been reduced to law. For British waters this reaches the order of magnitude of a foot, and consists of something lying outside the harmonic constituents with the periods of the generating potential or of a small number of compound constituents (A. T Doodson, *Brit. Ass. Report*, 1921) The nature of this residue has not yet been satisfactorily determined; although of tide-like periodicity, part of it is possibly of meteorological origin The variations of atmospheric pressure and wind produce changes in the level of the sea Under favourable conditions, and as a consequence of storms, the change of level in an estuary may exceed 6 ft Since such changes are not periodic they are not represented by the results of harmonic analysis

Prediction.—26 For many purposes it is of great importance to know in advance the times and heights of high water at a particular place on a particular day. Consequently governments and harbour authorities publish, a year or so in advance, *tide tables* giving such information for all the principal ports of the world In a few cases tables are similarly published giving the height of water above datum at every hour of the year, while for a certain number of navigable channels tables of the times of slack water are also issued. The determination of the information contained in these tables is known as tidal prediction, and obviously demands a knowledge of the laws of the tides at the place in question, including their correlation with astronomical variables

The standard method of tidal prediction is the harmonic method based on the idea of harmonic constituents (§ 13), and the necessary information for any particular place is provided by the process of harmonic analysis. For a number of ports, however, some of which are in British waters, it is found practicable to use the older non-harmonic methods based on the non-harmonic con-

stants. In any case, the only part of the dynamical theory which is utilized is that which relates to periodicity at one place, so that the empirical element is still very large.

Predicting Machine.—The process of ***harmonic prediction*** consists in the calculation of the value of each harmonic constituent for a given time and then the addition of the values obtained for all the constituents. When this is done for every hour of a year the computational task becomes enormous, and a calculating machine has been designed to obviate it. Fig. 5 illustrates diagrammatically the nature of the instrument. A cord passes over and under a succession of pulleys, every other pulley being balanced in a fixed position and the alternate ones being movable; the cord is fixed at one end and carries at the other a pen which traces a curve on a revolving drum In the diagram the instrument possesses one unit; there are two balanced pulleys and one movable one. If the lowest or movable pulley were made to oscillate up and down with simple harmonic motion, the pen would execute the same motion on twice the linear scale If the instrument possessed two units, *i e*, one additional movable and one additional balanced pulley, and the second movable pulley also rocked up and down, the pen would add to its previous motion that of this second oscillation on twice the scale. For any number of additional units the pen would add together all the separate simple oscillations The rocking motion is communicated to each movable pulley by means of a pin P, attached to a fixed point of the wheel of centre C and sliding in a slot attached to the pulley-frame. All the wheels C and the drum are geared together, so that, as the drum turns, all the movable pulleys rock up and down The gearing is of such a nature that, if one revolution of the drum represents a single day, the rocking motion of each movable pulley corresponds to one harmonic constituent. The nature of the gearing is determined by the relative speeds of the different constituents, but the length of each crank CP and the angle at which it has to be set are derived from the results of harmonic analysis. When the machine has been set appropriately it will run off a complete tide-curve for any length of time.

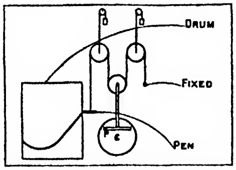


FIG 5 —TIDE-PREDICTING INSTRUMENT

Of course the irregular meteorological effects on sea level cannot be incorporated in a tide-table, and hence any individual prediction is liable to differ considerably from the actual occurrence. For the utilization of the energy of tides *see* TIDAL POWER.

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For information on actual tides *see* the *Admiralty Tide Tables*, Part II, and tables published by the U.S Coast and Geodetic Survey.

For full bibliographies *see* J. C. Honzean and A. Lancaster, *Bibliographie de l'astronomie* (1882) and a bibliography of publications from 1910–27 which is published by the International Union for Geodesy and Geophysics. (J. PR.)

TIDORE or **TIDOR,** a mountainous island of the Moluccas, D E. Indies, lying south of Ternate, nearly circular in shape, with an area of about 30 square miles. The southern part is occupied almost entirely by an inactive volcanic peak (5,900 ft.). Below the 1,000 ft. level coffee, fruit and tobacco are cultivated, the soil being very fertile. The northern half consists mostly of hills, though there are a few level strips along the coast. Pop., 31,832. Tidore is part of the residency of Ternate, and, with neighbouring islands, comes under the resident of Ternate. The inhabitants are akin to the Ternatans. They dislike work, but sell fish and cultivate garden produce. Some Tidorese do smiths' work, in which they are proficient.

The other islands of the Ternate-Tidore group are Hiri, Mayu, Taifore, Maitara, Pilonga, Maré, Pasuraja, Moti, Makian, Waidoba, Taneti and the Kayua and Goraityi groups. All stretch along by the coast of Halmaheira towards Bachian, with the exception of Taifore and Mayu, which lie out in the Molucca passage. Kayua (of coralline and crystalline rock formation), is nearly 10 m. long and has a mountain range traversing most of its length. The people are Mohammedans, and grow rice and maize, and fish. Makian has a mountain over 4,000 ft., is well-wooded, volcanic, and has suffered from eruptions. It has a population of over 8,000 Mohammedans, resembling the people of Ternate and Tidore, who weave, fish and grow tobacco, fruit, rice and sugar-cane. Sago, the staple food, is imported from Halmaheira. Moti is surrounded with coral reefs. Maitara has mountains which attain an elevation of nearly 3,000 ft., and is well forested and fertile.

Like Ternate, Tidore is the seat of an ancient and once powerful sultanate. The Portuguese established themselves there in 1521 and fought the sultan, whose capital they destroyed Later, the Spaniards, when Portugal had become incorporated with Spain, obtained a hold which they retained until well into the 17th century, aiding the Tidorese in maintaining their independence in Ceram, Halmaheira and other islands, against the sultan of Ternate and the Dutch. The latter, in 1654, conquered the island, but the nominal power of the sultan was (and still is) recognized by the Dutch Government (E. E L)

TIDY TIPS (*Layia platyglossa*), a small North American herb of the family Compositae, native to California. It is an attractive spring-blooming annual, about a foot high, bearing showy flowering heads, $1\frac{1}{2}$ in. broad, with sulphur-yellow rays tipped with white. This plant and other related Californian species, as *L elegans,* are grown as garden annuals. The white-flowered *L. glandulosa,* found from British Columbia to Mexico, is also cultivated.

TIECK, JOHANN LUDWIG (1773–1853), German poet, novelist and critic, was born in Berlin on May 31, 1773, his father being a rope-maker. He was educated at the Friedrich-Werdersche Gymnasium, and at the universities of Halle, Göttingen and Erlangen. At Göttingen Shakespeare and the Elizabethan drama were the chief subjects of his study In 1794 he returned to Berlin, resolved to make a living by his pen. He contributed a number of short stories (1795–1798) to the series of *Strauss-federn*, published by the bookseller C. F. Nicolai and originally edited by J. K. A Musäus, and wrote *Abdallah* (1796) and a novel in letters, *William Lovell* (3 vols. 1795–1796). Tieck's transition to romanticism is to be seen in the series of plays and stories published under the title *Volksmärchen von Peter Lebrecht* (3 vols., 1797), a collection which contains the admirable fairy-tale *Der blonde Eckbert*, and the witty dramatic satire on Berlin literary taste, *Der gestiefelte Kater*. With his school and college friend W. H. Wackenroder (1773–1798), he planned the novel *Franz Sternbalds Wanderungen* (vols. i.–ii. 1798), which was the first expression of the romantic enthusiasm for old German art.

In 1801 Tieck went to Dresden, then lived for a time near Frankfort-on-the-Oder, and spent many months in Italy. In 1803 he published a translation of *Minnelieder aus der schwäbischen Vorzeit,* between 1799 and 1804 an excellent version of *Don Quixote,* and in 1811 two volumes of Elizabethan dramas, *Altenglisches Theater.* The stories *Der Runenberg, Die Elfen, Der Pokal,* and the dramatic fairy tale, *Fortunat,* with earlier works, appeared in the collection *Phantasus* (3 vols., 1812–17). In 1817 Tieck visited England in order to collect materials for a work on Shakespeare (unfortunately never finished) and in 1819 he settled permanently in Dresden; from 1825 on he was literary adviser to the Court Theatre, and his semi-public readings from the dramatic poets gave him a reputation which extended far beyond the Saxon capital. The new series of short stories which he began to publish in 1822 also won him a wide popularity. Notable among these are *Die Gemälde, Die Reisenden, Die Verlobung, Des Lebens Überfluss.* More ambitious and on a wider canvas are the historical or semi-historical novels, *Dichterleben* (1826), *Der Aufruhr in den Cevennen* (1826, unfinished), *Der Tod des Dichters* (1834), *Der junge Tischlermeister* (1836; but begun in 1811), an excellent story written under the influence of Goethe's *Wilhelm Meister. Vittoria Accorombona*

(1840), in the style of the French Romanticists, shows a falling-off. In later years Tieck carried on a varied literary activity as critic (*Dramaturgische Blätter*, 2 vols., 1825–1826; *Kritische Schriften*, 2 vols., 1848); he also edited the translation of Shakespeare by A. W Schlegel, who was assisted by Tieck's daughter Dorothea (1799–1841) and by Graf Wolf Heinrich Baudissin (1789–1878); *Shakespeares Vorschule* (2 vols , 1823–1829); the works of H. von Kleist (1826) and of J. M R Lenz (1828). In 1841 Friedrich Wilhelm IV of Prussia invited him to Berlin where he enjoyed a pension for his remaining years He died on April 28, 1853.

Tieck's *Schriften* appeared in 20 vols. (1828–46); and his *Gesammelte Novellen* in 12 (1852–54) *Nachgelassene Schriften* were published in 2 vols in 1855 Of modern editions of *Ausgewahlte Werke see* those by G Klee (with an excellent biography, 3 vols, 1892), and G Witkowski (4 vols, 1903). *The Elves* and *The Goblet* were translated by Carlyle in *German Romance* (1827), *The Pictures* and *The Bethrothal* by Bishop Thirlwall (1825). *See* for Tieck's earlier life R Kopke, *Ludwig Tieck* (2 vols, 1855), for the Dresden period, H von Friesen, *Ludwig Tieck · Erinnerungen* (2 vols, 1871), also A Stern, *Ludwig Tieck in Dresden* (*Zur Literatur der Gegenwart*, 1879); B Steiner, *L Tieck und die Volksbucher* (1893); H Bischof, *Tieck als Dramaturg* (1897); H Luedeke, *L Tieck und das alte englische Theater* (Frankfurt, 1922); A. E. Lussky, *Tieck's approach to Romanticism* (Borna-Leipzig, 1925).

TIEL, a town in the province of Gelderland, Holland, on the right bank of the Waal (here crossed by a pontoon bridge), 25 m by rail west of Nijmwegen Pop (1927), 12,123 It possesses fine streets and open places, but of its fortifications the Kleiberg gate (1647) alone remains The principal buildings are St. Martin's church (15th century), the town hall, court-house and the historical castle of the family of van Arkel

TIELE, CORNELIS PETRUS (1830–1902), Dutch theologian and scholar, was born at Leiden on Dec 16, 1830 He was educated at Amsterdam high school and afterwards at the seminary of the Remonstrant Brotherhood He was destined for the pastorate in his own brotherhood Tiele certainly had liberal religious views himself, which he early enunciated from the pulpit, as Remonstrant pastor of Moordrecht (1853) and at Rotterdam (1856) Upon the removal of the seminary of the brotherhood from Amsterdam to Leiden in 1873, Tiele was appointed one of its leading professors In 1877 followed his appointment at the university of Leiden as professor of the history of religions, a chair specially created for him. Of his many learned works, the *Vergelijkende geschiedenis van de egyptische en mesopotamische Godsdiensten* (1872), and the *Geschiedenis van den Godsdienst* (1876, new ed 1891), have been translated into English, the former by James Ballingall (1878–1882), the latter by J. Estlin Carpenter (1877) under the title "Outlines of the History of Religion" (French translation, 1885; German translation, 1895) A French translation of the *Comparative History* was published in 1882 Other works by Tiele are: *De Godsdienst van Zarathustra, van het Ontstaan in Baktrie, tot den Val van het Oud-Perzische Rijk* (1864) a work now embodied, but much enlarged and improved by the latest researches of the author, in the *History of Religions* (vol. ii. part ii., Amsterdam, 1901), a part which appeared only a short time before the author's death; *De Vrucht der Assyriologie voor de vergelijkende geschiedenis der Godsdiensten* (1877; German ed , 1878); *Babylonisch-assyrische Geschichte* (two parts, Leipzig, 1886–1888); *Western Asia, according to the most Recent Discoveries* (London, 1894) He was also the writer of the article "Religions" in the 9th edition of the *Ency Brit* He died on Jan. 11, 1902

TIEN-SHAN or CELESTIAL MOUNTAINS, one of the most extensive mountain systems of Central Asia. In the widest acceptation, the system extends from the Aral-Caspian depression (about 67° E.) to the great bend of the Hwang-ho (about 103° E.). Chinese geographers confine the term to that part between Khan-tengri (80° 11′ E. and 42° 13′ N.) and the Barkul depression (92°–93° E.), where the northern ranges abut upon the Ek-tagh Altai; and this conception is accepted by some European geographers. P. P. Semenov applies the name to the ranges which lie immediately west of Khan-tengri, including Khan-tengri. The Tarbagatai and their north-western continuation, the Chinghis mountains, are sometimes considered to belong to the Altai system; but there are good reasons for regarding them as an independent range. Excluding these, the northernmost member of the Tien-shan system is the Dzungarian Ala-tau (45° N.), the southernmost, the Trans-Alai, or rather its west prolongation, Peter the Great Mountains in Karateghin (Bukhara), though some geographers assign both the Alai and the Trans-Alai Mountains to the Pamirs.

Khan-tengri and the Central Tien-shan.—The peak of Khan-tengri (22,440 ft) stands but on a spur which projects from the main watershed of the central Tien-shan, towards the south-west. The loftiest summit on the actual watershed is named Nicholas Mikailovich (22,670 ft). The general altitude of the crest of the watershed is about 16,500 ft , and it is overtopped by peaks rising 3,000–3,500 ft. higher. East of Khan-tengri is Khalyk-tau, and west three diverging lines of elevation, viz , the Terskei Ala-tau; the Kokshal-tau, continued in the Terez Mountains; and, between these two, the successive ranges of the Sary-jas, Kulu-tau, and Ak-shiryak. The snowy chain of Khalyk-tau is highest in the west and sinks gradually towards the east The highest parts of the range have generally an east-west strike and the range itself is continued east in the Kokteke (12,300 ft), with the Kui-kuleh pass at 11,500 ft

From Issyk-kul there is a sharp rise of 6,000–9,000 ft to the snow-capped ridge of the Terskei Ala-tau, the peaks of which ascend to 15,000–16,500 ft and even 18,000 ft. At this part the system has a breadth of 150 m The Terskei Ala-tau forms a sharp, continuous, snow-clad range. It is continued westwards in the Son-kul (alt. 9,500 ft), the Kara-kol, and the Suzamir-tau, until it abuts upon the Talas-tau. There are broad shallow basins south of the Terskei Ala-tau and between them from five to seven ridges as broad as the basins The ridges rise to 13,000–16,000 ft by long gentle slopes, are flat topped and snow covered with a few individual peaks and high passes. Being an uplifted peneplain and little or no erosion having taken place since late Tertiary times, the result is that although highly mountainous, in external appearance the district is that of a plateau The passes over the Terskei Ala-tau and the country to the south lie at great altitudes—Kulu-tau (13,560 ft), Bedel (13,800 ft), Kubergenty (12,400 ft.), Terekty (12,600 ft) and Jan-art (14,440 ft)—all in the Kokshal-tau, Terek (12,800 ft) and Turugurt (12,730 ft), both in the Terek range; Barskaun (12,000 ft.), Suka (11,650 ft), and Jauku (14,000 ft) in the Terskei Ala-tau; and Tez (11,800 ft.) and Akbel (12,000 ft), both in the Sary-jas, and Muz-art (12,000 ft) on the east shoulder of Khan-tengri. The snow-line on Terskei Ala-tau runs at 11,500 ft. The summits of the Kulu-tau reach 13,700 to 14,750 ft ; those of the Ak-skiryak 15,000–16,000 ft The Kokshal-tau consists of several parallel ranges, is truly alpine in character and bears large glaciers, which send out arms into U-shaped valleys, behind which the pyramidal mountain peaks tower up. The loftiest range is that to the north, which exceeds 16,000 ft., and the altitude increases generally from west to east as far as the Bedel pass in 78° 30′ E , where the road crosses from Ak-su and Uch-Turfan to the valley of the Naryn and Ferghana

Eastern and Northern Tien-shan.—The system is known here locally as the Barkul Mountains and the Karlyk-tagh Its middle parts are snow-clad, the snow lying down to 12,000 ft. on the north side, while the peaks reach altitudes of 13,000–14,700 ft., but the range is only crossed by passes in the east, at altitudes from 7,805–10,984 ft. Towards the east, the Karlyk-tagh radiates outwards, and decreases in altitude, though it rises again in the rocky Emir-tagh From the Karlyk-tagh a stony desert slopes south to the Chol-tagh. The Chol-tagh marks the northern escarpment, as the Kuruk-tagh, farther south, the southern escarpment, of the great Pe-shan swelling of the desert of Gobi. These two ranges are eastern prolongations, the former of the Khaidyk-tagh and the latter of the Kok-teke Mountains, which enclose on north and south respectively the Yulduz valley and the Lake of Bagh-rash-kul. Thus the Kuruk-tagh are linked, by the Kok-teke, on to the Khalyk-tau of the Khan-tengri group. The Khaidyk-tau, which are crossed by the passes of Tash-againym (7,610 ft) and Kotyl (9,900 ft.), are probably connected with the Trans-Ili

Ala-tau, or its twin parallel range, the Kunghei Ala-tau, in the west. The Narat-tau appear to form a diagonal link between the Khaidyk-tau and the Khalyk-tau and are crossed by passes Sary-tyur (10,800 ft.), Mukhurdai (11,800 ft.), Jambi (11,415 ft) and the Dundeh-keldeh (11,710 ft.).

West of the Barkul range is the gap of Otunkoza by which the Hami and Barkul caravan roads cross into the valley of Dzungaria, and at Urumchi (87° 30′ E), over 200 m. farther west, is a similar gap which facilitates communication between Turfan and Dzungaria Between these gaps stretches the snow-clad range of the Bogdo-ola, average altitude 13,000 ft., and rising to 17,000–18,000 ft. in the double peak of Turpanat-tagh. On the north side of this range the snow-line runs at an altitude of 9,500 ft. At the foot lies the broad, deep valley of Dzungaria (2,500–1,000 ft). On the south the Bogdo-ola is flanked by the nearly parallel range of the Jargoz, a range which carries no perpetual snow. But its altitude does not exceed 10,000 ft, and its steep rocky slopes meet in a sharp, denticulated crest West of the Urumchi gap, the Bogdo-ola is continued in the snow capped double range of the Iren-khabirga (11 500 ft.), which curve north-west and finally, as the Talki Mountains, merge into the Boro-khoro range. They culminate in the peak of Dos-megen-ora (20,000 ft) The Boro-khoro Mountains (average elevation 11,-500 ft) have all the characteristics of a border-ridge The slopes are clothed with Coniferae between 6,000 and 9,000 ft., and the range separates the valley of Kulja (Ili) on the south from the depressions of Zairam-nor (6,820 ft.) and Ebi-nor (670 ft). The passes in the Boro-khoro lie at lower altitudes than is usual in the Tien-shan ranges, namely at 7,000–7,415 ft.

On the north side of the valley of Borotala is the Dzungarian Ala-tau, the northernmost member of the Tien-shan The two principal series of parallel ranges are the northern series (going from east to west) of the Baskan-tau, Sarkan-tau, Karazryk-tau, Bionyn-tau, and Koranyn-tau, at an average elevation of 11,000–13,000 ft., and the southern series of the Urtak-saryk, Bejin-tau and Kok-su, at altitudes of 12,000–14,000 ft

Western and Southern Tien-shan.—On the north side of the Issyk-kul are the parallel twin ranges of the Trans-Ili Ala-tau and Kunghei Ala-tau. The two chains are connected by the lofty trans-verse ridge of Almaty The Trans-Ili Ala-tau swings away to the north-west, and is continued in the echeloned ranges of Kandyk-tau, Kulja-bashi, Khan-tau and the Chu-Ili Mountains of general altitudes between 4,000 ft. and 9,000 ft. These latter ranges separate the Muyunkum desert on the west from the Balkash deserts. The Trans-Ili itself culminates in Mt. Talgar at an altitude of 15,725 ft. The Kunghei Ala-tau rises 8,000 ft above the Issyk-kul and lifts its summits higher than 13,000 ft. The passes across the twin ranges lie at 8,000–11,000 ft (Almaty pass) in the Trans-Ili Ala-tau and at 9,000–10,885 ft. (Kurmenty pass) in the Kunghei Ala-tau. On neither of these ranges are there any true glaciers

The Alexander Mountains terminate over against the town of Aulie-ata (71° 20′ E) at the relatively low altitude of 2,460 ft, though farther east they rise to 13,000–14,000 ft., and even reach 15,350 ft. in Mt. Semenov. On the north their declivities are steep and rugged. They are crossed by passes at 6,550–11,825 ft.

From the middle of the Alexander range (74° E) the Talas-tau breaks away in a west-south-west direction, and from near the western extremity of this latter two parallel ranges, the Chotkal (14,000 ft.) and the Ala-tau, break away in a south-westerly direction, and running parallel to one another and to the river Naryn, terminate at right angles to the middle Syr Darya, after it has made its sweeping turn to the north-west The Talas-tau has an average elevation of 14,000–15,000 ft., its snow-capped summits at 15,750 ft; it is crossed by passes at 8,000–10,650 ft.

Near the west end of the Alexander range, (71° E.) the Kara-tau stretches north-west, between the Syr Darya and the Chu. It consists almost entirely of sedimentary rocks. Its average elevation is 5,000 ft., in places it reaches 7,000–8,000 ft. In the same north-westerly to south-easterly direction are the Ferghana Mountains. The Ferghana Mountains, which are cleft by the Naryn river, have a mean altitude of 10,000 ft, but attain elevations of 12,740 ft (Suyuk) and are crossed by the Terek pass at 9,140 ft.

On the south of the Ferghana valley is the lofty range of the Alai, backed by the parallel range of the Trans-Alai. Both ranges abut at their eastern extremity upon the Pamir plateau, and both extend a long way out into the desert. The Alai is a well-defined ridge with steep slopes, and both it and Terek-tau, which prolongs it towards the Kokshal-tau, are flanked next the Ferghana valley Palaeozoic metamorphic limestones and newer Tertiary series of softer conglomerates and sandstones. The general altitude of both ranges is 16,000–19,000 ft., but the Trans-Alai culminates in peak Kaufmann (23,386 ft.). The Trans-Alai is a true border range, the ascent to it from the Pamir plateau (13,000 ft.) on the south-east being gentle and relatively short, while both it and the Alai tower above the valley of the Alai to an altitude of 11,000 to 14,000 ft This valley is 75 miles in length and is continued towards the south-west by the valley of Karateghin Its breadth varies from three to 12 miles, and it falls from 10,500 ft. (north-east) to 8,200 ft. (south-west). It is drained by the Kyzyl-su, which, under the name of Vakhish, finally enters the Amu Darya Despite frequent avalanches of snow it is an important highway of communication between Bukhara and the Pamirs on the one hand and Kashgar and Ferghana on the other. The principal passes over it into the valley of Ferghana are Taldyk, 11,605 ft with a military road, Jiptyk, 13,605 ft; Saryk-mogal, 14,110 ft; Tenghiz-bai, 12,630 ft; and Kara-kazyk, 14,305 ft The Pamir plateau is reached by the Kyzyl-art pass at 14,015 ft

The Alai Mountains are continued westwards in the radiating ranges of the Karateghin, Zarafshan and Hissar Mountains and the Turkistan range, which reach altitudes of 18,500 ft The Trans-Alai are continued in the Peter the Great range, which culminates in the Sandal group (24,935 ft.). The passes across these ranges are difficult and at 10,000–13,000 ft. The last outlying range of the Tien-shan system in this direction is the Nura-tau. It rises abruptly from the desert and lifts its snowy peaks to altitudes of 15,000–16,000 ft, separating the river Syr Darya from the river Zarafshan The passes over it lie at 10,000–13,000 ft

Routes.—The traditional routes between China, and West Turkistan and Persia have crossed the Tien-shan system at some half a dozen points After traversing the desert of Gobi from Sa-chou to Hami, the northern route crossed over into the Dzungarian valley either by the Otun-koza depression or by the gap at Urumchi, or else it proceeded over the Muz-art pass on the east side of Khan-tengri or over the Bedel pass in the Kokshal-tau and so down into the valley of Kulja. The shortest route, though not the easiest, between Kashgar and East Turkistan, and Ferghana and West Turkistan is over the Terek pass or the pass at the head of the Alai valley, a dangerous route in winter by reason of snow

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TIENTSIN, a large commercial city in the province of Chihli, China. Estimated population 900,000. It is situated at the junction of the Peiho and the Hun-ho, which is connected by the Grand canal with the Yang-tsze Kiang. The town is built on a vast alluvial plain, which extends from the mountains beyond Peking to the sea, and through which the Peiho runs a circuitous course, making the distance by water from Tientsin to the coast about 70 m, as against 30 m. by railway.

In 1853 Tientsin was besieged by an army of T'aip'ing rebels, who were ultimately forced to retreat. The city and suburbs were occupied by allied forces, English and French, in 1860–62. The city was constituted an open port. There were further riots in 1870. During the period 1874–94 the city prospered under Li Hung-Chang, viceroy of Chihli. The entire city, native and foreign, suffered severely during the Boxer hostilities, June-July

1900. After this the city walls were razed and the municipal services considerably improved. There is a university, several cotton mills and important rice and salt markets. The river front of the Peiho is governed by foreign Powers, who have exacted from time to time various "concessions."

TIEPOLO, GIOVANNI BATTISTA (1692–1769), Italian painter, was born at Venice, and acquired the rudiments of his art from Gregorio Lazzarini, and probably from Piazzetta, though the decisive influence on the formation of his style was the study of Paolo Veronese's sumptuous paintings. He developed an extraordinary facility of brushwork, and proved himself, as a fresco-painter, a colourist of the first order, though this early mastery of technique made him frequently neglect form and composition He decorated many Venetian churches and palaces with ceilings and frescoes full of turbulent movement and rich colour, extending his operations to the near cities of the mainland and to Bergamo (Colleoni Chapel) and Milan (ceiling at Palazzo Clerici). In 1750 he went to Wurzburg to paint the magnificent ceilings and frescoes at the archbishop's palace. From 1753 to 1761 he worked again at Venice and in the cities of north-east Italy, until he was summoned to Madrid by Charles III to paint some frescoes for the royal palace He died at Madrid in 1769.

Tiepolo's altarpieces and easel pictures show more clearly even than his frescoes how deeply he was imbued with the spirit of Paolo Veronese, for in these smaller works he paid more attention to the balance of composition, whilst retaining the luminosity of his colour harmonies The majority of his works, both in fresco and in oils, are to be found in Venice in the churches of S. Aloise, SS. Apostoli, Gesuati, the Academy, the Palazzi Labia and Quirini-Stampalia, and the Doge's Palace

See Henry de Chennevières, *Les Tiepolo* (1898); and Pompeo Molmenti, *G. B. Tiepolo* (Milan 1910).

TIERCERON, in mediaeval architecture, an intermediate vaulting rib running from the spring of the vault to the ridge, at an angle between the cross rib and the diagonal or groin rib, or, in cross vaults, between the diagonal rib and the wall rib. Tiercerons came into use in the early Decorated period of English Gothic and Exeter cathedral (1308–67) shows the delicate beauty and lightness that the use of tiercerons gives. *See* GOTHIC ARCHITECTURE; VAULT.

TIERRA DEL FUEGO, an archipelago lying between 52° 27′ and 55° 59′ S lat. and 63° 43′ and 74° 44′ W. long. at the southern extremity of South America, from which it is separated by Magellan strait. At the First Narrows and at other points the strait is scarcely a mile wide. In shape the main island is a triangle with its base in the Beagle channel. The total area is about 28,000 sq m. of which 19,500 sq m belong to Chile and 8,500 to Argentina Argentina holds that part of the main island which lies east of the meridian of Cape Espiritu Santo (68° 36′ 38″ W.) and Chile holds all the western part of the main island and other numerous islands to the west and to the south of Beagle channel. The Argentine side is known as the Gobernacion of Tierra del Fuego (including Staten island) and the Chilean forms part of the Territory of Magellanes. Although in the '80s of the past century extensive deposits of alluvial gold were discovered, their exploitation was not generally successful and farms took the place of mines. The Argentina census of 1914 reported 64 haciendas covering 4,830 sq.m. with about 800,000 sheep, 7,000 cattle and 5,000 horses on the Argentina side. The sheep industry is particularly profitable and growing rapidly.

Physical Features.—The greater part of the main island is formed by the continuation of the Tertiary beds of the Patagonian table-land cut by the transversal depression of Magellan strait and by the lowland extending from Useless bay in the west to San Sebastian bay on the east and analogous to the transverse valleys of the Patagonian table-land. North of the lowland is an undulating table-land with an average height of 400 ft, intersected by numerous *arroyos* with little water and with good sheep pasture. In the west and south-west the general character of the main island changes; the ends of the Tertiary beds are raised—small hills and Mesozoic rocks appear, forming broken ridges east of the main range of the Andes. In this region appears the Antarctic forest. Lake Solier and Lake Fagnans receive the water from these mountains and hills. To the south of the lake rises the south-eastern prolongation of the Andes with ridges at a uniform height of 3,500 ft. in which predominate crystalline schists. Some peaks of Tertiary granite break the uniformity, such as Mt. Sarmiento (7,540 ft), Mt Darwin (about 7,500 ft) and Mt. Ulewaia (4,500 ft.), called Olivaia on some maps

The section of the archipelago south of Beagle channel includes the islands of Hoste, Navarin, Gordon, Londonderry, Stewart Wollaston and numerous islets, disposed in triangular form with the base on Beagle channel and the apex at Cape Horn. Important explorations in this region were conducted by the French Mission de Cap Horn (1882–83). The most recent explorations on the western part of the main island of Tierra del Fuego immediately south of Beagle channel (in the Fiords de Agostini. Admiral Martinez and others) were carried out by Alberto M de Agostini in 1913–14 The western group of islands includes Clarence island (formerly believed to be a single island but now known to be divided by a channel into two sections known as Santa Ives and Desolation islands) and numerous small islands and rocks.

Climate.—At Ushuaia ten years' meteorological observations have shown a mean annual temperature of 42 8° F, with a winter mean of 34 7°, a summer mean of 50 2°, and an average yearly precipitation of 24 8 inches. Of all winds, 80% are westerly and a great difference in precipitation between the windward and leeward sides of the islands has been noted not only in the western part but also on Staten and Observatory islands. Precipitation on all windward slopes is almost continuous, producing dense forests on the lower slopes, where it falls as rain, and snow and ice-fields on the upper slopes.

Inhabitants.—To the three geographical divisions correspond three well-marked ethnical groups—the Onas on the main island south of the Grande river, the Yagans (Yahgans) on the southern islands and the Alakalups on the western The origin of the Onas, like that of the other groups, is obscure Undoubtedly among them are many that resemble some Patagonian type, but they seem to be not the same as the Tehuelche type and may pertain to one of the earlier Patagonian races Their language is closely allied to that called Old Tehuelche, it is a hard guttural, slow-spoken speech, not at all resembling the soft, rapidly-spoken language of the Yahgans, which has many points of similarity with that of the Alakalups The isolation of the Onas is peculiarly marked as they are insular people who do not use boats The Yahgans live under conditions of extraordinary rigour. In order to obtain food, they venture naked with small canoes into the tremendous seas Their life is a constant battle with starvation and a severe climate and their number is being rapidly depleted They have no higher social unit than the family. The missionaries, who have reduced their language to writing, assert that it contains no less than 30,000 words, although the numerals stop at five, but it appears that a large number of words included in this total are compounds. Comparatively little is known of the Alakalups.

Discovery and Exploration.—Tierra del Fuego was discovered by Fernando de Magellan in 1520 when he sailed through the strait named after him and called this region "Land of Fire." In 1578 Sir Francis Drake first sighted the point which in 1616 was named Cape Hoorn (Anglicized Horn) by the Dutch navigators Jacob Lemaire and William Cornelis Schoote (1615–17) In 1619 the brothers Garcia and Gonzalo de Nodal first circumnavigated the archipelago No systematic exploration was attempted until the British Admiralty undertook a thorough survey of the whole group by Philip Parker King (1762–1828) and Robert Fitzroy (1831–36). The latter expedition (Voyage of the "Beagle") was accompanied by Charles Darwin, then a young man. To these admirable surveys is due most of the present geographical terminology of the archipelago, and although supplemented by later surveys in many parts by the Chilean navy they still form the basis and, to a large extent furnish the detail, for most hydrographic charts of the region.

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TIFFANY, CHARLES LEWIS (1812–1902), American jeweller, was born in Killingly (Conn), on Feb. 15, 1812 He removed to New York city in 1837, and with John B. Young opened a fancy goods store In 1847 the firm began to manufacture gold jewellery. It became Tiffany, Young and Ellis in 1841 and was reorganized as Tiffany & Co in 1853.

At the beginning of the Civil War, Tiffany turned most of his capital to the manufacture of swords, medals and similar war material. In 1868 the company was incorporated and branches were established at London and at Geneva Tiffany made a specialty of importing historic gems, jewellery and art works, and in 1887 bought some of the crown jewels of France. He was made a chevalier of the Legion of Honour in 1878. He died in New York on Feb. 18, 1902

TIFFANY, LOUIS COMFORT (1848–), American artist, son of Charles L Tiffany, was born in New York city on Feb. 18, 1848. He was a pupil of George Inness and of Samuel Coleman, New York, and of Léon Bailly, Paris. He became a member of the Society of American Artists (1877), of the National Academy of Design (1880), of the American Water Color Society, and of the Société Nationale des Beaux Arts, Paris. In 1900 he was made a chevalier of the Legion of Honour in Paris, and in America has received a number of medals. He travelled extensively in Europe, and painted in oil and water-colour, but eventually devoted himself to decorative glass work. He became president and art director of the Tiffany Glass and Decorating Company, and produced a "Favrile" glass, of unusual beauty of colour. In 1918 he founded the Louis Comfort Tiffany Foundation for art students at Oyster Bay (N Y), deeding his country home, Lawreton Hall, with over 60ac. of land, his art collection, and a maintenance fund of $1,000,000.

TIFFIN, a city of northern Ohio, U.S.A., the county seat of Seneca county; on the Sandusky river, 40 m. S.S.E. of Toledo. It is served by the Baltimore and Ohio, the Big Four, the Pennsylvania and electric railways. Pop. 14,375 in 1920 (94% native white); 1928 local estimate 16,800. Tiffin was settled in 1817 and was named after the first governor of the State. It was incorporated as a town in 1835 and as a city in 1850, when the village of Fort Ball, across the Sandusky, was united with it.

TIFLIS, the capital of the Georgian S.S R., and the administrative centre of the Transcaucasian S.F S.R, situated on both banks of the Kura river, and on the railway linking the Black Sea and the Caspian, in 41° 41′ N., 44° 48′ E. Pop. (1926) 282,918. Shut in by hills (1,500 to 2,400 ft.), it is sheltered in winter, but hot and stifling in summer, its average temperature ranging between 34·7° F, in winter and 73·4° F in summer. It manufactures bricks, tobacco, vegetable oils, soap, cognac, leather goods, furniture, and has a saw-milling industry. In 1926–7, the Zemo-Avchal hydro electric station, with a capacity of 13,000 kilowatts, was opened. There are municipal electricity, water, canal and tramway services, and the town is well built. The Sion cathedral traces its origin to the 5th century; other churches date from the 14th and 15th centuries, and the Armenian cathedral of Van from 1480. There are numerous educational institutions. The town is at the southern extremity of the Georgian Military road, which links it through the Dariel Gorge with Vladikavkaz. The Oriental markets and bazaars of the native quarter, where Persians, Kirghiz, Tatars and peoples from the east congregate, display the work of Georgian silversmiths, gunsmiths and sword-makers, carpets, dried fruits and silken goods are important items, and there is much exchange of Persian and Russian wares.

The Georgian annals put the foundation of Tiflis back to A.D. 379. (*See* GEORGIA, *History*) In the latter half of the 5th century the chieftain of Georgia, Wakhtang Gurgaslan, transferred his capital from Mtskhet to the warm springs of Tiflis, where he erected several churches and a fort. In 570 the Persians took the place and made it the residence of their rulers, but retained it only for ten years. Tiflis suffered successive plunderings and devastations at the hands of the Greeks in 626, of one of the commanders of the Caliph Omar in 731, of the Khazars in 828, and of the Arabs in 851. The Georgians, however, always managed to return to it and to keep it in their permanent possession. In the course of the succeeding centuries Tiflis fell repeatedly into Persian hands; and it was plundered by the Mongol conqueror Tamerlane towards the end of the 14th century. Afterwards the Turks seized it several times, and towards the end of the 17th century the Lesghians attacked it. In 1795, when the shah of Persia plundered Tiflis, Russia sent troops to its protection, and the Russian occupation became permanent in 1799. One of the fullest accounts of Tiflis is contained in Brosset's edition of the *Description géographique de la Géorgie* (St. Petersburg, 1842), by the illegitimate son of Wakhtang VI, king of Karthli (*i.e*, Georgia), who became a pensioner of Peter the Great

TIGELLINUS, TOFONIUS, minister and favourite of the emperor Nero, was a native of Agrigentum, possibly of Greek descent. During the reign of Caligula he was banished (A.D. 39) for adultery with the emperor's sisters, but recalled by Claudius (41). Having inherited a fortune, he bought land in Apulia and Calabria and devoted himself to breeding race-horses In this manner he gained the favour of Nero In 62 he was promoted to the prefecture of the praetorian guards. The great fire of 64 broke out afresh in his gardens, and he was suspected of being concerned with it. In 65, during the investigation into the abortive conspiracy of Piso, he and Poppaea formed a kind of imperial privy council. In 67 he accompanied Nero on his tour in Greece He deserted Nero at the last, and took the praetorians with him Under Galba he was obliged to give up his command, but managed to save his life. Otho on his accession (69) determined to remove him. While in the baths at Sinuessa, Tigellinus received the news that he must die, and, having failed to gain a respite, cut his throat.

See Tacitus, *Annals*, xiv, xv, xvi; *Hist* i. 72, Dio Cassius lix. 23, lxii. 13, 15, 27, lxiii. 12, 21, lxiv 3; Suetonius, *Galba*, 15; Plutarch, *Galba*, *Otho;* ancient authorities quoted by Mayor on Juvenal, i. 155; B. W Henderson, *Life and Principate of the Emperor Nero* (1903).

TIGER (*Felis tigris*), an animal only rivalled by the lion in size, strength and ferocity among the cat-like beasts of prey (*see* CARNIVORA), the difference between the two lying mainly in the skin and its coverings A tiger's skull may, however, always be distinguished from that of a lion by the circumstance that the nasal bones extend higher on the forehead than the maxillae, instead of stopping on nearly the same line Although examples of both species present considerable variations in size, the length of the largest Bengal tiger may exceed that of any lion. Ten feet from the tip of the nose to the end of the tail is no unusual length for a large male tiger. The female is somewhat smaller, and has a lighter and narrower head. The tiger has no mane, but in old males the hair on the cheeks is rather long and spreading. The ground-colour of the upper and outer parts of the head, body, limbs and tail, is bright rufous fawn; and these parts are beautifully marked with transverse stripes of a dark, almost black colour. The markings vary much in different individuals, and even on the two sides of the same individual. The under-parts of the body, the inside of the limbs, the cheeks and a large spot over each eye are nearly white. The tigers which inhabit hotter regions, as Bengal and the south Asiatic islands, have shorter and smoother hair, and are more richly coloured and distinctly striped than those of northern China and Siberia, in which the fur is longer, softer and lighter-coloured. Black and white phases have been recorded, but they are rare. The tiger is exclusively Asiatic, but has a wide range in that continent, having been found in almost all suitable localities south of a line drawn from the River

Euphrates, passing along the southern shores of the Caspian and Sea of Aral by Lake Baikal to the Sea of Okhotsk. Its most northern range is the territory of the Amur, its most southern the islands of Sumatra, Java and Bali. Westward it reaches to Turkish Georgia and eastward to the island of Sakhalin. It is absent, however, from the great elevated plateau of Central Asia, nor does it inhabit Ceylon, Borneo or the other islands of the Indo-Malay archipelago, except those named.

The principal food of the tiger in India is cattle, deer, wild hog and pea-fowl, and occasionally human beings The regular "man-eater" is generally an old tiger whose vigour is past, and whose teeth are worn and defective, it takes up its abode in the neighbourhood of a village, the population of which it finds an easier prey than wild animals. Though chiefly affecting grassy plains or swamps, tigers are also found in forests, and seem to be fond of haunting the neighbourhood of old ruins. As a rule, they do not climb trees, but when pressed by fear, as during an inundation, they have been known to do so. They take to the water readily and are good swimmers.

BY COURTESY OF THE N Y ZOOLOGICAL SOCIETY

THE TIGER (FELIS TIGRIS), THE MOST POWERFUL OF THE CAT FAMILY

The tigress gives birth to from two to six cubs, but three is the common number. She is an affectionate mother, and generally guards and trains her young with watchful solicitude They remain with her until nearly full-grown, or about the second year, when they are able to kill for themselves Whilst they remain with her she defends them with great courage and energy, and when robbed of them is terrible in her rage, but she has been known to desert them when pressed, and even to eat them when starved. As soon as they begin to require other food than her milk, she kills for them, teaching them to do so for themselves by practising on small animals. The tiger and the lion occasionally hybridize.

See Sir J Fayrer, *Royal Tiger of Bengal* (1875); F. W Champion, *With a Camera in Tiger Land* (1927)

TIGER-CAT, typically *Felis tigrina*, an American wild cat ranging from Mexico, on the east of the Andes, to Paraguay and the central forest region of Argentina. It measures something over 30in., including the tail. The fur is grizzly grey, with black spots. The name is also applied to the ocelot (*q.v.*).

TIGER-FLOWER, botanically *Tigridia*, a genus of bulbous plants (family Iridaceae), natives of Mexico, Central America, Peru and Chile. They have long narrow plicately-veined leaves springing from the bulb and a stem bearing two or three scattered smaller leaves and above a few flowers emerging from a spathe. The flowers are spotted (whence the name tiger-flower or tiger-iris) and have free segments springing from a tube; the three large broad outer segments are concavely spreading, the three inner are much smaller and more erect. *T. Pavonia* (flower of Tigris or tiger-flower) has large flowers with a golden orange, white or yellow ground colour.

TIGHINA (Turkish, *Bender*, the Gate, from the fortress erected by Suleiman the Magnificent in 1558, but demolished in 1897; Russian, *Bendery*), a town of Bessarabia, Rumania, capital of department of same name, on the Dniester. Pop. (1924) about 42,000, including many Jews and Ukrainians. It is connected by rail with Kishinev (37 m.) and southward via Basarabiasia with Cetatea Alba and Galatz, and a railway also runs over the river into Russia to Tiraspol and Odessa. Tighina possesses a tobacco factory, candle-works and brick-kilns and a saw-mill. Timber is floated down the Dniester, and the town is a centre for products of the surrounding districts. In the 12th century it was a Genoese trading centre, and has been held in turn by Tatars, Moldavians, Turks, Russians and Rumanians. The forces of Charles XII. camped here 1709–13.

TIGLATH-PILESER (Ass. *Tukulti-pal-E-sarra*, "my confidence is the son of E-sarra," *i.e.*, the god In-Aristi), the name of several Assyrian kings. Their numbering is not certain.

Tiglath-Pileser I., the son of Assur-ris-isi, ascended the throne *c.* 1120 B C, and was one of the greatest of Assyrian conquerors. His first campaign was against the Moschi who had occupied certain Assyrian districts on the Upper Euphrates; then he overran Commagene and eastern Cappadocia, and drove the Hittites from the Assyrian province of Subarti north-east of Malatia. In a subsequent campaign the Assyrian forces penetrated into the Kurdish mountains south of Lake Van and then turned westward, Malatia submitting to the invader In his fifth year Tiglath-Pileser attacked Comana in Cappadocia, and placed a record of his victories engraved on copper plates in a fortress he built to secure his Cilician conquests. The Aramaeans of north Syria were the next to be attacked, and he thrice made his way as far as the sources of the Tigris. The command of the high road to the Mediterranean was secured by the possession of the Hittite town of Pethor at the junction of the Euphrates and Sajur, and at Arvad he received presents, including a crocodile, from the Egyptian king, and, embarking in a ship, killed a dolphin in the sea. He was passionately fond of the chase and was also a great builder, the restoration of the temple of Assur and Hadad at Assur (*q v.*) being one of his works.

Tiglath-Pileser II. or III, son of Hadad-nirari II, appears to have reigned from about 950 to 930 B C, but nothing is known about him.

Tiglath-Pileser III or IV, was a successful general who usurped the Assyrian throne on the 13th of Iyyar 745 B C., after the fall of the older dynasty, and changed his name of Pulu (Pul) to that of the famous conqueror of earlier times In Babylonia, however, he continued to be known as Pulu. He was a man of great ability, both military and administrative, and initiated a new system of policy in Assyria which he aimed at making the head of a centralized empire, bound together by a bureaucracy who derived their power from the king The empire was supported by a standing army and an elaborate system of finance. The first task of Tiglath-Pileser was to reduce the Aramaean tribes to order, and so win the gratitude of the Babylonian priests Then he struck terror into the wild tribes on the eastern frontiers of the kingdom by a campaign which extended into the remotest parts of Media Next came the defeat of a northern coalition headed by Sar-duris of Ararat, no fewer than 72,950 of the enemy being captured along with the city of Arpad, where the Assyrian king received the homage of various Syrian princes. Arpad revolted soon afterwards, but after a siege was taken in 740 B C The following year Azariah of Judah appears among the enemies of Tiglath-Pileser, who had overthrown his Hamathite allies and annexed the nineteen districts of Hamath. The conquered populations were now transported to distant parts of the empire. In 737 B C. Tiglath-Pileser again marched into Media, and in 735 he invaded Ararat and wasted the country round the capital Van to a distance of 450 miles. In 734 B.C he was called to the help of Yahu-khazi (Ahaz) of Judah, who had been attacked by Pekah of Israel and Rezon (Rasun) of Damascus. Rezon, defeated in battle, fled to his capital which was at once invested by the Assyrians, while with another portion of his army Tiglath-Pileser ravaged Syria and overran the kingdom of Samaria Ammon, Moab, Edom and the queen of Sheba sent tribute, and Teima in northern Arabia was captured by the Assyrian troops In 732 B C Damascus fell; Rezon was put to death, and an Assyrian satrap appointed in his stead. Tyre also was made tributary The next year Tiglath-Pileser entered Babylonia, but it was not until 729 B C. that the Chaldaean prince Ukin-zer (Chinzirus) was driven from Babylon and Tiglath-Pileser acknowledged as its legitimate ruler. In the early part of Tebet 727 B C. he died, after having built two palaces, one at Nineveh, the other at Calah

See P. Rost, *Die Keilschrifttexte Tiglat-Pilesers III.* (1893), also Babylonia and Assyria, § v *History* ("Second Assyrian Empire"), and authorities quoted in § viii. *Chronology*

TIGRANES or **DIKRAN,** king of Armenia (*c.* 140–55 B.C.). He was the son or nephew of Artavasdes of Armenia, and a member of the dynasty founded by Artaxias, a general of Antiochus III. (*See* Seleucid Dynasty.) He was given to Mithradates II. of Parthia as a hostage, and purchased his freedom by ceding 70 valleys bordering on Media.

Tigranes ascended the throne in 95 or 94 B C. (Plut. *Luc.* 21), and immediately began to enlarge his kingdom He deposed Artanes, king of Sophene, and entered into alliance with Mithradates VI Eupator of Pontus, whose daughter Cleopatra he married. In 93 he invaded Cappadocia in the interest of Mithradates, but was driven back by Sulla in 92. During his first war with Rome, Mithradates was supported by Tigranes, although he abstained from interfering openly. But he meanwhile began war with the Parthians, whose empire was weakened after the death of Mithradates II. (about 88) by internal dissensions and invasions of the Scythians. Tigranes reconquered the valleys which he had ceded, and laid waste a great part of Media, the kings of Atropatene, Gordyene (now Bohtan), Adiabene (Assyria) and Osroene (Edessa) became his vassals, who attended him like slaves whereever he went; he also annexed northern Mesopotamia In 83 he invaded Syria, defeated the last successors of Seleucus and occupied Cilicia. In the war between Mithradates and Sulla he did not interfere, but after the death of Sulla (78) he occupied Cappadocia again and expelled King Ariobarzanes I, the vassal of the Romans. During the next years he had a war in Syria, against Cleopatra Selene, and in Cilicia, where he destroyed the Greek town of Soli. Tigranes now had become "king of kings" and the mightiest monarch of Asia So he built a new royal city, Tigranocerta, on the borders of Armenia and Mesopotamia, between Mt Masius and the Tigris, where he accumulated all his wealth and to which he transplanted the inhabitants of twelve Greek towns of Cappadocia, Cilicia and Syria (for the situation, which is much disputed, *cf* Tac *Ann* xiv 24, xv 5, ed Furneaux) He also transplanted many Arabic tribes into Mesopotamia But the Romans could not tolerate encroachment upon their sphere of power, and in 69 Lucullus invaded Armenia Tigranes was beaten at Tigranocerta on Oct 6, 69, and again near Artaxata in September 68. The recall of Lucullus gave some respite to the two kings, who even invaded Asia Minor again But meanwhile a son of Tigranes and Cleopatra, called Tigranes, like his father, rebelled against him (as the old man had already killed two of his sons, he had reason enough to be afraid for his life) and found refuge with the Parthian king Phraates III, who sent him back with an army The old king now gave up all hope of resistance, he put a price on the head of Mithradates, and when Pompey advanced into Armenia and united with the younger Tigranes, he surrendered (66 B C). Pompey now changed his policy, he received the old Tigranes graciously and gave him back his diadem, while he treated the son very coolly and soon made him prisoner The younger Tigranes was led in triumph into Rome, where he found his death when he tried to escape from his confinement by the intrigues of P. Clodius in 58 The father after his defeat ruled about ten years longer over Armenia, as vassal of the Romans He died about 56, and was succeeded by his son Artavasdes (*See* also MITHRADATES)

See Lucian, *Macrob* 15; Appian, *Syr.* 48; *Mithr* 67, 104, Strabo, xi., 531 *seq*; xii, 539; xvi., 745, *seq*; Plut., *Luc., Pomp, Sulla;* Justin, xxxvii., 3; xl, i.

TIGRÉ, a northern province of Abyssinia; one of the four former principal divisions of the country Tigré contains the towns of Axum (*q v*), capital of the ancient Ethiopic Empire, and Adua (Adowa, *q v.*). (*See* ABYSSINIA)

Tigriña, the dialect spoken in Tigré and Lasta, is nearer the ancient Gïz than is Amharic, the official and more widely diffused language of Abyssinia

See J. Schreiber, *Manuel de la langue tigrai* (Vienna, 1887–93); and L. de Vito, *Grammatica della lingua tigrigna* (Rome, 1895).

TIGRIS, the more eastern of the two rivers of Mesopotamia It rises from two principal sources. The eastern branch rises from several streams to the south and west of Lake Van. The western branch rises about ten miles south of Lake Geuljik. The upper waters of the Tigris therefore lie on the southern slopes of the Taurus the northern slopes of which are part of the basin of the Euphrates. The Tigris in its lower course seems to be particularly unstable Although there is no evidence of any great change in the upper waters, from Kut al Amara onwards the bed of the river has shown considerable variations At the beginning of the second millennium B C. the river appears to have been flowing along the Shatt al Hai; indeed the position of Lagash makes it almost certain that this was its normal course in Sumerian times. In Sassanid times it followed its present easterly course; during Arab times, however, it was apparently flowing along the Shatt al Hai There are no ancient remains on the Tigris therefore below Kut al Amara, and owing to the changeable nature of the stream even few modern villages In the alluvial area the Tigris lies lower than the Euphrates as far as the Shatt al Hai, and therefore in ancient times received the tailings of the canals, but did not supply water except locally for irrigation. It appears not to have deposited its silt as much as the Euphrates, probably due to the lack of suitable terrain for the formation of fresh water lakes, which are usually a silting ground for river deposits Since its abandonment of the old channel the Tigris has probably contributed very considerably to the formation of new land at the head of the gulf. The upper drainage area also seems to have altered to a slight extent The Arab geographers suggest that at one time at least part of the waters of the Khabur, a tributary of the Euphrates, flowed into the Tigris by a channel which was navigable when in flood As late as 1832 Ormsby reported a stream from Jabal Sinjar which joined the Euphrates near Sharqat This stream still appears to exist, but it no longer empties itself into the Tigris and in view of the waywardness of the rivers of Mesopotamia it is possible that Ormsby's observation was made at an unusual period

Topography.—The Western Tigris, on whose banks lies the important town of Diarbekr flows east along the southern slopes of the Taurus and receives a number of tributaries of small size The two main branches join at Til, from which point it runs in a south-easterly direction It continues to receive a number of small tributary streams, mostly on the left bank From the neighbourhood of Mosul to the confluence of the Greater Zab there lies a fertile triangle of land between the hills and the river Nineveh lay on the left bank opposite Mosul A little lower down the stream was the city of Kalakh At this point two great barrages were erected in ancient times, which still effectively block the river for navigation From a little above the confluence of the Greater Zab down to Tekrit the river flows through an uninhabited desert, the only important town being Kalaat Sharqat, the ancient Assur, which at present forms the railhead of the southern part of the Baghdad railway. About thirty miles below Sharqat the Lesser Zab joins the Tigris. From Tekrit, a city founded during the Persian domination, downwards, signs of ancient irrigation begin, although the alluvial plain is not entered till Samarra is reached Below Samarra as far as Kut al Amara, a distance of about 200 miles, there was in ancient times a canal which served to straighten the course of the stream The two principal tributaries in this region, the Adhem and the Diala, were also canalized, the Adhem reaching the main stream just below Samarra, the Diala below Baghdad. Close to the mouth of the Adhem are the ruins of an ancient city probably to be identified with Xenophon's Opis Near this point the river makes a great bend and flows south to Baghdad (*q v.*) at which point the Tigris and the Euphrates are only about 35 miles apart In ancient times the two rivers ran close to one another and there are traces of numerous old irrigation canals connecting them Below Baghdad lie the ruins of ancient Ctesiphon, on the left bank; opposite Seleucia on the other bank Kut al Amara marks the point where the Shatt al Hai leaves the present main stream. Below this point owing to the change in the course of the stream there are no ancient remains along the Tigris. The modern towns are Ali al Gharbi, Ali esh Sharki Amara, Qalaat Saleh and Kurna, below which point the two rivers unite to form the Shatt al Arab.

Navigation.—Although before the World War a launch navigated the river between Baghdad and Samarra (about 90 miles), and in 1838 a steamer went to within 28 miles of Mosul the upper Tigris is only navigable for native rafts. These rafts which may be as much as 35 tons burden are made of timber supported by inflated skins. During flood they cover the 275 miles between Baghdad and Mosul in three or four days. At their destination the wood finds a ready market in this treeless country, and the

skins are carried ba again on the backs of asses No upstream traffic is carried on. he river flows over a bed of clay, sand or conglomerate, and i ull of obstructions Opinion has however been expressed that hese obstructions and the ancient barrages at Sharqat were clear away, navigation to Mosul would be possible. In the lower pa of the river there are bridges of boats at Baghdad, Gerara, KuKut al Amara and Kale Sale Between Baghdad and Kale S the Tigris is navigable all through the year by vessels draw up to five feet of water Below this point the river is in a l condition, largely owing to the barrages built by native cultivars, but great efforts have been made to restore the channel. A ow water it is generally estimated that only three feet of wat is available The low water period is reckoned from July to ovember, and high water from December to June, but the rir is extremely liable to sudden floods.

The statistical detailso far as at present recorded are as follows. From Baghdad Kut the distance by river is 216 miles, the distance by land bein103 miles. At Baghdad the river is 114 feet above sea level, at ut it is 57 feet, the fall in the river surface being 1 in 20,00 The width of the river is about a quarter of a mile, its deh at high water 26 feet, and at low 4½ The discharge in flood 5,500 cubic metres a second, dropping to as low as 300 cubic mets at low water The velocity in flood is a little under four milean hour, dropping at low water 1¼ At Kut the Shatt al Hai dcharges about 1,000 cubic metres at high flood, but is dry at lw water Between Kut and Kut al Amara the river distance is 3 miles, and by land 119 The mean level at Amara is 28 feet, tl drop between the two points being therefore about 19 feet, thgradient of the river level is 1 in 35,000 The average width f the river in this reach, which is singularly free from any obacles for navigation, is about 365 yards, while the depth is 25 et in flood and about 6 ft 6 in at low water, with a respective locity of about the same as in the upper reach The discharge low water is similar but at high water about 1,000 cubic mets less at the head of the reach, owing however to branches at he lower end of the reach the discharge at high water only reahes about 2,500 cubic metres per second

Between Amara and Kurnathe river is affected by various channels which drain off muchof the water. At Amara on the left bank the Chala, with a bedbout 6 feet lower than the main stream, discharges about 1,000 cbic metres a second at high water falling to rather more than a tenh of that amount at low Below this point first the Majar Kebirand then the Machera draw off about the same amount Considrable changes take place theretore in the size of the stream betveen Amara and Kurna, at which point the level is ten feet above ea level The average width of the Tigris at this reach is a ittle under 200 yards, with a depth of 13 feet in flood and 6 ft 6 in at low water with a discharge of only 1,250 cubic metres per econd and 150 at high water and low water respectively. Belov Kale Sale although the depth is the same the average width is nly 65 yards. Below Ezra's Tomb some of the lost waters retun to the river from swamps and the stream becomes once morenearly 200 yards broad The two rivers meet at Karmat Ali at which point the Tigris, full of dark marshy water, is over thirty fet deep and over 400 yards broad

It will be seen from these dtails that the river presents great difficulties for navigation In flod time it is liable to overrun its banks and convert the whole rgion into a vast lake In addition to river steamers two typesof native boats are used. a large coracle or *Quffeh* and river boat, *Safineh*, capable of carrying a cargo of as much as 100 tons The coracles can only go downstream but the river boats are pled or towed upstream and are sailed or rowed with the current.

See Sir W. Willcocks, *The Irrigation of Mesopotamia* (1911), *Memorandum respecting the Navigation of the Tigris and Euphrates* (1913); *Colonial Office Reports* (annually). For ancient sites *see* S. Langdon, *Cambridge Ancient History* (1923) (Bibliography)

(L H. D B)

TILAK, BAL GANGADHAR (1856–1920), Indian nationalist leader, a Chitpavan Brahmin, was born at Ratnagiri July 23, 1856 At an early age he took the lead in providing education in Poona under Indian direction. In 1890 he was proprietor and editor of two weekly papers, *Mahratta*, printed in English, and *Kesari* (*Lion*), printed in Mahratti, which organs he used for anti-Government propaganda His violent condemnation in 1897 of the plague prevention regulations resulted in his being convicted for sedition and sentenced to 18 months' imprisonment For a similar offence he was sentenced in 1908 to six years' transportation, subsequently commuted to simple imprisonment After his release he took an active part in the home-rule campaign, and secured for his party the control of the National Congress He died in Bombay on Aug 1, 1920 His formative part in the cult of Indian unrest is shown in the report of the Rowlatt sedition committee (1918) His speeches are collected in *Lokamanaya B. G. Tilak* (2nd ed Madras, 1920).

TILBURG, a town in the province of north Brabant, Holland, and a junction station 13½ m E by S of Breda by rail Pop. (1927), 71,327 Tilburg has risen into importance since the separation of Belgium from Holland as one of the chief industrial centres of the south

TILBURY DOCKS, on the north shore of the Thames, in Essex, England They lie opposite Gravesend 25 m below London bridge, and about the same distance from the Nore, being thus within the Port of London They were constructed in 1886 There is extensive warehousing as well as accommodation for passengers, as the largest passenger steamers trading with the Port of London lie here Railway communication is provided by the L M S There is direct connection for goods traffic with all the northern lines The rapid development of the Port of London has necessitated many changes and extensions since the docks were built Changes began in 1917 when the Port of London authority extended the main dock 1,450 feet In 1926 a new entrance was planned with a length of 1,000 ft, width 110 ft, depth 45½ feet The site is 400 yd above Tilbury Ness New dry docks are also being built (1928) east of the old dry docks Provision is made for the landing of river cargo west of the entrance to the tidal basin and also for better passenger facilities

TILDEN, SAMUEL JONES (1814–1886), American statesman, was born at New Lebanon, N Y, on Feb 9, 1814 In 1834 he entered Yale university, but soon withdrew on account of ill health, and later studied in the College of the City of New York He was admitted to the bar in 1841, and rose rapidly to the front rank In the financial troubles between 1850 and 1860 it is said that more than half the railways north of the Ohio river and between the Hudson and the Missouri rivers were at some time his clients In spite of his activity at the bar, Tilden maintained an interest in politics, serving in the State assembly in 1846 and in the State Constitutional Conventions of 1846 and 1867 In 1848, largely on account of his personal attachment to Martin Van Buren he participated in the revolt of the "Barnburner" or free-soil faction of the New York Democrats, and in 1855 was the candidate of the "softshell" or anti-slavery faction for attorney general of the State During the Civil War, although he opposed several of the war measures of President Lincoln's Administration, he gave the Union cause his heartiest support

In 1866 Tilden became chairman of the Democratic State committee, and soon came into conflict with the notorious "Tweed ring" of New York city As the "ring" could be destroyed only by removing the corrupt judges who were its tools, Tilden, after entering the assembly in 1872 to promote the cause of reform, took a leading part in their impeachment By analysing the bank accounts of certain members of the "ring," he obtained legal proof of the principle on which the spoils had been divided His fame as a reformer brought him to the governor's chair in 1874, and he at once gave his attention to breaking up the "canal ring," made up of members of both parties who had been systematically robbing the State through the maladministration of its canals

In 1876 the Democrats nominated him for the Presidency, the Republicans nominating Rutherford B Hayes of Ohio The result was the disputed election of 1876, when two sets of returns were sent to Washington from the States of Florida, Louisiana, South Carolina and Oregon As the Federal Constitution contained no provision for settling a dispute of this kind the two houses of Congress agreed to the appointment of an extra-con-

stitutional body, the "Electoral Commission" (*q.v.*), which decided all the contests in favour of the Republican candidates. Tilden counselled his followers to abide quietly by the result. The remainder of his life was spent in retirement at his country home, Greystone, near Yonkers, N.Y., where he died Aug. 4, 1886. Of his fortune (estimated at $5,000,000) approximately $4,000,000 was bequeathed for the establishment and maintenance of "a free public library and reading-room in the City of New York"; but, as the will was successfully contested by relatives, only about $2,000,000 of the bequest was applied to its original purpose; in 1895 the Tilden Trust was combined with the Astor and Lenox libraries to form the New York Public library.

See *Writings and Speeches of Samuel J. Tilden* (1885) and *Letters and Literary Memorials of Samuel J Tilden* (1908), both edited by John Bigelow, also Bigelow's *Life of Samuel J. Tilden* (1895); and P. L. Haworth, *The Hayes-Tilden Election* (1927).

TILDEN, SIR WILLIAM AUGUSTUS (1842–1926), British chemist, was born on Aug 15, 1842, at St. Pancras, London; he was first apprenticed to a pharmacist, and in 1863 became demonstrator at the Pharmaceutical Society's school. In 1872 he was appointed senior science master at Clifton college; then, in 1880, he became first professor of chemistry at Manor college, Birmingham, and in the same year was elected to the Royal Society; in 1894 he transferred to the chair at the Royal College of Science, London, and there he remained until his retirement in 1919. He died on Dec. 11, 1926.

Tilden's first contribution to chemical research was in connection with the per-iodides of organic bases (1865), and for some years he studied the alkaloids (*q.v.*) and other substances obtained from plants. In 1874 he examined, together with W. A. Shenstone, the properties of aqua regia and nitrosyl chloride, and whilst investigating the action of the latter on various organic compounds he discovered the nitroso-chloride of pinene. This discovery eventually led to a valuable method for the identification of terpenes (*q v.*), and the reaction with nitrosyl chloride was subsequently used by many workers in this field. Tilden also studied terpineol and related bodies, and the action of heat on terpenes In 1892 he observed the presence of a rubber-like substance in a bottle of isoprene which had been standing for some years, but owing to the fact that rubber was not then so valuable as it is to-day, the matter was not further investigated. In addition to his researches in organic chemistry Tilden contributed to physical chemistry. He determined the specific heats of elements at various temperatures, and thus showed the limits of applicability of Dulong and Petit's law. (*See* CHEMISTRY: *Physical.*) He also verified Neumann's law of the additivity of the specific heats of elements in certain compounds.

His published works include *An Introduction to Chemical Philosophy* (1876); *A Manual of Chemistry* (1896); *Chemical Discovery and Invention in the Twentieth Century* (1917); *Life of Sir William Ramsay* (1918); and *Famous Chemists* (1921).

TILE, a thin, flat slab, usually of burned clay, glazed or unglazed, used either structurally or decoratively in building. The usage of the word varies widely; in connection with roofing, flat slabs of any material are sometimes termed tiles, as for instance, the marble tiles occasionally used in Greek temples or the bronze tiles used extensively in ancient Rome, and occasionally in China. Similarly, stone slabs, used for roofing, as in certain parts of England, are termed stone tiles; slate, however, is never so called, and wood shingles are so called only rarely. Many forms of rough terra-cotta used structurally in building are called tiles; thus an arch of hollow terra-cotta blocks between steel beams is known as a "tile arch"; partitions built of hollow terra-cotta blocks are known as hollow tile partitions, and the steel forms used for casting certain types of reinforced concrete floors are frequently referred to as steel tiles. The differentiation between tile, terra-cotta and brick is thus exceedingly vague.

Tiles divide themselves naturally into several classes: structural tile, such as the hollow terra-cotta blocks referred to above, for which *see* TERRA-COTTA; roofing tiles; floor tiles; and wall tiles.

Roofing Tiles.—There is no evidence of the use of roofing tiles in the Mediterranean basin prior to the development of Hellenic civilization, but the most ancient examples of roof tiles we possess show such highly developed forms that earlier usage must be assumed. The Greek form of temple roof which remained constant throughout the history of Greek architecture consisted of two types of tile, used together. First the roof surface was covered with tiles generally flat, but with adjoining edges raised. These were laid in overlapping courses, and were all of equal size so that the joints of each course occurred directly in a line with those of the courses above and below. Convex covering tiles, also overlapping, were then laid over the joints of the flat tiles below, and were so profiled as to cover, not only the joint, but the raised edges of the lower tiles; in this manner an absolutely watertight roof could be produced. In order to make the architectural effect more delicate the ends of both lower tile and covering tile were rebated, so that the thickness of the overlapping portion was only half the thickness of the tile. At the bottom of each row of covering tiles was either a marble or tile upright, curved, decorative member known as an antefix (*q.v.*).

In some cases the covering tiles were of pointed, straight line section—the most common Greek type—in others a tile of semicircular section was used, easy to manufacture, but lacking in the extreme refinement of the other type; in the simpler domestic work, the lower courses were also of curved section, a segmental concave shape replacing the flat tile with raised edges. The marble tile used in some Greek temples, as in that of Bassae (*c.* 430 B.C., by Iktinos) is universally of the type with flat under tile and pointed covering tile, although at times, in order to reduce the number of joints, the covering tile and the under tile are cut from the same piece of marble.

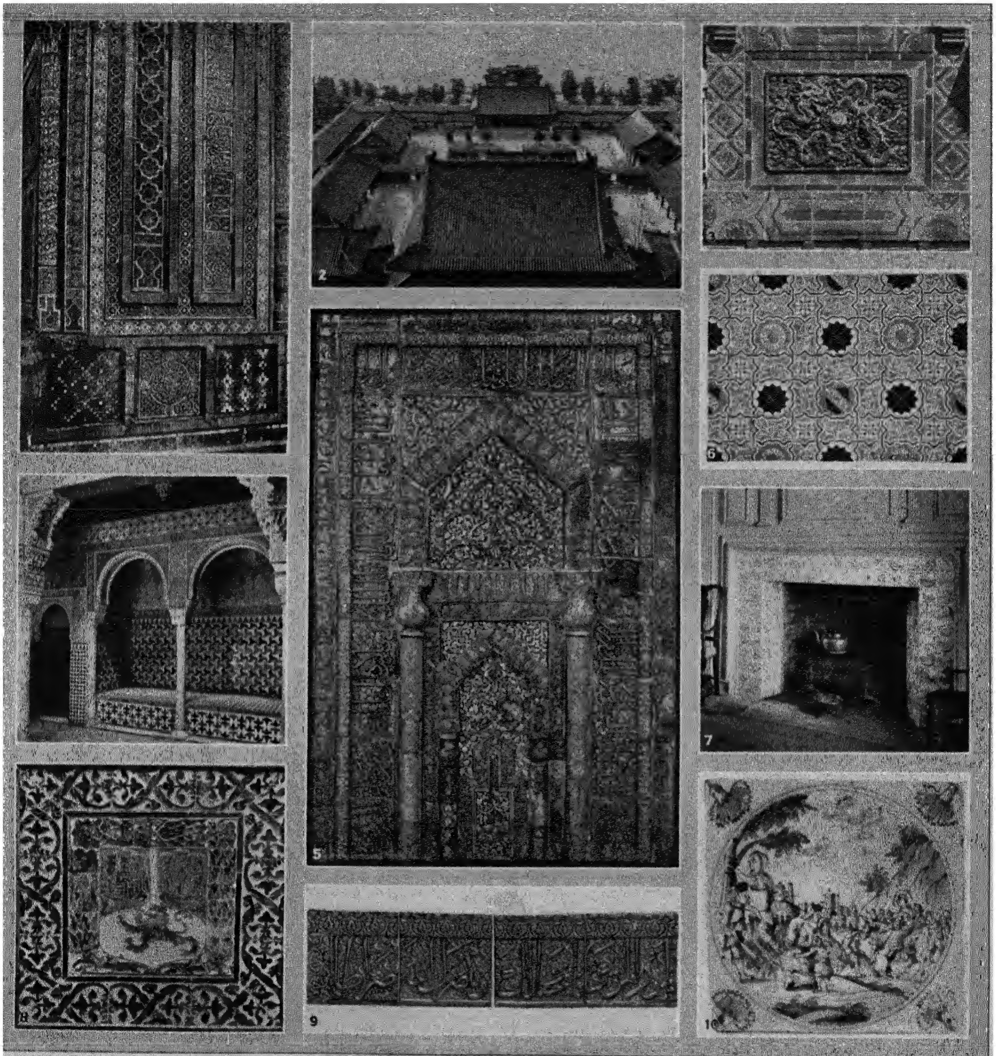
Two other types of roof tile were common in Roman times and probably represent common Mediterranean types of much earlier origin. These are the so-called "Spanish tiles," with a contour resembling a letter S, in which the convex part of each tile fits over the edge of the concave portion of the next, and the shingle or flat tile found frequently in the Roman ruins of the northern provinces. These flat tiles are often of stone.

The usual material of all of these types of tile is burned clay, varying in colour from orange-yellow to purple-red. It is known, however, that bronze tiles were relatively common on the most monumental buildings of the Roman empire. Due to the rarity and value of bronze during the middle ages and the Renaissance, no examples of ancient bronze roof tiles are now known.

All of the classic forms of clay tile continued in use in various parts of the world during the mediaeval period, but their supremacy as a roofing material gradually yielded to lead and zinc for churches, public buildings, palaces, etc., and to slate, stone and thatch for the smaller private houses.

Clay roof tiles used at the present day remain of substantially the same form; improvements have been only in methods of manufacture and not in design. The flat tile designed to hook over roof battens or boards, is perhaps the most common type of small house roof covering in England and parts of France, and the combination of concave under tile and convex over tile is almost universal on pitched roofs in Italy, Spain, Greece and Turkey. The S-shaped tile is also common around the Mediterranean. The curved tiles are almost always laid in a heavy bed of waterproofed mortar, with ridges and hips covered by courses of overlapping tiles, similarly bedded; with flat tiles, the use of mortar is restricted to the convex or pointed tiles covering the hips and ridges. The best modern usage in laying tiles of this type demands the complete covering of the roof surface with a watertight material such as slaters' felt or heavy water-proofed paper, before the tile is applied. The tiles themselves are held in place sometimes by copper nails which secure the under tiles direct to the roofing and the covering tiles to wood battens which run up the slope of the roof under each row of covering tiles, and sometimes by copper wire brought up through two holes in each tile and twisted together. In America the popularity of houses of Spanish and Italian types has led to widespread manufacture of tiles both of the S-shape and alternately concave and convex.

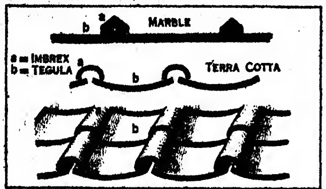
Although various attempts have been made to imitate clay tiles in stamped metal and concrete, these imitations are so lacking



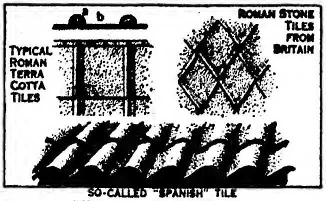
BY COURTESY OF (1) ERNST WASMUTH FROM SARRE, "DENKMÄLER PERSISCHER BAUKUNST," (5) THE DIRECTOR OF THE KAISER-FRIEDRICH MUSEUM
MUSEUM OF ART, NEW YORK; PHOTOGRAPHS, (2, 4) EWING GALLOWAY, (3) HERBERT G. PONTING, F.R.P.S.

ARTISTIC EXAMPLES OF THE USE OF TILE

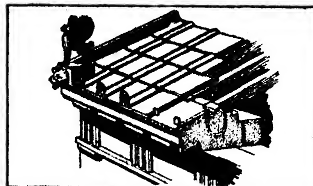
1. Elaborately designed tile wall decoration of Shah-Zinda, Samarkand
2. Roofs of the summer Palace of the royal family in Peking, China
3. Tile in the Hall of Classics, Peking, China
4. Court of Divans (cooling room of bath) in the Alhambra, Spain
5. Lustre tile Mihrab (niche in a mosque indicating the direction of Mecca, toward which Muslims turn when praying). In the Hall of Justice in the Alhambra, Spain
6. Painted tile in the floor of one of the alcoves of the Hall of Justice in the Alhambra
7. Tiles formerly around the fireplace of a Long Island home, built about 1745
8. Panel of wall tiles in Seville, Spain, of the 16th century
9. Persian frieze "Veramin," 13th century
10. Glazed blue and white Delft tiling

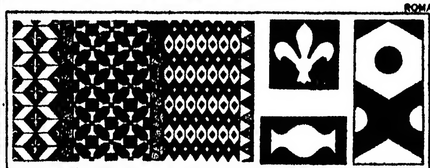


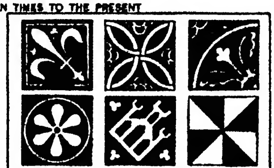
TYPICAL CLASSIC ROOFING TILES



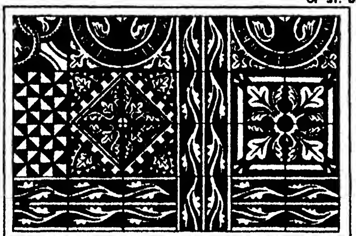
SO-CALLED "SPANISH" TILE USED IN LATIN COUNTRIES FROM ROMAN TIMES TO THE PRESENT

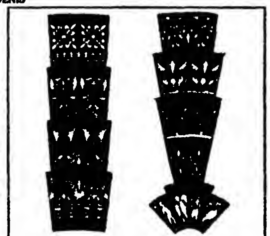

GREEK MARBLE TILE ROOF TEMPLE OF APOLLO, BASSAE 5TH CENTURY, B. C.

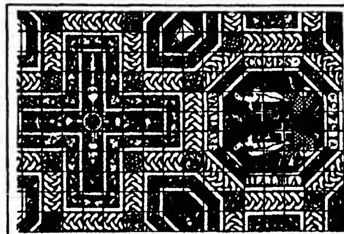

12TH CENTURY TILE FLOOR FROM MONASTERY OF STE. COLOMBE (YONNE) — DETAILS FROM A SIMILAR FLOOR IN THE ABBEY OF ST. DENIS


TYPICAL 14TH CENTURY FLOOR TILES


TYPICAL 13TH CENTURY FLOOR TILES


FLOOR OF THE CHAPEL OF THE CHATEAU D'HAULSY, (MARNE) 13TH CENTURY


PARTS OF A CIRCULAR PATTERN IN THE CHAPEL FLOOR FROM THE ABBEY OF CUNAULT 13TH CENTURY


FRENCH RENAISSANCE FAIENCE TILE FLOOR FROM THE CHATEAU OF POLISY (AUBE) 16TH CENTURY

CENTER AND LOWER ROWS, FROM EMILE AMÉ, "LES CARRELAGES EMAILLÉS DU MOYEN-AGE ET DE LA RENAISSANCE PRÉCÉDÉS DE L'HISTOIRE DES ANCIENS PAVAGES," (MOREL ET CIE.)

in the individual variation typical of ceramic ware that their use has been restricted to the cheapest type of jerry-built construction; their use, even there, is seriously questionable. Quite different are the roofing tiles of reinforced and water-proof concrete, which are common in industrial buildings, especially in Europe, although their use in America is increasing. These modern, industrial tiles are usually of large size—sometimes running to 4 ft. in length, and arranged to interlock, with the exposed surfaces grooved or channelled in such a way as to lead the water away from any joints. In these concrete tiles colouring matter is usually added in the material itself.

Roofing Tiles in the Far East.—Although the principle of the roofing tiles of China and Japan is the same as that in the West, there are many differences in detail. Thus, in temples and palaces in China, the under tiles are slightly concave and overlap, much like those of classic roofs; the covering tiles, however, are made absolutely cylindrical in general contour, with rebated ends, so that they form long, unbroken lines of shadow down the roof. Moreover, instead of the upright antefix of the classic roof, the Chinese tiles have ornaments that project downward, in generally scalloped shapes, over the face of the cornice. There is also, particularly in north China, a tremendous elaboration of ridge and hip tiles, which are frequently of great height, with an elaborately moulded section, and carry at their ends rows of animals, a great dragon or the like. At the ends of the ridge are large, grotesque beasts with their heads pointing inward; all these ornaments are modelled and baked in the tile itself. One of the chief glories of the Chinese roof tiles is their colour. This is produced by a shiny glaze that reveals the expected Chinese ceramic skill. The usual colour of temple and palace roofs is bright yellow but other colours frequently occur. In central and south China, even temple roofs are frequently black. The cheap roof tile of the ordinary house is also almost black, but without lustre and with overlapping covering tiles like those of the West.

The same pattern of rebatted, continuous, cylindrical covering tiles is common in the Buddhist shrines of Japan, but colours are rare, the ordinary tile being grey, with a very effective and artistic silvery lustre.

Floor Tiles.—Except as small fragments of tile occur in classic mosaic and terrazzo (*q.v.*), tile for floors does not seem to have been common in Europe prior to the 12th century. In the late 12th and 13th centuries, however, tile floors became usual in churches and other important buildings. The most common type consisted of square tile in two colours, usually a dark brown-red and a pale orange or brownish yellow. They were made by casting clay in such a manner that the parts to be in a lighter colour were sunk; when dry, these parts were filled with a clay of different composition which would burn to a lighter colour; the tile thus prepared was then burned. Patterns were formed of many tiles and consisted usually of circles or stars containing heraldic beasts, ecclesiastical symbols, etc.; in many cases the pattern was made with reversed colours, so that what was background colour in one tile was ornament colour in the one next it. In the earliest examples designs were formed by a mosaic treatment in which the pattern was made by the shape and size of the individual tiles, as in the 13th century example found at Fountains abbey and at Prior Crauden's chapel at Ely (1321–41), both in England. Other common types of mediaeval pavement have the pattern merely incised, producing the artistic effect of a sketch.

The development of floor tiles in Gothic France was similar. The 12th century examples are usually mosaic in type with black, dark green, light green and yellow as the predominating colours. The richest examples of these are in the abbey church of S. Denis, near Paris, where certain elaborate, chapel floor pavements still exist from the original building by Abbott Suger (1140–44). By

the end of the century, mosaic had yielded to two-coloured tiles of red and yellow, similar to the English tiles mentioned above. The same type remained constant until well into the 15th century, the designs becoming continuously thinner and more delicate; in the 16th century the art died out, superseded by the painted maiolica pavements of Renaissance feeling

The Gothic revival of the middle 19th century led, in England, to the revival of the designing and making of tiles of the mediaeval type and many modern pavements were placed in old churches as a result Most of this tile has a simple lead glaze and is made not by casting damp, plastic clay, as in the mediaeval examples, but by compressing powdered clay in steel dies so that shapes are more perfect and the rapidity of manufacture is vastly increased. This type of tile, usually known as "encaustic," is especially associated with the English ceramic works at Stoke-upon-Trent, particularly those of Minturn Recently, however, the manufacture of such tiles has become wide-spread in the United States and in Germany.

Meanwhile the Moorish skill in tile making had gradually come to be applied to floors. This type of maiolica tile was adopted in early Renaissance churches, both in Italy and Spain, although not many examples remain, as the glaze was too soft. The decoration of the Italian maiolica pavements consists of the same type of free and graceful classic arabesque trophies, acanthus ornament and coats of arms that is found on contemporary maiolica.

In France not only were Italian tiles imported and used, but there soon grew up a local manufacture of similar painted floor tiles, especially at Rouen (established by Masseot Abaquesne, 1542–57), Nevers and Marseilles With the increasing use of oak parquetry flooring for houses and marble for churches, toward the end of the 17th century, the use of tile diminished. There was similar importation of Italian and Spanish tiles into England during the early Renaissance and possible spasmodic attempts toward the making of certain types of this tile in England itself

In the 18th century the use of plain, undecorated, square, red tiles, now commonly known as quarry tiles, became common all over northern and western Europe, and to a less extent in the American Colonies

Although modern potteries all over the Western world are producing at the present time (1929) many varieties of elaborate, decorative floor tile, ranging from those in varied and brilliant colours with all sorts of blending glazes to the most complicated so-called Spanish tiles in relief, the greatest advances in modern floor tiles have been made in simple, vitrified, mosaic tiles for use in bath rooms, kitchens, swimming pools, etc. These are always machine pressed and are made of fine clays, thoroughly vitrified, and very hard. These are made in small squares, rectangles, hexagons and circles, in a few simple colours and are usually pasted, face down, on paper, in order to increase the speed of their application. (*See* MOSAIC) Some, by the addition of gritty substances, such as alundum or carborundum, are given a surface which prevents slipping, even when the tile is wet

Wall Tiles.—Earthenware was used spasmodically for wall decoration by the Egyptians, as in the doorway of the Abusir pyramid of Neterkhet (3rd Dynasty). More usually, however, they were in the form of mosaic (*q v*) Perhaps based upon earlier Egyptian examples, the people of Crete developed to an even higher degree the use of faience for walls. Thus our knowledge of early Cretan houses is largely furnished by many fragments of small faience plaques from the 18th century, B C., which formed portions of a large, mosaic, faience, wall decoration Moreover, there are in existence many modelled reliefs of faience from the middle and late Minoan period which were apparently inserted in the plaster of walls.

Farther east, in the Tigro-Euphrates valley, a tradition of ceramic wall decoration was early established (*See* WESTERN ASIATIC ARCHITECTURE.) This took the form of glazed and enamelled bricks rather than tiles proper It is, nevertheless, important, as being one of the first attempts to cover large and continuous wall surfaces with a decorative, ceramic material, and the friezes of marching beasts from Chaldean and Babylonian palaces, from the later Assyrian palaces and from their Persian successors, the famous friezes of the archers and the lions from the early 4th century palace of Artaxerxes II. at Susa, have remained models of this type of decorative work ever since. (*See* illustration of the Gate of Ishtar at Babylon, under BRICKWORK.) Moreover, the tradition of fine ceramic work continued vital throughout the stormy period of the fall of the Roman empire and the Mohammedan conquest It is in Syria, the Tigro-Euphrates valley and Persia that wall tiles were, undoubtedly, first made. Thus tradition relates that the lustre tiles of the mosque of Sidi Okba at Kairouan were brought from Baghdad in 894, and it is certain that by the 13th century the manufacture of wall tiles for both exterior and interior use was well established in various centres in Persia, notably Rhages and Veramine. The exterior use of wall tiles was most highly developed, and in Persia, also, the transition from enamelled and modelled brick to true, thin tile can easily be seen By the 15th century tile decoration was supreme in Persia and the character had changed. Mosaics and mouldings in relief yielded to a flat treatment with the richness entirely in the coloured, foliated ornament and the inscriptions painted on the tiles themselves. In later Persian art there is no distinguishable difference between the tiles of the exterior and the interior.

It was these Persian tiles which governed the taste of the eastern part of the Mohammedan world; the same running patterns of leaves, palmettes, the carnation and other flowers that appear on Persian carpets, decorate alike the interiors of mosques in Persia, Mesopotamia and Turkey, from potteries as far apart as Rhodes, Damascus and Kutayieh. In colour these have, universally, a blue-white ground with patterns predominantly blue and green and lesser touches of vermilion and rose and occasional yellows Several potteries in Asia Minor still operate and produce exquisite wall tiles in the traditional patterns and colours. Because of the gracious delicacy of the interlacing stems and the careful spacing of the leaves and flowers, together with a spring-like clarity of the colours, these Turkish, Syrian and Persian wall tiles are among the most perfect wall decorations of their type

Moorish Wall Tiles.—Farther west, in Spain and north Africa, the Mohammedan potters were developing a new type of design which gave rise to the famous Spanish *Azulejos*, whose decorative richness was such an important feature in the Alhambra at Granada (14th century), the so-called house of Pilate at Seville and similar buildings. Although transitional types occur, like the great plaque from Malaga at the beginning of the 15th century in the collection of M de Osma, in which the patterns are of an almost Persian freedom, with twining foliage, in the greater number the design was almost purely geometric, being formed of interlacing lines that generate 8- and 10-pointed stars, octagons, irregular pentagons and similar figures. There are, in addition, a great many early tiles from the 13th and 14th centuries in which the influence of Christian heraldry is dominant Even in the transitional plaque mentioned above, coats of arms appear and it is evident that the Mohammedan potters produced much purely heraldic tile work for Christian consumption Many of these tiles are rich with metallic lustre decoration; the chief colours are blue, green and brown, with white lines, and in the later work a growing use of black and yellow The earliest examples of Moorish wall tiles produced their geometric patterns by a mosaic method in which each bit of separate colour is formed by a separate tile. In order to develop a more facile method of producing the same effect, the technique known as *cuerda seca* (dry cord), in which the tiles are rectangular, and the pattern on each tile is formed by raised fillets between the different colours, which prevented the adjoining enamels from running together. After the Christian conquest a third method was introduced, called *cuenca* (bowl), somewhat similar to the northern Gothic process in which the portions to be coloured were depressed and then filled with their enamels. These tiles, even in their old traditional Mohammedan patterns, were popular throughout the 16th century and even later for wainscots in Renaissance houses. The potters were evidently Moors; the great centres of manufacture remained as before in Malaga, Valencia, Granada and Seville In the 16th century the Italian maiolica type of tile was introduced by Francesco Niculoso of Pisa, and these Spanish maiolica tiles

were much used, as in the door of the convent of S. Paula at Seville (early 16th century) or the exquisite altar-piece in the Alcazar at Seville made by the same artist in 1503, where the design is purely Italian. Both the *cuenca* and the *pisano* or majolica types of tile have been made in Spain almost continuously ever since, and the recent years have seen a great increase in the Spanish tile output both in Spain and for export.

Meanwhile in Germany there had been developing a type of tile used principally for stoves, with ornament in relief and a glaze of green, yellow or brown. This tile was in widespread use as early as the 14th century and many examples exist throughout Germany, upper Austria and Switzerland, in which the ornament is of great richness, with Gothic architectural forms in the earlier types and Renaissance forms later.

The most important of the north European tiles are undoubtedly those made in Delft from 1600 on. These are plain, square tiles, each containing a figure, a bit of landscape or a genre group, freely painted in a grey-blue upon a background of bluish-white. The little free-hand sketches were so instinct with life, and the colour so subtly beautiful that by the middle of the 17th century these tiles enjoyed a great vogue, not only throughout the Germanic countries, but in England and the American Colonies as well. Although outside of Holland they were chiefly used for fireplace and stove facings, in Holland itself they were often employed for wall wainscotings Some of the later examples have the decorations in manganese purple instead of blue During the 18th century many attempts were made to imitate the Delft ware and during the latter half of the 18th century, particularly in England, scenes printed from copper plates were used instead of the painted scenes

Although many of the ancient pottery centres are still producing tiles in the traditional manner and although modern imitations of old wares are of excellent quality, the greatest modern contribution to wall tile design has been the great development of square or rectangular tiles with relatively uneven surfaces and shapes on which colours and glazes of the greatest variety are unevenly flowed, so that each tile has marked individuality of colour and texture All sorts of crackled and crystalline effects are common as well as the blending of two or more colours The scientific development of glazings and colourings gives the decorator an almost unlimited palette for either exterior or interior use, even gold tiles being simple and comparatively inexpensive There has been a corresponding development in the use of tile in relief, usually with the background sunk and glazed in a different colour.

Important centres of tile production at the present day (1929) are: Asia Minor, for so-called Persian tiles; north Africa and Spain, for Moorish and Spanish tiles; north Italy for faience; Holland for "Delft" tiles, Belgium for many types of hand-made wall tiles; Germany for polychrome, machine-pressed floor tiles; England for reproductions of Gothic floor tiles and richly figured tile work generally; and the United States, particularly New Jersey, Pennsylvania, Ohio and southern California for vitrified floor and hand-made wall tiles.

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TILE-FISH (*Lopholatilus chamaeleonticeps*), a beautifully coloured fish of the family Latilidae, living in rather deep water in the western Atlantic. It was first discovered on a bank about 80 m. S E. of Boston, and proved to be a valuable food fish.

The tile-fish is said to reach a weight of 50 lb, but about 10 lb. is more nearly the average size.

TILING OF ROOFS: *see* ROOFS; TILE.

TILLAGE. The word "tillage" is practically synonymous with cultivation (*q.v.*), but it is of Saxon derivation and older usage. It is often employed in the form "tillages" in tenant right valuations and denotes the operations by which land has been prepared for crops by the outgoing tenant.

Tillage conveys perhaps a simpler and more drastic significance than cultivation. The first implement of tillage was the spade and it still remains, after thousands of years, the most effective.

The importance of agricultural engineering has recently been recognized and investigations into theoretical and practical questions affecting tillage are in progress throughout the world. (*See* TRACTORS; AGRICULTURAL MACHINERY)

TILLEMONT, SÉBASTIEN LE NAIN DE (1637–1698), French ecclesiastical historian, was born in Paris on Nov 30, 1637. The boy was brought up in the little schools of Port Royal, and in 1660 he was made a tutor in the seminary of Buzenval, Jansenist bishop of Beauvais Ten years later he came back to Paris, and presently became a chaplain at Port Royal. In 1679 the storm of persecution drove him to settle on his family estate of Tillemont, where he spent the remainder of his life, dying on Jan. 10, 1698

From the age of twenty he was at work on his two great books—the *Mémoires pour servir à l'histoire ecclésiastique des six premiers siècles*, and the *Histoire des empereurs* during the same period. Both works began to appear during his lifetime—the *Histoire* in 1690, the *Mémoires* in 1693—but in neither case was the publication finished till long after his death There is a full account of his life in the 4th volume of Sainte-Beuve's *Port Royal*

TILLETT, BENJAMIN (1860–), British Labour politician, was born at Bristol, on Sept. 11, 1860 He started work in a brickyard at eight years, and was a "Risley" boy for two years He served six months on a fishing smack, was apprenticed to a bootmaker, and then joined the Royal Navy He was invalided out of the navy and made several voyages in merchant ships. He then settled at the London docks and organized the Dockers' union of which he became general secretary, taking a prominent part in the dock strike of 1889 He was one of the pioneer organizers of the General Federation of Trades, National Transport Workers' Federation, National Federation of General Workers, International Transport Federation, and of the Labour party For many years he was an alderman on the London County Council. He was M P for North Salford from 1917 to 1924, and was re-elected in 1929.

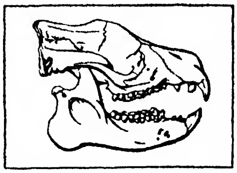
His publications include *A Brief History of the Dockers' Union* (1910), and *A History of the Transport Workers' Strike* (1911).

TILLEY, SIR SAMUEL LEONARD (1818–1896), Canadian statesman, was born at Gagetown, New Brunswick, on May 18, 1818, the son of Samuel Tilley, an American Loyalist, who had settled in St John in 1783. From 1860 to March 1865 he was premier of the province, and was prominent in organizing the conference on the union of the maritime provinces, which met at Charlottetown in 1864, and which soon widened into a discussion of Canadian federation In 1865 he was defeated in a general election on the federation question, but returned to power in 1866, partly through an intrigue of the colonial office From 1868 till November 1873 he held various portfolios in the Dominion cabinet; from 1873 to 1878 he was lieutenant-governor of New Brunswick, but in 1878 was again elected as member for St John, and entered the Conservative cabinet as minister of finance. Later in 1878 he introduced and carried through parliament the "national policy" of protection, on which issue the election of 1878 had been won. The tariff so introduced became the basis of Canadian financial policy. In October 1885 ill health forced him to retire from the cabinet. He was again lieutenant-governor of New Brunswick from 1885 to 1893. He died on June 25, 1896.

His *Life*, by James Hannay (1907), forms one of the "Makers of Canada" series.

TILLODONTIA, a group of extinct mammals from the Eocene of North America and Europe. The average size was about that of a living brown bear. The canine teeth are very

small, one pair of incisors in each jaw much enlarged and chisel-like The general structure is very primitive, the brain small and elongate, the cheek teeth of generalized (tuberculo-sectorial) type, the feet plantigrade, with five toes. The skull is more carnivore- than rodent-like in general aspect. The best known genera are *Tillotherium*, *Esthonyx* and *Trogosus*. Despite the relative large size of its members, the group is probably more suggestive of the Insectivora than of any other established order and it is apparently an early, extinct, rather aberrant offshoot of the earliest stock of the placental mammals. (G. G. Si.)



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY
THE SKULL OF THE TILLOTHERIUM FODIENS, AN EXTINCT MAMMAL

TILLOTSON, JOHN (1630–1694), English archbishop, was the son of a Puritan clothier in Sowerby, Yorkshire, where he was born in October 1630. He was a fellow of Clare Hall, Cambridge, and about 1661 he was ordained without subscription by T. Sydserf, a Scottish bishop. Tillotson was present at the Savoy Conference in 1661, and remained identified with the Presbyterians till the passing of the Act of Uniformity in 1662. Shortly afterwards he became curate of Cheshunt, Herts., and in June 1663, rector of Kedington, Suffolk. He now devoted himself to an exact study of biblical and patristic writers, especially Basil and Chrysostom. The result of this reading, and of the influence of John Wilkins, master of Trinity College, Cambridge, was seen in the general tone of his preaching, which was practical rather than theological. In 1664 he became preacher at Lincoln's Inn. The same year he married Elizabeth French, a niece of Oliver Cromwell; and he also became Tuesday lecturer at St Lawrence, Jewry. In 1670 he became prebendary and in 1672 dean of Canterbury. In 1675 he edited John Wilkins's *Principles of Natural Religion*, completing what was left unfinished of it, and in 1682 his *Sermons*. With Burnet, Tillotson attended Lord Russell on the scaffold in 1683. It was partly through Lady Russell that he obtained influence with Princess Anne, who followed his advice in regard to the settlement of the crown on William of Orange. He possessed the special confidence of William and Mary, and was made clerk of the closet to the king and dean of St. Paul's. On his advice the king appointed an ecclesiastical commission for the reconciliation of the Dissenters. He was elected to succeed the Nonjuror Sancroft as archbishop of Canterbury, but accepted the promotion with extreme reluctance, and it was deferred from time to time, at his request, till April 1691 In 1693 he published four lectures on the Socinian controversy. He died on Nov. 22, 1694.

Ralph Barker edited his *Sermons* together with the "Rule of Faith" (14 vols. 1695–1704). In 1752 an edition of his *Complete Works* appeared in 3 vols, with *Life* by Thomas Birch.

TILLY, JOHANN TZERCLAES, Count of (1559–1632), general of the Catholic League in the Thirty Years' War, was born in 1559 at the château of Tilly in Brabant. He was destined for the priesthood and received a strict Jesuit education. But, preferring the career of a soldier, he entered a Spanish foot regiment about 1574 as a volunteer, and in the course of several campaigns rose to the command of a company. This being reduced, he again became a simple pikeman, and as such he took part in the famous siege of Antwerp by Parma. He distinguished himself by his bravery, and the duke of Lorraine gave him the governorship of Dun and Villefranche, which he held from 1590 to 1594. Henry IV. attempted unsuccessfully to induce him to enter the service of France. Somewhat later he left the Spanish service for that of Austria to fight against the Turks. In 1602 he became colonel in the imperial army, and raised a regiment of Walloon infantry which he commanded in the assault on Budapest, receiving a severe wound. In 1604 he was made general of artillery; having shown great capacity and devotion to the emperor and the Catholic religion, he was made a field-marshal in 1605. In 1610 he left the service of the emperor to enter that of Maximilian, duke of Bavaria, the head of the Catholic League. In 1620 he became lieutenant-general to Maximilian and commander-in-chief of the field forces.

With the victory of the White Mountain (1620) the new army and its leader became celebrated throughout Germany and the subsequent campaigns (*see* Thirty Years' War) established their reputation. The battle of Höchst (1622) won for Tilly the title of count.

The defeat of King Christian was soon followed by the intervention of Gustavus Adolphus. The opening stages of the campaign did not display any marked superiority of the Swedes. At this time Tilly was commander of the imperial forces as well as of his own army. The first great contest was for the possession of Magdeburg (1631). Tilly has been blamed for the atrocities which accompanied the sack of this town after its fall (May 20). Yet his personal exertions saved the cathedral and other religious buildings from pillage and fire Four months later Tilly and Gustavus, the representatives of the old and the new art of war, met at Breitenfeld (*q.v.*). The victory of Gustavus was complete, though the imperial general, although severely wounded, drew off his men in good order. On the Lech, a few months later, Gustavus was again victorious, and Tilly received a mortal wound He died on April 30, 1632, in Ingolstadt.

See O. Klopp, *Tilly im 30-jährigen Krieg* (Stuttgart, 1861); K Wittich, *Magdeburg, Gustav Adolf und Tilly;* also memoir of Tilly in *Allg. deutsche Biographie;* Keym-Marcour, *Johann Tzerclaes, Graf v. Tilly;* Villermont, *Tilly, ou La Guerre de trente ans* (Tournay, 1859).

TILSIT, a town in the Prussian province of East Prussia, situated on the left bank of the Memel or Niemen, 57 m. S E. of Memel and 72 N.E. of Königsberg by rail. Pop. (1925) 51,071. Tilsit, which received civic rights in 1552, grew up around a castle of the Teutonic order, known as the "Schalauner Haus," founded in 1288. It owes most of its interest to the peace signed here in July 1807, the preliminaries of which were settled by the emperors Alexander and Napoleon on a raft moored in the Memel This treaty, which constituted the kingdom of Westphalia and the duchy of Warsaw, registers the nadir of Prussia's humiliation.

TIMAEUS (*c.* 345–*c.* 250 B C), Greek historian, was born at Tauromenium in Sicily. Driven out by Agathocles, he migrated to Athens, where he studied rhetoric under a pupil of Isocrates and lived for 50 years. During the reign of Hiero II he returned to Sicily (probably to Syracuse), where he died. While at Athens he completed his great historical work. The *Histories*, in at least 38 (Bury says 33) books, was divided into unequal sections, containing the history of Italy and Sicily in early times; of Sicily alone; of Sicily and Greece; of the cities and kings of Syria (unless the text of Suidas is corrupt); the lives of Agathocles and Pyrrhus, king of Epirus. The chronological sketch ('Ολυμπιονῖκαι, the victors at Olympia) perhaps formed an appendix to the larger work. Timaeus was bitterly attacked by other historians, especially by Polybius.

The most serious charge against Timaeus is that he wilfully distorted the truth, when influenced by personal considerations. thus, he was less than fair to Dionysius and Agathocles, while loud in praise of his favourite Timoleon. On the other hand, as even Polybius admits, Timaeus consulted all available authorities and records. His attitude towards the myths, which he claims to have preserved in their simple form, is preferable to the rationalistic interpretation under which it had become the fashion to disguise them. In chronology, he introduced the system of reckoning by Olympiads, with which he compared the years of the Attic archons, the Spartan ephors, and the priestesses of Argos This system was afterwards generally used by the Greek historians. Timaeus' prose is of the Asiatic school; Cicero praises it.

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TIMARU, a seaport of Geraldine county, New Zealand, on the E. coast of South Island, 100 m. S.W. of Christchurch by rail. Pop. (1927) 15,635. The slight inward sweep of the coast forms the Canterbury Bight, and the shore-line northward from

Timaru is called the Ninety-mile Beach. The harbour is formed by breakwaters enclosing a space of 50 acres. Chief exports are wool, flour and frozen meat, and the industries are in connection with these. Opals are found in the district. Timaru is the chief town in South Canterbury district.

TIMBER. The terms "wood" and "timber" are not synonyms, for wood occurs in the veins of leaves and as strings in thick palm-stems, also in thicker cylindrical form in twigs of shrubs and trees. The term timber, synonymous with the North American term *lumber,* applies solely to wood of considerable dimensions produced by trees. (*See* LUMBERING.)

Two great classes of trees provide timber. (1) *Conifers,* including pines, spruces and larches, usually have more or less needle-like leaves, and their naked seeds are most frequently borne on cones: they yield the so-called *softwoods.* (2) *Dicotyledons,* including oak, ash, beech and teak, commonly have broader flat leaves and their seeds are always produced in closed seed-cases: they provide the *hardwoods.*

Origin and Structure of Timber.—The part of the tree above ground typically consists of a main *trunk* and the branch-system whose ultimate finest branches are the leaf-bearing twigs.

The trunk and branches grow in *length* solely at their tips, so that the oldest part of a trunk or branch is its base and the youngest is its slender tip But after a portion of a trunk or branch has ceased to grow in length it can grow in *thickness* year after year and especially by producing new wood This takes its origin from a microscopically thin sheet, the *cambium,* lying between the bark and the wood: the cambium deposits new wood outside the pre-existing wood. In the cool-temperate climate the cambium produces new wood only during spring and part of the summer and is inactive during autumn and winter: the wood produced first in each year is frequently (*e g.,* ash, Scots pine) different from that produced later in the year, so that a distinction is drawn between the early *spring-wood* and the later *summer-wood* (frequently termed *autumn-wood*). In such cases a cross-section of the tree-trunk will show a number of concentric *annual rings,* whose number is equal to the age of the region of trunk cut. In the case of the beech and a number of other trees, the annual rings show no marked differentiation into spring-wood and summer-wood, but are recognisable because a very thin layer produced latest in the growing season differs in appearance from the rest of the wood. Finally many kinds of evergreen tropical trees (*e.g ,* mahogany) show no distinct annual rings

In certain kinds of trees, for instance species of pines and leaf-shedding oaks, after the wood has attained a certain age it darkens in colour, so that when a cross-cut of a 100-year old part of the trunk is taken the darker older central wood contrasts as *heart-wood* with the surrounding pale *sap-wood.*

Structure of Wood.—With the aid of the microscope it can be seen that a softwood consists mainly of very narrow hollow spindle-shaped "fibres" (properly, tracheids), running parallel to the long axis of the trunk or branch The solid wall of each fibre consists of wood-substance and on at least two of its sides shows a series of thin round patches, the pits, through which water or sap can pass from fibre to fibre.

In addition to the fibres, certain softwoods, including those of true pines, have very thin resin-containing tubes, the *resin-ducts,* which run parallel with the fibres. In structure each duct in microscopic miniature recalls a tall factory chimney, as its central tubular hollow is surrounded by microscopic, short, more or less brick-shaped cells, which are hollow and have thin walls. All commercial softwoods (excluding that of the yew) contain resin but some of them (*e.g.,* Californian redwood) have in place of resin-ducts merely resin-containing short cells.

Traversing the wood at right angles to the fibres are thin string-like or ribbon-like structures that run from the outside of the wood radially inwards towards or actually to the pith. These are the *medullary rays,* which are usually nearly or quite invisible to the naked eye in cross-sections of softwoods. They consist of more or less brick-shaped cells, which in the sap-wood contain albuminous substances and at times such other nutritive substances as sugar, starch or fatty oil: in the sap-wood they consequently invite attack by animals and fungi. Softwoods that, like true pines, have resin-ducts in the wood also possess these in the thicker medullary rays.

The fundamental difference between softwoods and hardwoods is best understood if we imagine a number of the wider "water-fibres" very greatly widened and strung end to end with their terminal walls absorbed, so that long continuous tubes, sometimes yards in length, are produced. These water-conducting tubes are termed *wood-vessels:* in cross-section they are often visible to the naked eye as *"pores"* All commercial hardwoods have wood-vessels, which in the sap-wood contain air with or without liquid sap In addition to the vessels, the different hardwoods have "fibres" of various forms.

Finally medullary rays are present, and in many hardwoods some of them are much thicker than in softwoods and visible to the naked eye in cross-section, producing the so-called "silver grain" on the radial side view of the wood of, for instance, oaks, beech, plane, etc. Their contents in the sapwood are identical with those of softwoods.

Sap-wood and Heart-wood.—The change of sap-wood into heart-wood is a vital one, occurring only in the living tree, and thus is very different from the process of seasoning of timber which takes place *post mortem.* The sap-wood is living inasmuch as its brick-shaped cells contain living protoplasm· the heart-wood is dead, as the protoplasm dies and the cells lose their nutritive contents, which are replaced by air and more indigestible substances such as "tannin," gums and resin The heart-wood contains less water than the sap-wood, and its water-conducting elements ("fibres" and vessels) become more or less plugged by microscopic bladders or gums, or the pits are closed Consequently sap-wood is more easily impregnated with wood-preservative liquids than is heart-wood of the same tree. In different trees the age at which sap-wood first changes to heart-wood differs. for instance the change takes place earlier in larches than in true pines, so that the former have fewer annual rings of sap-wood outside the heart-wood and produce valuable durable heart-wood earlier in the life of the tree, and contain a smaller proportion of the perishable sap-wood (*see* DRY ROT).

Grain of Timber.—Most frequently the fibres and other structural elements of knotless timber run parallel with the long axis of the trunk or branch, and the wood is described as being *straight-grained.* If a plank or post be sawn in a direction not parallel to the axis of the trunk, the grain of the sawn article is not parallel to the sides of this and the plank or post is described as *cross-grained* But not infrequently the grain of the trunk (or branches) runs in a spiral direction as if the trunk had been twisted round its long axis: the grain is then described as *spiral* or *torse,* and the timber when cut up is inevitably cross-grained There are yet other, especially tropical, woods in which the grain more or less swings from a left-handed to a right-handed spiral direction, so that the wood when cut into plain boards shows a *double cross-grain* or *interlocked grain,* and when cut along the radii of the trunk ("on the quarter," rift-sawn) shows *roe-figure,* for instance in mahogany.

In addition to these deviations from the straight grain the structural elements of the wood may pursue a wavy or *sinuous* course, for instance in so-called rammy-ash. When the waviness is exaggerated the grain is said to be curly.

Knots, being the basal parts of branches that have become embedded in the thickening trunk, are naturally associated with a change of direction of the fibres The wood of large excrescences on the trunk of certain trees known as *burrs* exhibits structure similar to that which would be produced by many crowded branches: and a somewhat similar structure is shown by bird's eye maple.

The fibres of most timbers overlap and dovetail with one another at their ends, which are at different levels, and the medullary rays as seen in circumferential or tangential view are arranged apparently irregularly or in spirals But some woods when examined from the same view-points show lines running across the grain and producing what is known as *ripple-marking:* this is

caused by either contiguous fibres ending at the same levels with little or no overlapping or medullary rays placed at the same levels, so that the structure of the wood is *tiered.* Such structure is often shown by true American mahoganies

Chemical Composition.—The wood-substance composing the walls of the hollow structural elements that constitute the solid frame-work or skeleton of wood may, for the present purpose, be regarded as always being composed of two main constituents, *lignone* and *cellulose,* together with smaller quantities of additional more or less gum-like bodies The lignone can be removed from the wood by steam or warm weak acids (and is so removed in the manufacture of chemical wood-pulp), the cellulose remaining.

The various substances here described collectively as cellulose are carbohydrates, which may be popularly defined as sugars or substances capable of being converted into sugars Thus cellulose of wood yields for instance a sugar, glucose, which by fermentation can produce ethyl alcohol (spirits of wine) Cellulose by appropriate treatment with nitric or acetic acid produces soluble compounds which when precipitated serve to make artificial silk, dopes, films (collodion, etc.), and in the case of nitric acid, explosives

The general agreement of all kinds of timbers as regards chemical composition is illustrated by the fact that all these under destructive distillation yield tar and tar-derivatives and methyl alcohol (wood spirit).

But the various kinds of wood also have additional chemical bodies which differ in the different species, and include tannin-like bodies, resins, scented ethereal oils and colouring substances

Physical Constitution.—Physically wood-substance is a very stiff jelly or *gel,* and consequently is comparable with glue, gelatin or gums Like these, it is hygroscopic and swells as it absorbs water and shrinks as it dries Wood-substance can take up only a definite amount of water, which lies near 30% of its dry weight when the wood is in a saturated atmosphere A piece of wood containing this maximum amount in its walls but none in its cavities is described as having reached *fibre-saturation point,* and has attained its maximum volume: when liquid water is added to it the water remains in the cavities and no additional swelling ensues.

It is a familiar fact that when water is added to dry glue or gelatin these show a decline in hardness, strength and stiffness, and a rise in flexibility and extensibility: as wood-substance is a gel, the same changes in its properties take place when water is added to a piece of dry wood until fibre-saturation point is reached. Moreover, just as when heat is applied together with water to glue this shows increased loss of stiffness (by "melting"), so when moist steam is applied to wood this can readily be bent for the manufacture of furniture and so forth

The weight or heaviness of wood is recorded as the weight of a unit of volume of the wood, which is the density The units employed in the British Empire and United States are cubic feet and pounds avoirdupois: elsewhere, and in scientific work, they are cubic centimetres and grammes

Since the fundamental chemical composition of wood-substance approaches identity in all timbers, its specific gravity in these varies but slightly and lies near 1·55; that is, dry wood-substance weighs slightly more than one and a half times as much as water. Consequently when two perfectly dry pieces of wood of equal size differ in weight, the one is heavier than the other because it contains more wood-substance, in other words the density of perfectly dry wood is a measure of the amount of wood in a unit volume The various kinds of timbers differ in their densities, some woods, including ebony and box, even when fully seasoned, sink in water, whereas some balsa-woods are lighter than cork. Consequently density facilitates identification of different woods.

Water Content.—The amount of water present in a piece of wood is of profound practical importance, since it determines the weight (consequently cost of transport), size, shape, heat-raising power, hardness, strength and stiffness of the piece, as well as the vulnerability of the wood to attacks by fungi and insects: it also determines the changes in these characters that will ensue when the wood is transferred to another place.

In commerce the water-content of the wood is recorded as the percentage weight of the wood and contained water, but in scientific work and in this article, as a percentage weight of the wood when it is absolutely dry. According to the latter method of recording, a log of wood is described as containing 200% of water when it contains 200 lb of water to every 100 lb. of dry wood. Such a high water-content does occasionally occur naturally, for instance in freshly felled swamp (Louisiana) cypress; more frequent in freshly felled timber is 100% in the sap-wood. Heart-wood contains much less. Here a popular error must be corrected in cold-temperate regions the wood of a tree does not contain less water in winter than in summer; often the reverse is the case.

When exposed to the open air, preferably under cover, a freshly felled piece of wood dries and shrinks until the water-content at its surface has a vapour pressure equal to that of the atmosphere The water-content of pieces of timber thus seasoned in the open air, and not too massive, varies according to the season and site between 15 and 20% in Great Britain but is much less in drier climates, for instance, that of Egypt, in which it may be 6%

Brought indoors into heated work-shops or rooms further drying and shrinking takes place, so that furniture in Great Britain contains about 7 to 9%, and in drier parts of South Africa and the United States only 6% or less

Placed in a drying oven at a temperature of 100°C, all the water, save that which is chemically combined, is regarded as having been dried out and the wood is described as absolutely dry. When dry wood is once more exposed to moister air it reabsorbs water and swells.

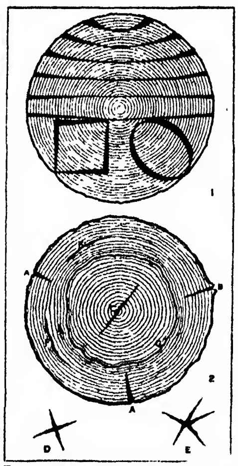
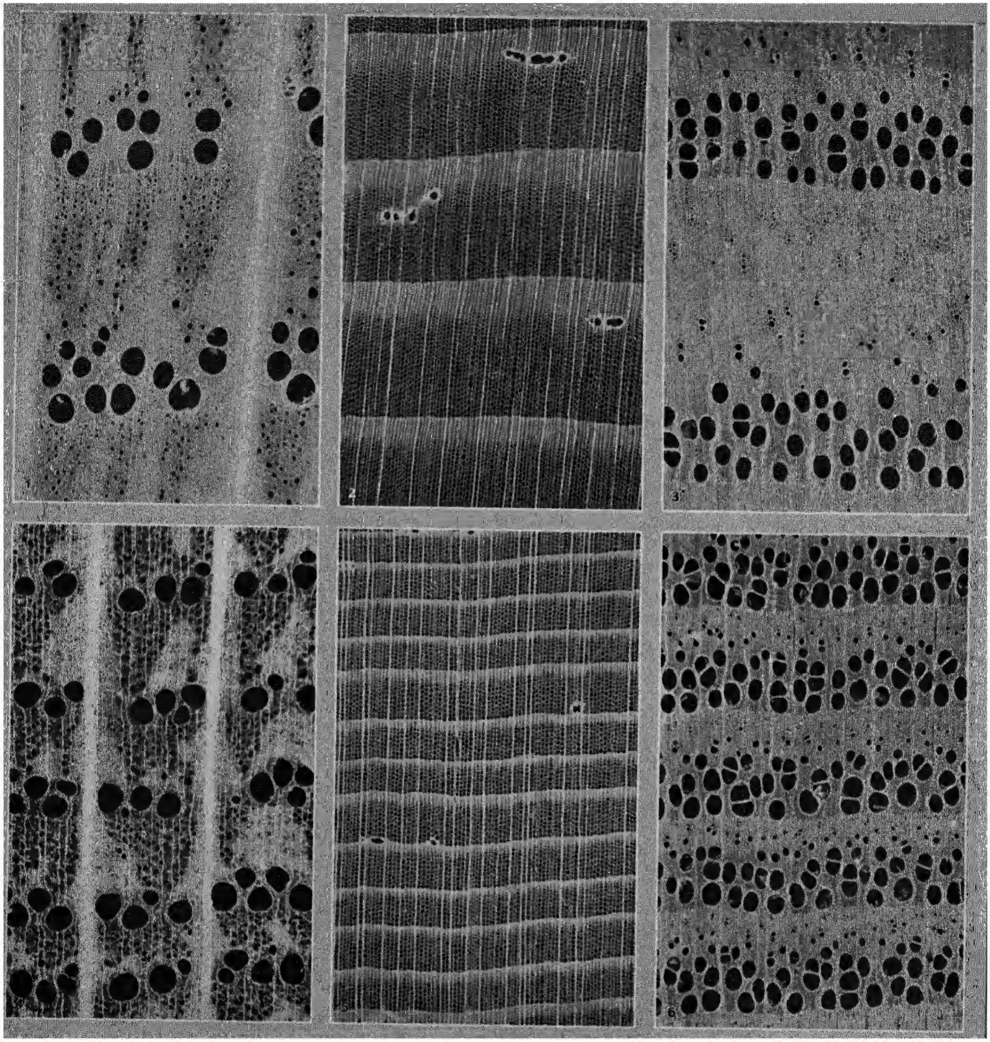


FIG 1.—SHRINKAGE AND CHANGE OF SHAPE INCLUDING WARPING
FIG. 2 —SHAKES AND SPLITS (A) SEASONING SPLIT (B) FROST-RIB AND SPLIT (C) SIMPLE HEART-SHAKE (D) DOUBLE HEART-SHAKE (E) STAR-LIKE HEART-SHAKE (F) PARTIAL CUP-SHAKE (G) COMPLETE CUP-SHAKE

Different kinds of wood undergo different changes of volume with the same percentage gain or loss of water: heavy or non-resinous woods generally shrink or swell more than do light or resinous woods, with the consequence that softwoods usually show smaller changes of shape and volume than do hardwoods. But shrinkage and swelling are not proportional to density, for non-resinous woods of the same density show considerable differences in this respect; for instance, Central American mahogany with changed water-content undergoes comparatively slight change of size and shape

A piece of wood tends to shrink and swell unequally in different directions. Along the grain shrinkage and swelling are so slight that measuring rods made of well-seasoned wood are very reliable. Across the grain shrinkage and swelling are many times as great: in a radial direction 30 to 50 times and tangentially (or parallel to the annual rings) 60 to 100 or more times Consequently when a piece of wood dries it undergoes greater or less change of shape. The accompanying diagrams show cross-sections of pieces of wood respectively cut into boards, joists and cylindrical rods, and the change of shape caused by drying; the warping of boards 2 to 4 contrasts with the preservation of flatness of board 1 which is cut nearly parallel to the radii (quarter-cut or rift-sawn).

A piece of wood whose fibres, like those of very knotty wood or burrs, run in various directions obviously is especially liable to split when dried. It is partly for this reason that the burr-wood used in the manufacture of beautifully figured furniture is cut



BY COURTESY OF THE FOREST PRODUCTS RESEARCH LABORATORY OF GREAT BRITAIN AND THE IMPERIAL FORESTRY INSTITUTE OF THE BRITISH EMPIRE

MAGNIFIED TRANSVERSE SECTIONS OF TIMBER

Upper and lower photographs illustrate respectively broad and narrow annual rings of Oak, *Quercus robur* (1, 4), Douglas Fir, *Pseudotsuga taxifolia* (2, 5), and Ash, *Fraxinus excelsior* (3, 6). The spring-wood of their annual rings, produced at the beginning of the growing season, is more open or porous, and weaker than the summer-wood, produced later in the season. The proportion of weak spring-wood is greater in the wide than in the narrow rings of the Douglas Fir, but the reverse is the case in the Oak and Ash

into very thin sheets, termed *veneers,* which are glued on to straight-grained wood. *Plywoods* (including the commonest of these, three-plywood) consist of thin veneer-like sheets glued together so that the grains of the successive sheets cross one another at a given angle (usually at right angles), with the consequence that plywood warps less and shrinks more uniformly than does plain wood and is less unequal in strength in different directions.

Colour.—The different kinds of wood may be wholly white or in the heart may be black or have colours ranging from brown, yellow, red, green to violet, or mixtures of these. It is quite exceptional for one and the same wood when perfectly sound to show such a wide range of variation as does that of *Liriodendron* (whose English name is Canary white wood and North American name is yellow poplar): this wood varies in colour from light yellow to green and iridescent blue. The colour thus facilitates identification and helps to decide the decorative use to which a wood shall be put. It is not true that dark coloured woods are more durable than light coloured, though this is true of the heart-wood when compared with the sap-wood of the same timber. Abnormal discolouration of wood is very frequently caused by fungi attacking the wood or its contents, such as the case with the *blue sap(wood)* of softwoods, rusty red of woods attacked by various fungi (including some causing dry rot), black lines and white patches of many rotting timbers, and sometimes false heart-wood in trees which normally lack a coloured heart-wood

Heating Power.—The heat-yielding power of a piece of wood sinks with increase of the water-content of this. consequently the succeeding remarks refer to wood absolutely dry. During the combustion of wood the heat liberated is mainly derived from the wood-substance. as the weight of this in a unit volume of wood is the density, it follows that the heavier a wood is the more heat can it supply. the presence of resin in wood, however, increases the heat-giving power. But when wood is used as fuel the most important character often is the form in which the heat is liberated Very heavy woods produce short or no flames and burn slowly, light woods can produce long flames and burn fiercely: consequently for fire-lighting or steam-producing the latter are used, whereas for keeping rooms warm, woods of intermediate density (*e g.,* oak, beech) are most efficient

Mechanical Properties.—The trunk and woody branches of a tree owe their strength and stiffness mainly to their wood Accordingly, wood must possess strength to resist breakage or permanent damage by slow crushing, stretching, bending and twisting; it must also resist shock in the form of sudden application of these stresses it must possess sufficient stiffness to give the requisite pillar-strength to the trunk, and when a deforming stress is removed must return to its former shape.

In conformity with its difference of structure along and across the grain, wood differs in strength and stiffness in these two main directions. As regards crushing (compression) and stretching (tension) wood is strongest and stiffest along the grain, and weakest at right angles to this: but as regards shear it is strongest at right angles to the grain: a beam in bending is strongest and stiffest when the load is applied perpendicular to the grain Consequently, joists, beams, floor-boards, posts, axe-handles, wheel-spokes and so forth are strongest when their grain is straight and parallel to the sides of these objects, and they are weakened by cross-grain and considerable knots.

The remarkable mechanical property of wood is its combination of strength and lightness: for instance, if the crushing strength be divided by the density in the cases of constructional wood and iron, steel and other metals, the resultant value is highest in wood Nevertheless, the tensile strength of steel or iron is so much higher than that of wood that one of the former is used in engineering construction for members required to resist rupture by tension, whereas wood is often used where resistance to bending or compression is needed. (*See* STRENGTH OF MATERIALS.)

The peculiar *elastic* properties of wood render possible its employment as resonance-wood, used for instance in the bellies of violins, and the sounding boards of pianos. Wood undergoing decay soon declines in strength and elasticity, and even when only partly decayed emits when struck a dull, in place of a sharp ringing sound.

Wood, thanks to its structure, elasticity, low tensile strength, and relative softness, can be riven or *cleft* along the grain and yields a more or less smooth surface.

Defects of Timber.—(*a*) *Standing Tree.* Wood may have structural peculiarities that represent defects from the mechanical point of view but may enhance the value because of the decorative effect. This is the case where *deviations of the grain* such as wavy or curly grain, or abundance of knots, weaken the wood.

Always decreasing the value of timber are long splits, termed *shakes,* directed along the grain of the standing tree. These in cross-section may run parallel with the annual rings (or contour of the trunk) and are termed *cup-shakes,* and may assume the form of short arcs or complete circles (*ring-shake*): in the latter case when the log is sawn the central part separates from the outer part. But in cross-section the shake may run in a radial direction, it is then a *heart-shake* such a shake is widest towards the centre and tapers outward, and contrasts with the radial splits induced by drying of the felled timber which are wider at the outside and taper inwards Heart-shake may assume the form, in cross-section, of a single split traversing the centre and is described as *simple,* or this split may be crossed at right angles by another thus producing *double* heart-shake, or, finally a number of splits may radiate from the centre and thus constitute *star-shake,* which is often associated with discolouration and decay Radial *frost-shakes* are frequently associated with "frost-ribs" that are visible on the growing tree as ridges running down one or more sides of the trunk With these shakes contrast the internal radially directed splits that first arise in felled timber which has been so rapidly dried that "*case-hardening*" has resulted.

In coniferous wood resin-containing cavities, known as *resin-pockets* or *pitch-pockets,* occasionally occur: they are of varied dimensions but usually of width quite considerable in comparison with the length Sometimes longer *resin-veins* easily visible to the naked eye traverse the wood or this may clearly show a general excess of resin in the absence of veins or pockets. In some cases excess of resin or abnormal development of the ducts is due to wood-attacking fungi. In hardwoods so-called *gum-veins* are occasionally present in Australian species of *Eucalyptus,* including jarrah, and in true mahoganies

(*b*) *Felled Timber.*—Tunnels or other cavities are also produced by animals in felled timber. In sea-water they result from attacks by Mollusca (*e g.,* shipworms) or small Crustacea (*cf* shrimps), and on land are due to insects. Decay or rot of timber taking place in the standing tree or felled timber is always due to fungi (*see* DRY ROT), and is associated with discolouration and weakening of the wood but much less frequently with the production of internal cavities.

Opposed to the shakes already considered are *cross-shakes,* which are cracks or splits running at right angles to the grain In the overwhelming majority of cases they are due to decay of the wood, caused by fungi, and consequent shrinkage (*see* DRY ROT) They render wood useless for mechanical usage. But the logs of certain species of trees, including spruce, sabicu and some African mahoganies, occasionally show cross-shakes, even when there is no trace of decay.

For a discussion of Felling, forms and sizes *see* LUMBERING *See* also TIMBER PRESERVATION

Special Softwoods.—The name cedar is given to various unrelated, usually fragrant, softwoods and hardwoods. The true cedars (*Cedrus*) are familiar as trees of three kinds: the Himalayan deodar, the cedar of Lebanon and the Atlas Mountains cedar. Junipers (*Juniperus*) supply the *pencil-wood cedar,* the most important being the North American *J. virginiana,* though pencil slats are also made from another species growing in Kenya Colony: the heartwood is durable, as the scented cedar-wood oil is antiseptic and distasteful to insects Lawson's cypress (*Chamaecyparis Lawsoniana*), indigenous in western United States. yields the valuable *Port Orford cedar.* Other North American cedar woods are produced by arbor vitae trees (*Thuja*), the durable red cedar wood (*T. plicata*) being used for shingles.

Bald, marsh or Louisiana cypress (*Taxodium distichum*) grows

in swamps of south-eastern United States and Central America: its durable wood is unsurpassed for conservatories.

The European larch (*Larix decidua*) is rather heavy and the red heartwood is very durable. The rather similar North American timbers are those of the tamarack (*L. americana*) and the western larch (*L. occidentalis*). Larch timbers find many of the same uses as hard-pines (*see* later).

Pine, true.—The name pine is given to a medley of softwoods, but should be restricted to timbers belonging to the genus *Pinus*. Such genuine pine-timbers may be ranged into two classes, hard-pines and soft-pines, the former of which are generally heavier.

Hard-pines include one of the two most important softwoods of Europe, Baltic "red deal" (*Pinus sylvestris*, the Scots pine), which grows widely over Europe, and is represented in North America by a very similar timber, red or Norway pine (*P. resinosa*). The name pitch-pine as applied to North (and Central) American timbers in Great Britain and the United States, respectively, is liable to cause confusion: in the latter country it refers to relatively poor wood of *P. rigida*, whereas in Great Britain and Europe it refers to pine-timbers of the highest class produced by *P. palustris* and two or three other species all exported from south-eastern United States to England.

Soft-pines include the timber of the American Weymouth pine (*Pinus Strobus*), which is known in England as "Canadian yellow pine" and in the United States as "Eastern white pine": it is not used out of doors, but for making matches, patterns and for high-class cabinet work.

Pines, so called—A wide range of coniferous trees are known in Australasia as pines, and include the Kauri-pine (*Agathis australis*) of New Zealand, and Huon-pine (*Dacrydium Franklinii*) in Tasmania The Oregon or British Columbian pine is Douglas fir (*Pseudotsuga taxifolia*) which grows in the Pacific States of North America.

Californian redwood (*Sequoia sempervirens*) has a reddish heartwood light in weight, very durable, and used for the manufacture of shingles and patterns.

White deal is the wood of the Norway spruce (*Picea excelsa*) which is wide-spread over Europe. The white wood ranges in quality from the common grades used in packing cases, woodwork of houses and pulp, to mountain-grown wood of the highest quality which provides the best sounding boards of pianos. To similar uses the black, white, red and Sitka spruces (*Picea* spp.) are put in North America (*See* SPRUCE)

Special Hardwoods.—The ash-tree (*Fraxinus excelsior*) is widespread over Europe and supplies the timber of commerce, which is almost solely sap-wood, as any heart-wood is produced late in life The wood is remarkably tough and, after steaming, can be permanently bent without losing its shock-resisting power It is used in the manufacture of axe-handles, oars, bodies of carriages and motor-cars, hockey-sticks and so forth. In North America six species of *Fraxinus* supply commercial timbers.

The beech-timbers of commerce are the woods of *Fagus sylvatica* and *F. americana* in Europe and North America respectively The latter shows a distinction into white sap-wood and reddish heart-wood, but not so the former which is of uniform reddish white Being perishable out of doors beech-wood is mainly made into articles used indoors, including furniture.

In addition to the softwoods enumerated a number of scented hardwoods from various countries are termed cedars: of these the most familiar is the tropical American cedar (*Cedrela odorata*) used in the manufacture of cigar-boxes and boards of boats.

Very similar to the timbers of ordinary oaks are those of the true chestnuts, *Castanea vesca* of Europe and *C. dentata* of North America, but these lack wide medullary rays and consequently display no striking "silver grain."

Species of *Diospyros* growing in tropical Asia and Africa supply the black ebonies of commerce. The black of the heart-wood may be interrupted by patches of white (in Andaman marble-wood) or brown (in calamander wood). The Japanese and North American *persimmon* woods belong to species of *Diospyros*, and pieces of the latter have little or no black wood

The commercial timbers are produced by several species of European and North American species of elm (*Ulmus*). They generally have heart-woods lasting well in permanent contact with water; the water-pipes of London in olden times were often made of hollowed trunks of elms.

Australia is the world's centre for the growth of eucalyptus-trees, a number of which produce hard, heavy, strong timber of large dimensions, and include *jarrah, karri, tallow-wood,* and *tuart.*

Greenheart is a tropical South American wood, which is generally stated to be that of *Nectandra Rodiaei*, varies in colour from yellow-green to darker admixtures of colours. Resistant to shipworms it is used widely for piling in docks: for fishing rods it is pre-eminent.

Commercial hickory woods of good quality are produced by a number of species of *Hicoria* in the United States. These find much the same uses as ash, since they are tough, but being stiffer than ash they can be used for the shafts of golf-clubs.

The name mahogany is improperly given to a medley of woods which range from white to bluish red in colour and grow in various countries. The original mahogany was that of *Swietenia mahagoni* growing in the West Indies: this species together with the allied *S. macrophylla* growing on the mainland of Central America supply true American mahogany. These reddish-brown woods shrink and warp but little, are durable, light and polish readily to yield beautiful decorative effects. Any other woods named mahogany should share these characters. Such is the case with West African mahoganies produced by certain species of *Khaya* (belonging to the same family, Meliaceae, as *Swietenia*), which are indistinguishable by most people from the American mahogany. The West African "Gaboon mahogany" is a wood belonging to trees (or a tree) of an entirely different family, and is not a mahogany: neither are any of the so-called mahoganies of India, Australia, the United States and South America.

Maples, including the European sycamore, belong to the genus *Acer* and yield white firm woods that have a silvery sheen. North America supplies maples used in block-floorings and the beautiful bird's eye maple used in furniture.

True oak timbers are produced by species of *Quercus*, which is a genus not growing south of the equator, and the commercially important ones are European, North American and Japanese in origin The European timber is mainly derived from the wide-spread *Q. pedunculata* and *Q sessiflora*, and stands apart from the other commercial kinds in being the sole one that can be safely used alone in the construction of casks and barrels for the storage of beer, wines and spirits without causing deterioration of flavour of these Great Britain produces a unique type, termed "brown oak," which is used in the manufacture of panelling and furniture in Europe and North America. The European oak imported into England is known as Russian and as Austrian oak, when exported from Baltic ports and Fiume respectively North American commercial oak timbers are produced by a larger number of species of *Quercus* belonging to two groups, the "white" and "red oaks," which contrast in structure and uses

Genuine lustrous satinwoods in origin are respectively East Indian (*Chloroxylon Swietenia*) and West Indian (*Xanthoxylum*).

Teak timber is produced by *Tectona grandis* which yields commercial supplies only in the Indian Peninsula, Burma, Siam and Java. The valuable yellow to brown heart-wood is hard, strong, stiff and very durable; moreover, unlike oak, it does not attack iron. As the wood also "stands" well, it is excellently suited for use in window-sills, ships and flooring. The wood shows annual rings, and thus contrasts with such spurious teak timbers as "West African teak" (*Chlorophora*) and Indo-Malayan "eng or yang teak" (*Dipterocarpus*).

The two most important walnut timbers are those of *Juglans regia,* whose distribution stretches from England to northern India, and *J. nigra,* which is North American. The heart-wood of both species is brown, that of the former species is often traversed by brown lines, while that of the American is wholly of a blacker brown. Both woods are unrivalled for the manufacture of gun-stocks and are excellent furniture wood, as when it has been thoroughly seasoned and polished it shrinks and swells very

little. The wood has clearly marked annual rings and thus contrasts with two tropical spurious "walnuts," the East Indian (*Albizzia Lebbek*) and West African (*Lovoa Klaineana*). A third misnamed wood is known in Great Britain as "satin walnut" (also as "hazel-pine") and in the United States, its native country, as gum (sweet or red).

Confusion frequently arises in England as to the identities of several woods that are more or less white. From the United States there are exported to England several kinds of wood having that character. (1) One is named "canary whitewood" in Great Britain but "yellow poplar" in America: it is produced by the tulip-tree (*Liriodendron Tulipifera*), and ranges in colour from light yellow to iridescent blue. (2) In addition are woods produced by true poplar trees (*Populus*), which are named "cottonwoods" in the United States (3) Thirdly there are woods known in England as lime and in America as basswood, that are produced by lime-trees (*Tilia* spp.), which of course are very different from the limes (*Citrus*) producing the familiar juicy fruits.

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TIMBER LINE, the altitudinal boundary of natural tree growth In any elevated area in low or middle latitudes the line is generally clearly marked, but its height is dependent not only on general but also on local climatic and soil conditions. (*See* SNOWLINE.)

TIMBER PRESERVATION. The art of protecting timber from decay or the ravages of insects is of very ancient origin. It is probable that the Egyptians, who were experts in the preservation of organic bodies, also preserved wood by artificial means. Pliny mentions that the ancients employed essential oils, such as oil of cedar, olive oil, oil of spikenard, or vinegar. An even more universal method was to char wood to protect it from decay, a well-known instance of which is the charred piles under-pinning the temple of Diana at Ephesus. The beginning of the 19th century saw the introduction of modern methods of injecting wood with either salt or oil solutions Later, a further impetus was given to wood preservation by the introduction of railways, requiring large quantities of wooden sleepers, and by the discovery of telegraphy, which necessitated large numbers of telegraph poles. There is at the present time an urgent need, other than that of direct monetary importance, for prolonging the life of timber, and that is to conserve the world's timber supply by every possible means, which includes, amongst others, the antiseptic treatment of timber. Antiseptic treatment was introduced into America about 1850, and gradually spread to most civilized countries of the world, though in India and Australia, where extremely durable timbers are available, such as teak and jarrah, the treatment of railway sleepers has only been undertaken in quite recent years.

Causes of Decay.—Timber may deteriorate from several causes; amongst the more common are decay due to fungi, the attack of insects and marine-borers, and mechanical defects such as abrasion, crushing, splitting or other types of fracture. One of the commonest forms of decay is known as "dry rot," produced by several species of fungi, of which the most important is *Merulius lachrymans.* The number of insects which attack wood is very great, but probably those which do most damage are the death watch beetle (*Xestobium rufo-villosum*), injurious to structural timber; the powder-post beetle (*Lyctus* sp.) and the common furniture beetle (*Anobium punctatum*), destructive to furniture. A number of marine molluscs (*Teredo,* the shipworm) and crustaceans (*Limnoria,* the gribble, and *Chelura*) are most destructive to wood construction in sea-water. In the tropics the greatest enemy to timber are the termites known as white ants

Antiseptics Used in Wood Preservation.—Antiseptics used in the preservation of wood may be divided into two broad classes, namely, oils and salts, of which the former are mostly derived from coal-tars, though wood-tar products and certain essential oils must be added to the list. The oils are in certain processes mixed with salts, as for instance in the Card process, while, recently, considerable attention has been paid to mixtures of coal-tar creosotes and earth oils Certain salts attracted attention as possible antiseptics for the treatment of timber, as early as 1705, when Homberg used mercuric chloride, although this salt is more commonly associated with Kyan, after whom the process is named. Of all salts which have been used in treating wood that which has best stood the test of time is chloride of zinc, discovered by Boucherie, but known as Burnettizing, after Sir William Burnett. Copper sulphate was used as long ago as 1840, but has since fallen out of favour; the most recent to be seriously considered are fluoride salts, which were first exhaustively tested by an Austrian engineer, named Malenkovic. Between 1904 and 1908 an entirely new process was brought out by Powell, which consisted in boiling timber in molasses, to which was added a small percentage of arsenic for use where white ants were prevalent.

It was Bethell who started on practical lines the treatment of wood with coal-tar products in 1838, though it is certain that the possibility of injecting these oils into timber was attempted before this date. Probably no name is better known in connection with timber preservation than that of Bethell, who used a product of coal-tar commercially known as creosote, which is at present by far the most popular antiseptic in use. It should here be noted that true creosote is a wood-tar product, though the word is now commonly and erroneously used for the coal-tar product. Coal-tar creosotes differ greatly in composition, depending on the quality of the tar and the coal from which they are produced, and various commercial grades are prepared to meet different requirements. For standard products the *British Engineering Standards Association's Specification,* No. 144/, 1921, dated Aug. 1921, should be consulted.

Methods of Treatment.—Before treatment all bark should be removed and the ends of the timber cleansed. It is important to note that the inner bark either stops or retards lateral penetration, which is one of the most difficult obstacles to be overcome. All processes, with the exception of the Boucherie and Powell processes, require that the timber should be seasoned. The degree of seasoning required will vary with the process, the class of timber to be treated and the use to which it is to be put. The moisture in wood occurs in the pores and cavities between the fibres and in the cell walls; the former being termed free-water and the latter sorbed water. As the timber seasons, the free-water is first given off until there remains from 25% to 30% by weight of the sorbed water. The moisture content should be reduced to below 20%, so that all the free, and part of the sorbed, moisture disappears, leaving the cavities free to take up the antiseptic.

The methods by which timber may be antiseptically treated fall under three heads, namely, the brush method, treatment in open tanks and treatment in closed cylinders under pressure.

By the open tank method the timber is immersed either in coal-tar creosote or a salt solution, in a tank which is heated by placing a fire beneath it, or preferably by means of steam coils. The antiseptic is gradually raised to a temperature of 90° C to 95° C, maintained at that temperature for a period dependent on the thickness of the material under treatment, and then allowed to cool down to atmospheric temperature. The heating period should, generally speaking, be maintained for an hour for every inch in thickness of the material. When the timber is heated in the solution it expands, and air is expelled from the cellular and intercellular spaces; as the timber cools that air is replaced by antiseptic. Fair penetration may be obtained by this process, which in pine-wood sleepers containing a moderate percentage of sapwood, amounts to approximately 5 lb. per cubic foot. This method of treating timber is applicable to cases where moderate

quantities of timber have to be dealt with. A process by which wood is treated with saccharine solutions, known as the Powell process, is carried out in open tanks; the timber is boiled in a diluted solution of sugar, to which a small percentage of arsenic is added for protection, in tropical countries, against the attacks of white ants The process consists in boiling green timber for several hours, the time varying according to the dimensions and species of wood under treatment It is then allowed to cool down and is placed in a drying chamber. This process has been successfully employed in Australia, while extensive tests carried out with Powellized sleepers on Indian railways give good results

Pressure Processes.—These are carried out in cylindrical retorts varying in size from 6 to 9 feet in diameter, and 30 to 160 feet in length, capable of withstanding a pressure of 200 lb per square inch, and fitted with doors at either one or both ends. Inside the cylinder are placed rails to take the trolleys on which the timber is loaded, and below the rails is inserted a system of steam pipes for heating the antiseptic solution, and in certain plants a steam spray line To the cylinder are attached pressure and vacuum pumps and in some cases air pumps. A second cylinder or storage tank is generally provided, which is generally placed above the pressure cylinder. Surrounding the treating plant is the timber yard, which is conveniently laid out with feeder lines to and from the treating cylinder. The Full-cell or Bethell process, which employs coal-tar creosote, consists in subjecting the seasoned timber to a pressure of 100 to 180 lb. for one or more hours, after which the oil is run off and the timber allowed to drip In some cases a vacuum is drawn for a short period, to hasten the removal of the coal-tar creosote left on the surface of the timber. Some operators when dealing with green timber, first subject it to a steaming period of several hours, and then draw a vacuum for one or two hours, in order partially to remove the free moisture in the wood, but this does not result in such satisfactory penetration as does the treatment of seasoned timber. Treatment by a full-cell process results in an absorption of from 7 to 15 lb. of coal-tar creosote per cubic foot.

The open-cell process may be carried out according to two different methods; one method was patented by C. B Lowry, by which the coal-tar creosote is run into the cylinder at a temperature of 200° F, and a pressure of from 180 to 200 lb. is applied, until no more oil can be forced into the timber, *i.e*, until the timber has been treated "to refusal." The pressure is then released, the oil run off, and a vacuum drawn, until the oil in the intercellular spaces has been removed; this oil may amount to 40% of the original absorption, leaving some 6 to 7 lb per cubic foot behind in the timber The other open-cell process, discovered by Rüping, aims at as deep a penetration as possible and at the same time economizes, recovering, as does the Lowry process, a portion of the oil originally introduced To carry out this process a second cylinder, capable of withstanding 100 lb. air pressure, is placed at a higher level than the treating cylinder The air-dried timber is placed in the treating cylinder and subjected to an air pressure of 60 to 80 lb per square inch. The high level cylinder is filled with the preservative to within a few inches of the top, and an equal air-pressure is applied to its upper surface The antiseptic is then allowed to flow by gravity from the upper to the lower cylinder, the air displaced in the latter being led into the former by a by-pass The two cylinders are then disconnected and the pressure in the treating cylinder is gradually raised to 150 lb. per square inch and held there until 10 to 12 lb per cubic foot have been absorbed. The pressure is then released and the oil run off; this results in a partial vacuum being set up, and allows the compressed air in the wood to expand and to force out the surplus oil.

A process invented by Card, for which a patent was granted in 1906, consists in treating timber with a mixture of 20% coal-tar creosote and an 80% solution of chloride of zinc, the strength of the latter being regulated so that ½ lb of dry salt be taken up per cubic foot. It is a full-cell process, the operation being similar to that of the Bethell process, except that the mixture is kept in emulsion by a powerful centrifugal pump which circulates it through a spray pipe.

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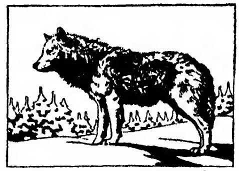

BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

THE TIMBER- OR GREY-WOLF

TIMBER-WOLF (*Canis occidentalis*), or grey wolf, an American species (*see* WOLF). The length of good specimens is about 64in., inclusive of the tail, and the range of colour is from black to white. Cattle ranchers and shepherds have established a war of extermination against this wolf and the coyote.

TIMBREL or **TABRET** (the *tof* of the ancient Hebrews, the *deff* of Islam, the *adufe* of the Moors of Spain), the principal musical instrument of percussion of the Israelites, identical with the modern tambourine. The tabret or timbrel was a favourite instrument of the women, and was used with dances, as by Miriam, to accompany songs of victory, or with the harp at banquets and processions; it was one of the instruments used by King David and his musicians when he danced before the Ark.

TIMBUKTU (Fr. Tombouctou), chief town of a district of the colony of French Sudan, French West Africa, 9 m. N. of the main stream of the Niger in 16° N and 5° W.

Timbuktu lies on a terrace formed by the southern scarp of the Sahara, about 800 ft. above sea-level, surrounded by sandy dunes covered with mimosas and other spiny trees. Timbuktu communicates with the Niger by a series of marigots or channels with alternating flow, which fill at flood time and empty themselves into the Niger when the dry season supervenes In January, the maximum period, the waters reach the walls of the town through the marigot from Kabara, which is the port of Timbuktu

Timbuktu has been described as "the meeting point of the camel and the canoe," "the port of the Sahara in the Sudan," and (more correctly) "the port of the Sudan in the Sahara" It was formerly a much larger place than it was found to be at the time of its occupation by the French in 1893–1894. Extensive ruins exist north and west of the present town The great mosque which at one time stood in the centre of the town now lies near the western outskirts, where its high but unsightly earth tower forms a striking landmark The mosque of Sidi Yahia (in the centre of the town) and that of Sankoré in the north-east also possess prominent towers Whereas in 1895 the town was little more than a vast ruin, under French protection the inhabitants, relieved from the fear of Tuareg oppression, set about repairing and rebuilding their houses; new streets were built; European schools, churches and other establishments were opened. But Timbuktu has not yet recovered; the population is only 7,000 with a majority of Sonrhai; at the time of the commercial transactions from March to June, the population reaches 25,000

The industries of Timbuktu—cotton-weaving, earthenware, leather-work and embroidery—are of subordinate importance, and the great bulk of the people are occupied exclusively with trade. The whole traffic of the surrounding lands converges on Timbuktu, two great caravans of 3,000 or 4,000 camels are yearly charged with salt from the Taudeni district, salt being an article which the Niger countries lack.

Timbuktu, which possesses some valuable Arabic manuscripts —notably the *Tarik es-Sudan,* a 17th-century history of the Sudan written by Abderrahman Sadi of Timbuktu—and is a centre of Moslem teaching, is a converging point of the chief west Sudanese and Saharan races—Arabs or Arabized Berbers to the west; Sonrhaï in the immediate vicinity, and thence south-eastwards along the Niger; Ireghenaten or "mixed" Tuareg southwards across the Niger as far as the Hombori Hills and in the fertile Libbako plains beyond them; Fula, Mandingos, and Bambara in and about the city; and Imoshagh (Tuareg) belonging to the Awellimiden confederation mainly to the north and east.

The local administration—preserved under French rule—is in the hands of an hereditary *kahia,* a kind of mayor, descended from one of the Ruma families. (A. BE.)

History.—The history of Timbuktu is intimately connected with that of the city of Jenné and the Songhoi empire. The Songhoi (*q.v.*) are a negro race reported to have come to the Niger countries from the Nile valley. In the 8th century they made themselves masters of a considerable tract of country within the bend of the Niger, and built the city of Gao (*q v*), 200m. in a direct line S S E of Timbuktu, making it their capital In the 11th century they were converted to Islam. Besides Gao, the Songhoi founded Jenné (*q v*), which early attained considerable commercial importance Meanwhile (11th century) a settlement had been made at Timbuktu by Tuareg Perceiving the advantages for trade with the north offered by this desert rendezvous, the merchants of Jenné sent agents thither (12th century), and Timbuktu shortly afterwards became known to the inhabitants of the Sahara and Barbary as an excellent market for their goods, and also for the purchase of the many commodities of the western Sudan In the 12th or 13th century Timbuktu fell under the power of the Mandingo kings of Melle or Mali, a country lying west and south of Jenné. Its fame as a mart for gold and salt spread to Europe, "Timboutch" being marked on a Catalan map dated 1373 In 1353 it had been visited by the famous traveller Ibn Batuta In 1434 the Tuareg made themselves masters of the city, which in 1469 was captured by the Songhoi king Sunni Ali It was at this time (1470) that Timbuktu was visited by an Italian, Beneditto Dei In the days of Sunni's successor Askia (1494–1529) the Songhoi empire reached its highest development, and Timbuktu rose to great splendour The "university" of Sankoré became a chief centre of Mohammedan culture for the peoples of the western Sudan

The riches of Timbuktu excited the cupidity of El Mansur, sultan of Morocco, who, in 1590, sent an army across the Sahara under an "Andalusian" Moor (that is, a Moor descended from those expelled from Spain), which captured Timbuktu (1591) and completely broke up the Songhoi empire For about 20 years after the conquest the pasha who ruled at Timbuktu was nominated from Morocco, but the distance of the Niger countries from Marrakesh enabled this vast viceroyalty to throw off all allegiance to the sultan of Morocco The Niger Moors, known as *Rumas* after El Mansur's musketeers, quarrelled continually among themselves, and oppressed the negro tribes By the end of the 18th century two hundred years of oppression had reduced Timbuktu to comparative desolation and poverty By this time the whole country was in a state of anarchy, and in 1800 the Tuareg swooped down from the desert and captured the place They were in turn (1813) dispossessed by the Fula, who in 1840 gave place to the Tukulor (*See* SENEGAL, *History*)

At this period European interest in the region had revived Maj. Gordon Laing, who had reached Timbuktu from Tripoli in 1826, had been murdered by order of the Fula; but René Caillié, coming from the south, had been in the city in 1828 and had returned in safety. Heinrich Barth, an officially accredited representative of the British Government, reached Timbuktu from the Central Sahara in 1853 and some effort was then made to bring the place under British influence. El Backay (Bakhai), the sheikh who received Barth, gave him letters professing much friendship for the British, and in a letter to El Backay, dated April 15, 1859, Lord Clarendon, secretary of State for foreign affairs, said that "the friendship binding us shall not diminish through the centuries" and "as our Government is very powerful we will protect your people who turn to us" A nephew of El Backay's went to Tripoli, saw the British consul and was told that a British steamer was ascending the Niger and that the Government had recommended those on board "to make every effort" to reach Timbuktu. But no one from the lower Niger reached El Backay, whose influence appears to have declined after Barth's visit; and no further attempt appears to have been made by the British to keep in touch with Timbuktu. Indeed, between Barth's visit and the French occupation only one white man, Oskar Lenz, in 1880, reached Timbuktu and he crossed the desert from Morocco. It was in the following year, 1881, that the French, thrusting forward from Senegal, began the conquest of the countries of the Niger bend When they reached Timbuktu in December 1893 they found that the town had again fallen beneath the rule of the Tuareg. The townsfolk, indeed, from the time of the decay of the Ruma power being at the mercy of all comers, were content to pay tribute to each in turn and sometimes to more than one simultaneously, for which they indemnified themselves by peaceful intervals of trade whenever the land routes were open and the Niger clear of pirates But at times even the short tract separating the town from Kabara was so beset with marauders that it bore the ominous name of "Ur-immandess," that is, "He (God) hears not." Little wonder then that the townsfolk freely opened their gates to the French as soon as Lieut Boiteux reached Kabara in command of a small flotilla

The occupation of the town, against orders, was a daring exploit of a handful of marines The force which "garrisoned" Timbuktu consisted of seven Europeans and twelve Senegalese The somewhat larger body left with the gunboats was attacked by the Tuareg (Dec 28) and suffered severely Col T P E Bonnier, who was at Mopti, 200m to the south-west, marched to the relief of Boiteux and entered Timbuktu without opposition on Jan 10, 1894 He then set out with about 100 men to chastise the nomads. In the night of Jan 14–15 his camp was surprised and the colonel and nearly all his men perished The enemy did not follow up their victory, and within a short period French rule was firmly established in Timbuktu In 1903 the French authorities placed commemorative tablets on the houses occupied by the four travellers, Laing, Barth, Caillié and Lenz, during their stay in Timbuktu Under French rule the town has regained a measure of importance

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TIMBY, THEODORE RUGGLES (1819–1909), American inventor, was born on April 5, 1819, in Dover, New York His most noted invention was the revolving turret, which he first conceived in 1841 He first constructed a small model and displayed it in Washington Later he built a steam-propelled model in Syracuse, N Y (1842) This he exhibited in the city hall, New York, where it was inspected by President Tyler and his cabinet In 1843 he obtained a caveat from the patent office During the Civil War, when the "Merrimac" had been constructed with heavy iron armour by the Confederate Government, it became evident that a new type of ship must be built to compete with it. At this juncture John Ericsson came forward with plans for a floating battery. These plans were presented to the naval department and promptly accepted Immediately an organization known as the "Battery Associates' was formed to build armoured ships according to Ericsson's plans When Timby heard of this Government contract, he presented the caveat for his patent on the revolving turret, which was to be the main feature of Ericsson's floating battery The Battery Associates, recognizing Timby's claim, agreed to pay him $5,000 on each turret built Soon afterwards, with Ericsson as engineer of the design and construction, the battleship "Monitor" was completed When she met the "Merrimac" and gained her famous victory, Ericsson was given general recognition as the inventor of the revolving turret No serious efforts were made to correct the misapprehension until Timby's death. From 1861 to 1891, Timby invented and patented, at home and abroad, a system of coast defences, such as the sighting and firing of heavy guns by electricity; the tower and shield; the cordon across a channel; the planetary and subterranean systems, and numerous modifications of the turret system He died in Brooklyn, N Y, on Nov. 9, 1909.

See the *Memorial to the 57th Congress for Recognition of T R Timby* by the Patriotic League of the Revolution (1902), and the *Memorial to T. R. Timby* (1911) by the Timby Memorial Trust

TIME, the general term for the experience of duration. For time in its psychological sense *see* SPACE-TIME; for time in music, *see* below, for the methods of reckoning time *see* CALENDAR; DAY; MONTH; and the articles TIME MEASUREMENT and TIME, STANDARD.

In Music, time is a term signifying the number of beats in a measure or bar. When there is an even number of beats, as 2 or 4, the music is said to be in common or duple time. When there are 3 beats in a measure it is said to be in triple time. Further, when the beats are of the value of an aliquot part of a semibreve the time is termed simple. Thus four crotchets, or their equivalents, in a measure constitute simple common time, while three crotchets, or their equivalents, constitute simple triple time. When, on the other hand, the beats are of the value of dotted notes, and therefore not aliquot parts of a semibreve, the time is termed compound. Thus four dotted crotchets in a measure constitute compound common time, while three dotted crotchets in a measure constitute compound triple time. The time of a composition is indicated at the beginning by what is termed the "time signature," in the shape of a fraction specifying the number of aliquot parts of a semibreve which each measure contains, as $\frac{4}{4}$ (=4 crotchets) or $\frac{3}{8}$ (=3 quavers).

TIME, STANDARD. In an isolated community clocks and watches would naturally be set to the local mean time (*see* TIME MEASUREMENT), and before the period of railway communication the different towns as a rule kept local time

The need for a more systematic plan of standard times was chiefly felt in America Whilst the railways in England were run by Greenwich time, and the railways in France by Paris time, it was not to be expected that railway systems in the middle and western States would adopt Washington time, differing by several hours from the local time of the region which they served. Hence each railway had its own time, or, in the case of the longer lines, several different time zones, and great confusion arose at overlapping points. The remedy of this state of things is due to Sandford Fleming, a Scotch Canadian, who in 1878 brought forward the plan of adopting for the whole earth 24 standard meridians 15° apart in longitude, starting from Greenwich. These meridians were to be the centres of 24 time zones, in each zone the time adopted would be uniform, and it would change by one hour in passing from one zone to the next After long discussion the railway managers of the United States and Canada decided to adopt the system

Zone time based on the Greenwich meridian is now adopted almost everywhere except in Holland. In most countries the time differs by an integral number of hours from Greenwich time, in accordance with the original plan; but in some of the British dominions, also in Venezuela and Uruguay, a compromise involving half-hour differences has been adopted. European countries (except Holland) are ranged in three groups, keeping respectively Greenwich time, mid-European time (one hour fast), east European time (two hours fast). In the United States and Canada there are five time-zones, called Atlantic, Eastern, Central, Mountain, Pacific respectively 4, 5, 6, 7, 8 hours slow on Greenwich time. A full list of standard times of the different countries, as well as of those keeping non-standard time is published year by year in the *Nautical Almanac.*

In the summer months a number of countries advance their time by one hour, or, as we may put it, adopt the time of the next zone to the east Thus legal time in Britain is Greenwich time in winter and mid-European time in summer This plan was first brought into practice in Germany early in 1916, closely followed by Austria, Holland, Denmark and Norway. These countries, except Holland, have since abandoned it. In England a movement in favour of this plan of "daylight saving" had existed for some years, led by William Willett; a bill to introduce it passed the second reading in 1908, and again in 1909. Under pressure of war economy and persuaded by the example of Germany, parliament adopted the measure in May 1916. The advantage of *summer time,* as it is called, depends very much on the latitude, and it is scarcely suitable for more northerly or southerly countries; it is rather unpopular in agricultural communities. In Britain, France, Belgium and Holland, where it continues to be used, it is strongly supported.

The advantage of adopting a continuous reckoning of the hours from 0 to 24 instead of using the divisions A.M. and P.M. is obvious, and this reckoning is now in general use in some countries. For civil purposes the reckoning starts from midnight. In astronomy, however, there exists a reckoning, called astronomical time, beginning from noon; thus March 10 15^h astronomical time is 3 A.M. on March 11 by civil time. Up to 1925 astronomical reckoning was used in the national ephemerides; but it was found that this caused some difficulty and confusion to seamen, and an international agreement was made to adopt civil reckoning in the ephemerides from 1925 onwards. It was recognized that this would probably lead to the abandonment (total or partial) of the astronomical reckoning by astronomers themselves. Unfortunately, the decision was interpreted in some quarters as implying a change of nomenclature—that "astronomical time" was henceforth to mean civil time—a purposeless and confusing change for which there is no authoritative sanction. The most prominent offender was the British Admiralty, who caused in this way a change in the use of the designation G.M.T. (Greenwich Mean Time) in the *Nautical Almanac* without authority. The situation was considered by the International Astronomical Union in 1928, who advised astronomers not to use the letters G.M.T. in any sense for the present The terms Greenwich Civil Time (G.C.T.), Weltzeit (W.Z.) and Universal Time (U.T.) denote time measured from Greenwich mean midnight and are not ambiguous. For time reckoned from mean noon the expression Greenwich Mean Astronomical Time (G.M.A.T.) is the most satisfactory. The Julian day is counted from Greenwich mean noon as heretofore.

(A. S. E.)

TIME MEASUREMENT. The problem of the measurement of time demands a reference to its philosophical foundation, if it is to be viewed otherwise than as an empiric treatment of a practical necessity. Without touching the contention of relativists that time is in a certain sense merely a fourth dimension added to space, we may take it that to any individual it appears different and separate from his space, and is simpler than space to treat because it has merely one dimension. The difficulty arises precisely because of this fact, that it is fundamental and there is nothing similar or simpler to compare it with. Duration, permanence, existence even, all presuppose the lapse of time and therefore some means for its detection, or, what is the same thing, some primitive measure of it. The fact upon which all these ideas are based is the possibility of repetition of experience. When experiences are repeated, closely enough, we associate them with the ideas of things and reality. Such appears to be the psychological history of the construction of our world. We look then for the measurement of time to some process with recognizable repetitions, which may be counted. This replaces the impalpable idea of duration by counted steps and thus brings time into the class of measured quantities. Pulse beats, the alternations of day and night, the periods associated with definite spectral lines are instances of natural processes that have actually served this purpose, besides artificial instruments such as the balance watch and the pendulum clock; but to isolate the essential features we may idealize an instrument for the measurement of time as a gyroscope (A) mounted without friction inside a case (B), which may or may not itself rotate, and is held, friction free, at the common axis (O); or more abstractly still we may imagine two particles A, B, revolving at different angular speeds about a common centre O. Each new passage of A past B is a repetition, giving a countable step of time. This may be used for measurement of time precisely as a pair of compasses is used for measuring space. If we do not know that the revolution of A with respect to B is constant, that corresponds to the use of a pair of compasses not known to be stiff at the joint; the measure can still be made for what it is worth and may be the only one possible. If the lapse of time measured falls between two integral counts, we have the problem of subdividing the standard unit by constructing a smaller one which is standardized by comparing it with the standard. No new problem, theoretical or practical, is introduced thereby, and

known methods are applicable to its treatment. The parallel and contrast between the measurement of time and of one dimensional space may be probed further. Measurement of the latter is effected practically through the construction of an (arbitrary) standard yard or metre, from which copies are taken and comparisons made. If a copy A′ B′ is compared with the standard A B, the mark A′ is seen to agree with the mark A, at a particular time, and the mark B′ to agree with the mark B, *at a different time,* the difference being the time taken by the observer to travel from A to B. If we introduce mirrors at A′, B′, so that the congruences may be observed simultaneously, this does not abolish the time difference but only reduces it by making light the traveller. The difference is essential in kind. Now consider the standard for time measurement, a gyroscope in which there is a mark A, rotating within a case on which there is a mark B. Compare this with a copy A′, B′. The cases B, B′ may be in rotation, and the marks B, B′ cannot be brought into permanent coincidence. Thus the step of time between two passages of A′ across B′ may be compared with that occupied between two passages of A across B, only with an allowance for the time taken for a signal to pass across the space between B and B′. If B and B′ are the same, as they may be if both are effectively the sphere of stars, then the allowance for the passage of the signal is abolished, and the comparison of the two standards of time is more perfect than that of two standards of distance; the reason for this is that for the two ends of a standard of space we cannot have the same time, but for two ends of a standard of time we can have the same point of space. We can pass to and fro in space but not in time

If two points A_1, A_2 pass across B at an interval which is an ascertained fraction of the period of A_1, with respect to B, then, *knowing nothing else about them,* an hypothesis is required, in order to tell from this observation what fraction of four right-angles A_1 A_2 subtends at O. If A_1, A_2 rotate as if rigid and uniformly, the fraction is the same as the fraction of the period If they rotate independently, say under the action of the same acceleration to the centre O, no conclusion can be drawn without further data. Generally it must be remembered that in order to define the motion, *e.g.,* in its relation to the right angle, it would be requisite to define first the metric of the space in which it takes place in addition to assigning its own "law" But in the absence of special statement, rigidity and uniform rotation will be presupposed, making the time interval and the angle A_1OA_2 equivalent measures

Units of Time.—The practical standard for measuring time is the rotation of the earth, and is very close to the ideal one. If we take the earth as the body A and the sphere of stars as the body B enclosing it, their relative period gives an observable unit of time, the so-named sidereal day. It differs from the mean solar day employed in civil reckoning in a way defined below The stars are, of course, not quite fixed with respect to one another, but as they are their own standard of reference, their mean is fixed, and there appears to be no meaning to be attached to the idea that it is in motion, especially if we allow in the case of each star for all systematic apparent motions such as those due to the earth and the sun, and the individual motions peculiar to each star, leaving only an accidental residuum to cancel itself out. Taking then the mean of the sphere of stars as the zero, and supposing the local Euclidean geometry continued outwards to mark the positions of the stars, the rotation of the earth with respect to the sphere of stars becomes an absolute quantity, that is to say, a quantity completely defined. In describing it so, some practical qualifications are subsumed. Thus, small allowances varying in different latitudes and different times of the day and year require to be made on account of the finite velocity of light by which the stars are recognized. Also, it is convenient to measure from a slowly moving zero, the equinox, which is easier to identify than the mean of the stars. Reference is made to these and others below. The principle is unchanged.

A smaller unit than the day is provided by the pendulum clock, of which one beat or a semi-oscillation equals a second, of which there are $24 \times 60 \times 60 = 86{,}400$ in the day. Much loose writing is found in relativist literature about "clocks," as though the clock were a simple instrument which it was unnecessary to define further. Such is not the case. We may regard the clock as a machine to imitate the rotation of the earth. If the 24-hours dial of a sidereal clock is imagined as set in a plane parallel to the equator, with the right side up, its index will continue to point always to the same star. The theory of the clock is complicated and has nothing primitive about it. It indicates, however, that the construction of a clock that shall go uniformly is possible; but the practical execution of clocks, though enormously improved recently, is not perfect. The going is liable to derangement from a number of causes, not all of which are clear. In short, the clock is in the position of a secondary standard only, which must be adjusted to the primary standard, viz, the sidereal day or observed rotation of the stars. The same remarks apply with increased force to portable watches and the marine chronometer, in which the beats are given by a balance wheel actuated by a spiral spring. The method by which the clock is adjusted to the rotation of the earth is described below. To subdivide the second, given by the beat of the clock, various devices are employed which are described more particularly in the article CHRONOGRAPH. In principle, they all rely upon converting time measures into space measures, by introducing a machinery that shall move a recording paper at a sufficiently uniform speed, making the clock mark seconds upon this, or, alternatively, making a tuning fork or other rapid vibrator impress closer marks, and subdividing the distance between the marks by any device suitable for space measurement. When we go beyond times which the chronograph can record, we have passed out of the region of actually countable steps of time

For a larger measure than the sidereal day, we turn to the year. The year can only be defined precisely by means of a curiously elaborate theory. The year being the period of the revolution of the earth about the sun, we must define its motion and the point to which it returns Since the motion is perturbed by the moon and the other planets, the orbit does not repeat itself, and any specification has no more than an "instantaneous" value at an assigned epoch. The process is to form a "theory of the sun," assigning its motion, for we may just as well contemplate geometrically a motion of the sun round the earth, as of the earth round the sun. To do this, all the observations of the sun's position are assembled, over the whole period of time for which they can be considered sufficiently exact, and the orbit is determined of a character assigned by theory, and agreeing with the observations as well as they allow over the whole period. The outcome is an ellipse of changing shape in a changing plane. The changes of course are small and slow, but by no means negligible. The mean motion with respect to the stars may, however, be taken as unchanged, and this defines the length of the *sidereal year.* But as remarked elsewhere, a return relative to the stars is not convenient to identify It is more convenient to count from the equinox, or point where the equator intersects the sun's path A return to this point corresponds also with a return of the seasons. Hence we define the *tropical year,* which is slightly shorter than the other because the equinox is in regressive motion.

From the theory of the sun comes also the definition of a derivative but indispensable measure, viz, *mean solar time.* The mean solar day is the mean period of rotation of the earth with respect to the sun The sidereal day is the period of rotation of the earth with respect to the equinox. If the sun makes a circuit of its orbit starting from the equinox, in a tropical year, the earth will have rotated just one time more with respect to the equinox than with respect to the sun in that period The tropical year is found to contain 366·2422 sidereal days Hence it contains 365·2422 mean solar days, and we have two parallel sets of units, days, hours, minutes and seconds, in the ratio of $1{\cdot}002738 : 1$, or $1 : 1 - {\cdot}002730$, the solar unit being the greater. Moreover, the mean solar day starts at a different point from the sidereal day. The latter starts when the equinox is on the meridian. The former starts when an artificially defined "mean sun" is on the meridian. The "mean sun" is an imaginary body defined for the purpose of keeping time, in such a way that it moves in the equator in agreement with the apparent sun's mean motion in the ecliptic. It is the transit of this body across the meridian of Greenwich that gives

the zero for "Greenwich mean time." As, of course, the "mean sun" cannot be observed, its reputed place with respect to the stars is calculated from the *theory of the sun*, in advance, in the ephemerides, and this permits us to observe other stars instead of it and to deduce the moment of its transit. By these means any observatory, of known longitude, constructs for itself "Greenwich mean time" from its own observations. In respect to the measurement of time the relations of the year with the system of mean time are more prominent than its use as a major unit of time In the latter connection it belongs to the subjects of the CALENDAR and CHRONOLOGY

For astronomical purposes and for long measures of time the Julian day is to be preferred to the year, because it avoids all irregularities of chronology The Julian day is simply the ordinal count of mean solar days, commencing at Greenwich noon. The number for 1925, Jan 1, mean noon is 2,424,152, following the system of Joseph Scaliger, who devised it and introduced it into chronology The number for the beginning of any other year may be derived from this, but is tabulated also in the *Nautical Almanac*, and elsewhere

Rotation of the Earth.—The rotating earth is the prime time-keeper and can be readily idealized into a perfect time-keeper. It is therefore desirable to examine critically how closely it approaches an absolute standard It might be supposed that the links were few and easily dealt with Such is not the case They are numerous, and a fairly full outline of the treatment must suffice, referring for detail to the sources.

Let the position of the earth be defined by its principal axe of inertia (OC,OA,OB). If for the moment we suppose the earth rigid, these will be fixed in its body and evidently one may be called its polar axis (OC), while the other two (OA,OB) define the equator where they mark determinate longitudes. The instantaneous motion of the earth may be defined in a simple manner with respect to these axes, namely if $A'B'C'$ are their positions after an interval δt, $A'B'C'$ may be derived from ABC by rotations $\omega_1\delta t$, $\omega_2\delta t$, $\omega_3\delta t$ about the axes OA, OB, OC. It is less simple to connect ABC, the position at the time considered, with their position $A_0B_0C_0$ at an assigned moment or "epoch" It is done by means of the so-named Eulerian angles, θ, ϕ, ψ where $\theta=CC'$, $\phi=A_0C_0C$, $\psi=180°-C_0CA$ These angles serve also to express ω_1, ω_2, ω_3, viz.:

$$\omega_1 = \dot{\theta}\sin\psi-\dot{\phi}\sin\theta\cos\psi,$$
$$\omega_2 = \dot{\theta}\cos\psi+\dot{\phi}\sin\theta\sin\psi,$$
$$\omega_3 = \dot{\psi}+\dot{\phi}\cos\theta$$

Further, by Euler's well-known theory of the rotation of a rigid body, ω_1, ω_2, ω_3 are given by the equations

$$A\dot{\omega}_1-(B-C)\omega_2\omega_3 = L, \qquad B\dot{\omega}_2-(C-A)\omega_3\omega_1 = M,$$
$$C\dot{\omega}_3-(A-B)\omega_1\omega_2 = N,$$

where A, B, C stand for the principal moments of inertia and L, M, N are the couples applied to the body about the principal axes. In the case of the earth we have very approximately, at least, symmetry about the polar axis, and the main rotation taking place about the same axis. Hence $A\backsim B$, $N\backsim O$, and ω_1, ω_2 are small. From the third equation, therefore $\omega_3=n$, a constant, and the equations for ω_1, ω_2 become $A\dot{\omega}_1+(C-A)n\omega_2=L$, $A\dot{\omega}_2-(C-A)n\omega_1=M$ The solution of these two consists of a free oscillation of arbitrary amplitude and phase with period $\frac{2\pi A}{(C-A)n}$, supplemented by any particular integral of the equations. Leave aside for the moment the free oscillation or "complementary function," and direct attention to the particular integral. For simplicity consider first the sun alone. By differential attraction on the protuberant parts of the earth in the neighbourhood of the equator the sun produces a couple, say P, applied to the earth's body, the axis of which is in the equator and directed to a point q, perpendicular to the plane through the polar axis C and the position of the sun S. This couple is a maximum at either solstice and vanishes when the sun is at either equinox. It is easy to see that it does not change sign when the sun crosses the equator. The values of the components L, M are then $L=P\sin(\odot-nt)$, $M=-P\cos(\odot-nt)$, where $\odot$ stands for the distance of the sun from the origin, measured along the equator. Now the equations for ω_1, ω_2 may be written

$$A(\dot{\omega}_1-n\omega_2)+(Cn\omega_2-L)=O,\quad A(\dot{\omega}_2+n\omega_1)-(Cn\omega_1-M)=O,$$

and the sun's position, and therefore P and $\odot$, change slowly compared with nt. Hence it may be seen that an approximate solution is

$$\omega_1=\frac{-M}{Cn}=+\frac{P\cos(\odot-nt)}{Cn},\ \omega_2=+\frac{L}{Cn}=+\frac{P\sin(\odot-nt)}{Cn},$$

which actually suffices for all purposes. The interpretation of this solution is that the pole C is at any moment turning in the positive sense with angular velocity P/Cn about the point s where CS meets the equator. Therefore the actual direction of the motion of C varies over two right angles, but the mean effect is a displacement of the north pole towards the vernal equinox, or what is the same thing, a regression of the equinoxes along the ecliptic. Besides its mean value, P contains also a reference to the actual positions of the sun and moon Hence all the inequalities that are required to specify their positions figure as periodical inequalities in ω_1, ω_2, in special degree those of a more permanent character, such as the position of the node of the moon's orbit on the ecliptic, which will evidently affect the value of the couple contributed by the moon All these inequalities combined constitute the *nutation*, an oscillation of the node of the equator upon the ecliptic, distinguishing at any date the *true* equinox from the *mean* equinox.

Since the motion of the equinox enters into every observation of position, other than merely differential ones, its determination is of the highest importance It is an intersection of the equator with the ecliptic or plane of the earth's annual motion round the sun This itself is in motion since the earth is perturbed by the other planets, but the motion may be calculated and allowed for It is, however, essential first to construct the "theory of the sun," already referred to, based upon a combination of all trustworthy observations of the position of the sun with respect to the fixed stars, and for the present object especial attention must be given to the two places in each year where the sun crosses the equator This connects the equinoxes with the stars which can be observed with the sun, for the most part a small number of the brighter stars, and therefore not characteristic of the whole. But they again may be connected with a larger mass of fainter stars, and so on, gradually approximating to a reference to the mean of the whole body of stars which it is agreed to treat as fixed As remarked above, it is from actual determination of the position of the equinox at different epochs that the period of the precession is deduced It is a matter of astronomical convenience to take the sidereal day, not from a revolution with respect to the body of stars, but with respect to the true equinox Hence the "sidereal day" as employed is not even of constant length, to reduce it to constant length we must remove from it the *nutation* which has been incorporated in it. The chief amount is an 18-year fluctuation, running for half the period in one direction and half in the other and dislocating the proper zero of the day by rather more than $\pm$1sec at maximum.

Return now to the question of a possible free oscillation of the axis of rotation of the earth, with respect to axes fixed in its body. We have so far supposed the earth rigid; but the earth, though very stiff in its main body, is not rigid. If it were rigid and if we suppose the actual axis of rotation to depart slightly from the principal axis of greatest inertia, it follows from the foregoing equations of motion that the axis of rotation would describe in the body a circle about the axis of inertia in a period $\frac{2\pi A}{n(C-A)}$ days, which the ascertained period of the precession shows to be about 305 days No such motion exists, whence for a long time it was falsely concluded that the two axes coincided so closely that observation could not separate them. This is not the case. Observations by F. Küstner, extended by S. C. Chandler, and now conducted internationally at a number of suitably placed

observatories, show that the axis about which the earth rotates moves around its mean position, at a distance of some 30ft. or less (0″.3), in a complicated curve, which can be analysed into two main components, one with a period of about 432 days, and the other one year. Both are therefore greater than the period for a rigid earth. It was pointed out by S. Newcomb that the proper interpretation is found in a slight yielding of the body under rotational stress, such as would accord with the estimated rigidity, viz, a little greater than that of steel. The longer period probably refers to this cause. A period of a year might easily be furnished by some seasonal effect.

Change of Length of the Day.—The foregoing has assumed that the couple N, the resolved part of the whole couple about the polar axis, is zero, or say that its mean value is zero, which implies that the rotation period for the earth must be constant But reasons are known to be in operation that may change it Thus if the body of the earth had gradually shrunk, as pretty certainly it must have done, the coefficient C would have diminished, and the angular momentum remaining unaltered, the angular velocity would have increased On the other side, the tides which in their phases generally follow the moon by a time that is fixed at any place, move in the same sense as the earth rotates, but much more slowly, so that they furnish a species of friction clutch or brake upon the earth and must slow down its rotation. A more general consideration of the earth-moon system and their secular changes of relative distance and relative motion shows that the slowing effect is divided between the earth's rotation and the moon's mean motion, but does not alter this consideration Hence it is very unlikely that the day, which we have used as a standard, is really constant The only tests we can apply to it are the other circulating bodies, the moon, Jupiter's satellites, the sun, the planets Of these the moon is the most favourable It moves much more slowly than the inner satellites of Jupiter, but its theory though complicated accords much more closely with observation Now there is another theoretical cause for secular acceleration in the moon's motion, but the theoretical value does not accord with the observational value That the difference is really to be ascribed to a lengthening of the day is indicated by tracing a proportionately smaller unexplained secular movement in the sun and residuals from the planets Venus and Mercury, all of which are in general agreement with the unexplained residues from the moon

The two causes of tidal friction and bodily changes in the earth affect in different degree the apparent accelerations of the moon. and the sun and planets This permits us to determine separately the two effects by fitting their joint outcome to the observed residues requiring explanation in both cases These residues are remarkable In place of a smooth curve of regular progression, they correspond very closely to a broken series of straight lines, which would mean sudden changes of increase or decrease of the length of the day at definite dates Thus in 1897 there was a sharp increase of the length by about ·004sec. and in 1918 an equally sharp decrease by the same amount The portion of these changes that must be attributed to tidal friction seems to accord numerically with what can be calculated The loss of energy takes place almost entirely in the shallow seas, such as the Irish Sea, where turbulent motion ensues and, so to speak, the energy of the tide is trapped As regards the other constituent, it is a different matter If the whole earth contracted proportionately, a decrease in the length of the day of the amounts mentioned above, would entail a shrinkage of half a foot in the radius over all the surface. This seems very improbable, and still more is the change that would account for the increase of the day in 1897.

The outcome of this criticism is that as far as astronomy is concerned, uniform duration is an abstraction, an idea; we cannot find any standard time-keeper that can be called absolute or even uniform. It is perhaps improbable that one should be found. The atom is a more likely place to look for an invariable standard. But this, too, may be a delusion. Atomic motions are certainly not less complicated than planetary motions In any case, their periods, of the order of 10^{-15}sec., are too small a standard

Practical Determination of Time.—Coming to the actual determination of time, we have a similar sequence of a direct method, simple and at first sight complete in theory, but requiring to be overlaid in practice with very numerous corrections in order to bring execution near to the idea As already pointed out, the clock is a secondary standard, which must be adjusted in subordination to observations of the earth's rotation The astronomical observation is thus often described as "finding the error of the clock" The astronomical observation, where any accuracy is aimed at, is always that of sidereal time. The beginning of the day at any place is the transit of the true equinox across the meridian Hence, as already remarked, it is affected by nutation The equinox itself cannot be observed, being merely the intersection of two abstract lines upon the sky; but by a very long chain of observations, going back continuously to Hipparchus 150 B C., and earlier, the relative spacing on the sky of all the lucid stars, and a great many more, has been determined with continually increasing accuracy, together with the "proper motion" belonging to each Relative to this mass of material the position of the equator and ecliptic are assigned, or what comes to the same thing, the coordinates of each star are given relative to the equinox and equator A collection of this kind is called a *star catalogue.* Star catalogues are of various grades. As far as measurement of time goes we need only consider the *fundamental catalogues,* which are based on an elaborate critique of all the material, and of which the latest example is Boss's *Preliminary General Catalogue of 6,188 Stars; Epoch 1900* The places of the stars given in such a catalogue cannot be used directly. They are "mean places at the epoch," and require correction for (1) proper motion in the interval, (2) precession, (3) nutation, (4) aberration, (5) parallax where sensible, (6) refraction, before the data will accord with the true or apparent place on the day and at the place considered As a rule these numerous and troublesome corrections (excepting the last) are computed and applied in the *Nautical Almanac* or other national ephemeris Imagining then the whole heavens to rotate in a piece about the polar axis, if we could observe correctly the passage of a single star across the meridian of the place and compare it with the time registered by the clock, we should have determined the error of the latter This, however, again requires several precautions In the first place, the meridian must be marked, by an instrument that can survey all parts of it Such an instrument must turn (1) at right angles to an axis that is set, (2) horizontally, and (3) due east and west. We must define what line in the instrument is to be perpendicular to the axis In a telescope this can be done with great precision But the three geometrical conditions can only be achieved imperfectly, and the only way to find whether they are achieved or not, is to study the way that faults in respect to them would affect the observation, and then to make a set of observations expressly to find the faults. Further, no matter with what care and solidity the instrument is built, it cannot be trusted to keep the same values for its faults or errors from one night to the next, nor even, with changing temperature, throughout a single night This complicates the question very much, for these observations are themselves fallible in very much the same degree as the direct determinations of the time of transit of a star. In particular, the determination of the level of the axis has proved the source of erratic variations in "clock error" which have certainly nothing to do with the clocks Yet reference to the level in some form is indispensable In the *transit circle* at an observatory, level error is usually found by turning the telescope downwards to a bath of mercury, which supplies a mirror that is a fiducial level, and viewing the reflection in it of the webs in the focal plane of the object glass. The distance from the web to its image involves the fault of level in the axis, which can thus be measured and applied to the observations. For field work a smaller reversible instrument is used, in which the axis is first levelled with the help of a spirit level and half-way through the observation the pivots are lifted from their bearings and reversed east and west This seems to give more consistent results than the other method, allowance being made for the lower telescopic power of the portable instrument. But the matter is obscure Further sources of error arise in registering the apparent time of transit. (*See* CHRONOGRAPH) In the end the

best determinations of clock error are much less consistent than the going of the best clocks. Yet the former must be treated as primary sources and the latter subordinated to them. This is a matter of considerable delicacy, for the primary data, besides having erratic features, are also irregularly spaced owing to weather conditions We must take a considerable body of primary determinations, and use the going of the clock to detect and reject their erratic features, before we use the mean run so found in order to assign the error of the clock. This work cannot be done without the exercise of judgment, and, according to their experience, different persons exercise their judgment differently. The result is seen in the comparison of time as determined at different observatories, a comparison that has been made possible with accuracy and simplicity by means of wireless time signals. If the times differed by constant amounts it could be ascribed to an error in the reputed longitudes. But they do not. They vary rather irregularly by quantities of the order of 0·1sec, even 0·2sec., which are perhaps not very large, but are much larger than is tolerated in any other region of astronomy, and much larger than the methods would lead one to expect.

Time measurement, being a problem concerning the phase of the earth's rotation, is eminently a matter for international regulation. It is inconvenient for states to use local time strictly, and a system of zones has been devised and is accepted by most civilized states, whereby within each zone the same mean time rules, but changes abruptly by one whole hour, or half an hour in some cases, at its borders. Thus the local time at Washington observatory is 5h 8m 16s. late on Greenwich, but the mean time kept is 5h. slow precisely. Since mean time is in any case a constructed time, not an observed one, no difficulty is introduced by this convention.

Some other agreements are wanted. Till 1925 Greenwich mean time commenced at noon; from the beginning of that year the meaning of the term was changed so that the reckoning commenced at the previous midnight and the hours 0–24 agreed with those reckoned for civil time. Others have adopted the term "universal time" to describe exactly the same system, so that there are now three designations current for a single scheme. A further convention regulates the "date line," in travelling across which a calendar day is dropped from the reckoning in passing eastward, or is added in passing westward. The line is arbitrary; it runs for the most part along the 180th meridian, but deviates to the east to include Fiji and Tonga with Australasia and to the west to include the Aleutian Islands with the continent of North America.

Wireless Signals.—A new era has been introduced into the determination of time by wireless telegraphy Local time is required for two purposes, first by observatories, in the form of local sidereal time, in order to set the telescopes upon any catalogued object on the sky, and second by an explorer or sailor in order to construct local mean time and to determine the longitude by comparison with Greenwich mean time, which he is supposed to read from his chronometer. Time signals are now used, originating in some well-equipped central observatory, where the full care that is necessary can be given, they are issued as wireless signals from a large number of stations distributed over the world. Received at any fixed observatory, of known longitude, a short calculation gives the local sidereal time and abolishes the necessity of observing it directly; while for a traveller who desires to determine his longitude, the signal supplies a continuous check upon the rate of his chronometer and saves the uncertainties of prolonged extrapolation. Still more important from the point of view of systematic science is the power conveyed of comparing the determinations of time at different observatories continuously with one another, by receiving at any point the signals from different sources, or by receiving at different observatories any one arbitrary signal, and afterwards comparing the results. As already remarked, the results are in poor accord with one another; it would be an important advance if a large improvement of them should result. The faults are now visible and that is the first step towards removing them. The gain would appear first merely as a closer co-ordination of instrumental results, taken under different circumstances of place and time, but could not fail to result ultimately in increased certainty of prediction. At the present stage the investigation figures as a co-ordinated attempt to improve the determination of longitudes.

International regulation of astronomical questions is centred in the International Astronomical Union (I.A.U.), a post-war organization formed at Brussels in 1919, in which a number of earlier conventions were assembled in connection with the International Research Council and operating through the principal research institution of each adherent country. Perhaps the most energetic and fruitful work on special problems is still done by the initiative of individual observatories, but the task is furthered in many ways by the committee created by the I.A.U. Two of these committees have special reference to the subject treated here, the Committee on Longitudes by Wireless Telegraphy, and the International Time Commission. The former has been organized to execute a scheme of world longitudes, by the issue of time signals, in some cases specially designed, from the powerful stations at Bordeaux, Nauen, Saigon (French Indo-China), Annapolis (Maryland), Honolulu, and others, and the determination of their times of receipt at as large a number of observing stations as possible. In a preliminary explanation in 1926 upward of 40 observatories took part; the results are voluminous, and are not yet (1928) fully discussed in co-ordination with one another, but enough has appeared to prove that a much increased precision of longitude determination has been attained; thus, replacing the rather crude discrepancies that used formerly to occur, we find that the time required for the passage of wireless signals across the Atlantic, about ·02sec., appears as a clearly measurable correction in all the better series. The International Time Commission was designed in a more general way to organize the issue of wireless time signals suitable for all users, to receive those that were issued, and to standardize such work generally. Its bureau is at the observatory of Paris, and in the issue of signals it works in conjunction with the stations, military and civil, controlled by the French Government.

For the standard data regarding precession and the motion of the earth round the sun *see* S. Newcomb, "Tables of the Motion of the Earth," vol. vi. (1898), and "Determination of the Precessional Constant," vol. viii. (1905) in "Astronomical Papers" of the *American Ephemeris*. Quoting those relevant to this article, we have

Tropical year	365·24220 mean solar days
Sidereal year	365·25636 mean solar days
General precession in one tropical year	50·2453″ (epoch 1900)

The general precession is compounded by taking the luni-solar precession, less the regressive motion of the ecliptic itself (12·31″ per century). The luni-solar precession varies in proportion with the cosine of the obliquity of the ecliptic.

From the length of the tropical year we deduce 1 mean solar day = 24h. 3m. 56·5554s., sidereal

1 sidereal day = 24h 3m. 55·9095s., solar

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TIME SALES: *see* Instalment Selling.

TIMGAD, a ruined city 23 m. S.E of Batna in the department of Constantine, Algeria. Timgad, the Thamugas of the Romans, was built on the lower slopes of the northern side of the Aures

Mountains, and was situated at the intersection of six roads. It was traversed by two main streets, the Cardo Maximus running north and south, and the Decumanus Maximus east and west. The residential part of the town was on a lower level than the capitol and most of the other public buildings. The ruins of the capitol occupy a prominent position in the south-west of the city. Some of the columns of the façade (which are of the Corinthian order and 45 ft. high) have been re-erected. The dimensions of the capitol correspond with those of the Pantheon at Rome. Immediately north of the capitol are the remains of a large market; to the east are the ruins of the forum, basilica and theatre. The auditorium of the theatre, which held nearly 4,000 persons, is complete A little west of the theatre are baths, containing paved and mosaic floors in perfect preservation. Ruins of other and larger thermae are found in all four quarters of the city, those on the north being very extensive

Across the Decumanus Maximus just north-east of the market is the arch of Trajan—still erect, and restored in 1900. The arch is of the Corinthian order, and has three openings, the central one being 11 ft. wide. Each façade has four fluted columns 19 ft. high. The chief material used in building the arch was sandstone. The fluted columns are of fine white limestone and smaller columns are of coloured marble At the other (eastern) end of the street are the remains of another triumphal arch West of the capitol are the ruins of a large church, a square building with circular apse, built in the 7th century. There are also remains of six other churches. About 400 yd. south of the city, the walls nearly entire, is a ruined citadel, a quadrangular building 360 ft by 295 ft., with eight towers It was built (or rebuilt) by the Byzantine army in the 6th century Near the northern thermae is the house of the director of the excavations and a museum containing small objects found in the ruins

Numerous inscriptions have been found on the ruins, and from them many events in the history of Thamugas have been learnt. In the year A D. 100 the emperor Trajan gave orders to build a city on the site of a fortified post on the road between Theveste and Lambaesis. This city, called Colonia Marciana Traiana Thamugas (Marciana in honour of Trajan's sister) appears from the inscriptions to have been completed, as far as the principal buildings were concerned, in seventeen years. In the 3rd century Thamugas became a centre of Christian activity, and in the next century espoused the cause of the Donatists. The city declined in importance after the Vandal invasion in the 5th century, and was found in a ruinous condition by the Byzantine general Solomon, who occupied it A D 535. It is believed that the Berbers from the neighbouring mountains destroyed the city, hoping thus to prevent it being used as a stronghold from which to harry them Thamugas was, however, repeopled, and in the 7th century was a Christian city. After the defeat of Gregorius, governor of Africa, by the Arabs in 647, Thamugas passes from history.

After centuries of neglect James Bruce, the African traveller, visited the spot (1765), made careful drawings of the monuments and deciphered some of the inscriptions. Bruce was followed, more than a century later (1875), by Sir R. Lambert Playfair, British consul-general at Algiers, and soon afterwards (1875–1876) Professor Masqueray published a report on the state of the ruins. Since 1881 Thamugas has been systematically explored, and the ruins excavated under the direction of the *Service des monuments historiques*. Among the objects discovered are a series of standard measures—five cavities in a stone slab.

Seventeen miles west of Timgad, on the site of the Roman city Lambaesis, is Lambessa (*q.v.*).

See G. Boeswillwald, R. Cagnat and A. Ballu, *Timgad, une cité africaine sous l'empire romain;* and A. Ballu, *Guide illustré de Timgad* (Paris, 1903).

TIMGUR: *see* NUBA.

TIMISOARA (formerly TEMESVAR), a city of western Rumania, capital of the department of Timiş Torontal. Pop. (1928) 58,600, largely Magyar. It lies on the navigable Béga canal and on the river Béga, and consists of the inner town, formerly strongly fortified, and of four outlying suburbs, the intervening space, formerly the glacis, having been laid out in parks. Timisoara is the seat of a Roman Catholic and a Greek Orthodox bishop. Amongst its principal buildings are the Roman Catholic cathedral, built (1735–57) by Maria Theresa; the Greek Orthodox cathedral; a castle built by John Hunyady in 1442, now used as an arsenal; the town and county hall, the museum and large barracks In the principal square rises a Gothic column, 60 ft. high, erected by the emperor Francis Joseph in 1851 to commemorate the successful resistance of the town to the siege of 107 days laid by the Hungarian revolutionary army in 1849. Timisoara is a centre of commerce

Timisoara is an old town, and although destroyed by the Tatars in 1242, it was a populous place at the beginning of the 14th century, and was strongly fortified by King Charles Robert of Anjou, who resided there several years. The Hunyady family had also their residence there. In 1514 the peasant leader, Stephan Dozsa, was defeated by the Transylvanian voivod, John Zápolya, near Timisoara, captured and executed. It was taken by the Turks in 1552, and recovered by Prince Eugene of Savoy in 1716. After this it grew steadily in importance, serving as the capital of the whole Banat. It was again besieged by the Hungarians in 1849, and occupied by Serbia in 1919, but ultimately allotted to Rumania.

TIMMINS, the principal town in the Porcupine gold-mining area in northern Ontario, Canada, 268 m north of North Bay, on the Temiskaming and Northern Ontario railway It is the centre of the most important gold-mining area in Canada, where in 1926 the output of gold amounted to $23,810,600 The most outstanding mine in the district is the Hollinger, the third largest gold-mine in the world Timmins has grown rapidly from a population of 3,843 in 1921 to the 1927 estimate of 15,000

TIMNE, a long-headed people of medium stature, skilled traders, in Sierra Leone, whose language is related to Landuman and Limba Their paramount chief traces his genealogy back to the beginning of the 16th century Dowry and dower are both customary. Descent is patrilineal, and there is both family and personal property, the first inherited by the brother or nephew, the second by the son. The Timne are organized in clans

See N. W. Thomas, *Anthropological Report on Sierra Leone* (1916).

TIMOLEON (*c.* 411–*c.* 337 B.C), of Corinth, Greek statesman and general As the champion of Greece against Carthage he is closely connected with the history of Sicily, especially Syracuse (*q v.*) He was driven into exile for 20 years by the anger of his family at his acquiescence in the death of his brother Timophanes, who had made himself tyrant In 344 (Plutarch, Diodorus gives 343–342) he was chosen to go to Syracuse in answer to an appeal to Corinth for help against factions within and the Carthaginians without. He landed at Tauromenium (Taormina) and first attacked Hicetas, tyrant of Leontini, who was master of Syracuse at the time. Carthage first supported Hicetas, then abandoned him, and he was besieged in Leontini and surrendered Timoleon then reorganized Syracuse on the basis of the constitution of Diocles, and introduced new settlers from Greece About 340 Hicetas was reinforced by a new army from Carthage, which Timoleon defeated on the Crimissus, and a renewed attempt ended in Hicetas' final defeat and death in 338 A treaty was concluded confirming the dominion of Carthage to west of the Halycus. Timoleon then (337–336) retired into private life He became blind some time before his death, but persisted in attending the assembly and giving his opinion, which was usually accepted as a unanimous vote. He was buried at the cost of the citizens of Syracuse, who erected a monument to his memory in their market-place, and a gymnasium called Timoleonteum.

Lives by Plutarch and Cornelius Nepos; *see* also Diod. Sic xvi. 65–90; monograph by J. F Arnoldt (1850), which contains an exhaustive examination of the authorities; also SICILY: *History;* and SYRACUSE, with works quoted.

TIMON, of Athens, the noted misanthrope, celebrated in Shakespeare's play, lived during the Peloponnesian War. He is more than once alluded to by Aristophanes and other comedians. Plutarch introduces a short account of his life in his biography of Mark Antony (ch. 70), who built a retreat called Timonium (Strabo xvii. 794) at Alexandria Timon also gave his name to one of Lucian's dialogues.

TIMON (320?–230), of Phlius, Greek sceptic philosopher and satirical poet, a pupil of Stilpo the Megarian and Pyrrho of Elis Having made a fortune by lecturing in Chalcedon he retired to Athens, where he died His writings (Diogenes Laërtius, ix. ch. 12) were numerous both in prose and in verse. he is said to have written epic poems, tragedies, comedies and satyric dramas, besides the Σίλλοι, three books of sarcastic hexameter verses, written against the Greek philosophers

The fragments (*c* 140 lines) are printed in F W A Mullach, *Frag phil. graec.* i (1860)

TIMOR, the largest of the Lesser Sunda Islands, in the Malay Archipelago, the north-eastern part of which, together with a small enclave in the south (Ocussi-Ambeno), belongs to Portugal, whilst the south-western half belongs to Holland and forms part of the Dutch East Indies. Dutch Timor with Sumbawa, Sumba, Flores and the Alor and Solor Isles, forms a residency of the D.E. Indies known as Timor and dependencies, with a population of 1,143,626. Timor stretches from S W to N E for 300 m. and has a mean width of 60 m. It lies west of the Arafura Sea It is outside the great volcanic belt extending from Java eastwards but it is within the volcanic region, and has a volcanic peak near the centre of the island There are no active volcanoes, but mud geysers exist It differs greatly from the other Lesser Sunda Islands, being traversed by a series of parallel mountain chains, with outliers in many places, especially on the eastern coast, descending to the sea. The centre of the country is a confused mass of very steep mountains. There are ridges from 4,000 to 8,000 ft in height, whilst the highest peak is Mt Rameau, 9,600 ft, in the centre of Portuguese Timor Mt Durulau, near it, is 8,300 and Mt. Suro 7,500 ft More than 20 other mountains range from 3,500 to 6,500 ft along or near the Dutch-Portuguese boundary

The geological structure of Timor is Archaean rock, with Permian beds, chiefly of limestone, containing numerous fossils Volcanic rocks are present Off the south-western coast are the islands of Semau, Rotti and Savu Semau (which has some remarkable springs) is small and unimportant Rotti, which is much larger, has well-developed Triassic beds and volcanic material It has extensive plains, several streams useful for agriculture, and many inlets, of which Buka Bay is the largest Savu is more than half the size of Rotti The climate differs considerably from that of Java and Sumatra, there being a short rainy season and a prolonged dry period Many trees lose their leaves during the dry season A temperature of 104° is reached

Fauna and Flora.—The flora has Australian forms, such as the eucalyptus. Vegetation is scanty and scrubby generally, though the uplands yield fairly under cultivation The woodlands, which nowhere form fine forests, contain much excellent sandalwood The fauna of Timor is of special interest since it proves, conclusively, that Timor has never formed part of Australia within recent geological epochs. The deep sea channel between has proved such an obstacle that only one Australian type is found—a marsupial, the cuscus (*Phalanger orientalis*), whereas Asiatic types include the grey monkey (*Macacus cynomologus*), deer, wild pig, civet-cat, shrew mouse, bat and a particular species of wild-cat, *Felis megalotis*, which is found only in Timor and Rotti As regards birds, there is a slight preponderance of Asiatic over Australian. Amongst the insects are few beetles, a rare rose-chafer (*Lomaptera timorensis*), such moths as the *Noctuae*, a new species of *Ophiodes*, *Remiga virbia*, and a humming-bird moth (*Protoparce orientalis*), and many butterflies, Pieridae and Lycaenidae being common, others including the rare and beautiful swallow-tails *Papilio aenomaus* and *P. liris*, and the deep purple-winged *Cethosia leschenaultii*. The very few land shells of Timor are allied to or identical with Moluccan and Celebes forms There are snakes, and a species of crocodile.

The soil of the plains is poor and as the Timorese have a very scanty knowledge of irrigation and primitive means of ploughing, cultivation is backward The mineral resources of Timor include gold, copper, gypsum and petroleum, but little or nothing has been done to use them.

The population of Timor is about 800,000, that of Rotti 46,823, and of Savu 27,365. It includes very few Europeans and Eurasians, or foreign Asiatics (the latter being mostly Chinese, with a small number of Arabs), and consists of Timorese, a much-mixed race, probably Malayo-Papuan-Polynesian. There is a more pronounced strain of Malayan blood in the people about the coast, whilst in the west (Kupang, Semau, etc.), there has been intermingling with the people of Rotti and Savu, who are lighter-complexioned, good-looking, well-featured people, of Malayan (and probably Polynesian) stock Inland amongst the mountains live the native Timorese, generally a dusky brown or blackish people, slender-figured and of tall or medium height Forbes mentions a race of dwarfish people living in the Fatu Matabia mountains. There are small communities of Christian converts, Catholic and Protestant in Dutch Timor, Catholic in Portuguese Timor, and a few Mohammedans along the coast The people of Rotti and Savu are largely Christian, and Mohammedan Except along the coast, the Timorese have been little touched by civilization They lead a very primitive life and are often at war with each other, there being numbers of small native kingdoms, under both Dutch and Portuguese rule The usual dress of the men consists of two pieces of patterned cottoned material, with a decorated belt, often a sort of shawl, thrown over the shoulder when not in full use, and sometimes a kind of turban headgear, and a cloth wallet is carried Women wear a *sarong*, also with a shawl, and they are fond of armlets of gold and silver, necklaces of glass, quartz or clay, and gold and silver chest plaques. Chiefs have special decorative garments tattooing is practised Weapons are the bow and arrow, spear (and shield), sword, and blow-pipe, for hunting, the use of the gun is known, and the men are very good horsemen The usual Timorese house is built of wood, on piles, and is round in shape, with a roof of grass or palm-leaf thatch, and only one room, (except in the case of chiefs and other notables), villages, and sometimes houses often being stockaded. There was a special hut in which the leader of a successful head-hunting expedition underwent purification—to appease the ghosts of the slain Pomali, or taboo, is very prevalent in Timor, and apart from the custom of placing a palm branch, as a sign of taboo, before fruit-trees, houses, growing crops, etc, to protect them—an effective method of preventing robbery—villages possess a regular *pomali* house, known as the *Uma-Luli*. It stands in a cleared space, within which not a stone may be overturned, or a twig plucked The building itself is raised above the ground on pillars and has two doors, one at the side and one at the end The presiding official at the ceremonies of *pomali* is known as the *Dato Luli*, and has great power Certain relics are preserved in the *pomali* house and there is a special part reserved where offerings are made to the *Vatu Luli*, or sacred stone Some houses have a *Luli* chamber, where sacrifices of animals (pigs) are made and where a bunch of rice is hung—to ensure a bountiful harvest. The dead are placed on a stage raised above the ground, sometimes covered with a roof, and kept until a burial feast can be arranged Stone carved seats for graves are known in Rotti

Polygamy and concubinage are practised, but not cleanliness Industry consists of weaving, plaiting and the manufacture of ornaments and weapons. Fishing and copra manufacture occupy people along the coast Trade is mostly in Chinese, Arab and Malay (Bugis) hands. Many languages and dialects are spoken. Rotti and Savu have languages of their own

History.—The first Dutch landing on Timor was in 1613 (the Portuguese had settled there nearly 100 years before), after a Portuguese garrison had been driven out of a fort on the neighbouring island of Solor. The Raja of Kupang permitted a settlement and from 1619 onwards the Dutch remained there Their chief enemies were the "black" Portuguese of Occussi, whose allies were the Timorese of Ambenu and Amarassi, and occasionally the white Portuguese, from Portuguese Timor. In 1749 the whole combination invested Kupang, but the Dutch succeeded in relieving the garrison and the Portuguese were almost annihilated Twenty years later the Portuguese, whose headquarters had been Lifau, in Occussi, made Dilli their capital,

but the "black" Portuguese of Occussi continued their attacks on the Dutch at Kupang, who, beyond making a treaty with 15 of the neighbouring Timorese chiefs, did little to resist them In 1797 the Dutch, who by this time had extended their influence as far as Atapupu, were in sufficient force to resist successfully a British attempt to take possession of Timor in the name of the Prince of Orange, which they repeated on the occasion of a second British attempt, in 1810, but after the capitulation of Java, the Dutch flag on Timor was hauled down, and during the period of British rule the Portuguese seized the Dutch district of Atapupu, being ejected therefrom by the Dutch when Timor was handed back to them by the Convention of 1814, though this led to many "incidents" and frontier disputes

The Dutch claimed the western half of Timor, but no attempt had been made to delimit frontiers A Dutch offer to buy out the Portuguese was refused, and in 1851 the attempt of a Portuguese Commissioner to fix a boundary was repudiated by his Government In 1859, however, a treaty was signed in which the main boundary through the centre of the island was described, and also the boundaries of the enclaves, claimed by both parties, though no previous survey had been made In 1893 a Convention was signed agreeing to carry out a survey of the main boundary, and, if possible, abolish enclaves In 1898 a Boundary Commission was set up, the main boundary was surveyed first, and then the boundaries of the enclaves, the task being complicated by dissensions amongst the native chiefs concerned, who forcibly prevented the survey of territories in dispute between themselves In 1904 a treaty was made recording the new boundaries, but the ratification was postponed until the Occussi enclave survey could be carried out A mixed commission formed in 1909 stopped work owing to a dispute about the meaning of an article of the Treaty of 1904, there were frontier affrays in 1913, and then came further treaty disagreement, resulting in recourse to arbitration In 1914 the Swiss Plenipotentiary at Paris, M Lardy, a member of the Hague Court of Arbitration, decided in favour of the Dutch view of the track of the eastern frontier of the Occussi enclave, Portugal accepted it and the Treaty of 1904 was then carried into effect

Dutch Timor has an area of a little more than 5,000 sq m, with a population of about 360,000 The capital, Kupang, and the seat of the Resident, is situated on Kupang Bay, in the extreme west of the island It has a harbour, and is the chief port, the only other port being Atapupu, on the western coast, near the boundary between Dutch and Portuguese Timor Both ports (also Baa, in Rotti, and Seba, in Savu), are places of call for vessels of the Royal Packet Navigation Company, which give communication with the other Lesser Sunda Islands, with Celebes, and with Java Kupang, which has a population of 5,493 (275 Europeans and Eurasians, and 1,286 foreign Asiatics, mostly Chinese), is a difficult port during the north-west monsoon Other towns are Sukubianaua, Sufa, Tiamplong, Putain, Lalogama and Atambua. Exports from Timor and Dependencies during 1926 were 66,974 and imports 234,714 guilders, consisting chiefly of sandal-wood, copra, ponies, cattle and hides Lack of inland communication hinders the development of the country Beyond a riding road across country from Kupang to Atapupu, and thence southwards, roads do not exist, but money has been voted for a survey on which to base a plan for road construction. Timor has no cable connection with Java or any other part of the Archipelago, but Kupang has a wireless station.

Portuguese Timor has an area of 18,989 sq kilometres The population is 442,261, the most heavily populated district being that of Motael, in which the capital, Dilli, is situated Until 1896 Portuguese Timor was joined administratively to the Portuguese colony of Macao, in China, but in 1896 it became autonomous, under a governor, who resides at Dilli, which is also the chief port of the colony, and is served by vessels of the Dutch Royal Packet Navigation Company, there being no Portuguese steamship service between Portuguese Timor and other parts of the Malay Archipelago, but a small Portuguese steamer takes cargo to Kupang. Its population is 3,500. Other towns are Liquica, Manatuto and Baucan, on the west coast Exports from Portuguese Timor in 1926 were 1,235,878 patacas and imports 1,168,242 patacas, chief exports being coffee, copra, hides, cocoa, shells and wax; imports cotton piece-goods, petroleum and wine.

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TIMOR LAUT, TENIMBAR or **TENIMBER** (Dutch, TIMOR LAOET), a group of islands in the Malay Archipelago, south-west of the Aru Islands, between 6° 20′ and 8° 30′ S, and 130° 40′ and 132° 5′ E They are on the Archaean Ridge on which the Kei Isles stand, most are of recent coralline formation, and some are volcanic There are 66 islands, the largest being Yamdena, with an area of 1,100 sq m, 74 m long by 26 Thickly wooded hills extend along the east coast, the west coast is lower, where, opposite the island of Seira, a gulf extends far inland In places there are precipitous cliffs, and a narrow foreshore fringed with coco-nut palms and mangrove There are many small islands off the western coast of Yamdena—Seira, Wuliaru, Wotar and Laibobar The largest, Laibobar, has a volcano over 1,500 ft. Off the north-eastern coast of Yamdena, is Larat (15 m by 6), with a rocky coast and high cliffs, and with thick vegetation along the foreshore, beyond Larat lies Vordata, which is high, and off the south-western coast, separated by Egerton Strait, Selaru, which is about 30 m long, rather flat, and less wooded than Yamdena and Larat and with much grass land Other islands are Molu and Selu There are extensive swamps on many of the islands and the climate is not good, fever being very prevalent during the south-east monsoon The soil supports crops such as maize, rice (in small stretches), coco-nut and sago palms, yams and fruit such as plantains, mangoes and papayas Maize is the staple food There are practically no rivers and there is a lack of fresh water. The slight depth of soil prevents trees from attaining great height The flora includes sterculias and fig trees (*F rostigma*), leguminosae (trees and shrubs), myrtles, the scarlet hibiscus, pandans, palms, and a species of bread-fruit tree There are rare and lovely orchids of many kinds, crotons, dracaenas, and many varieties of ferns The fauna, a poor one, except in birds, comprises wild buffaloes, in large herds, wild pig, the *cuscus*, flying fox, many snakes, lizards and frogs, and 60 species of birds, including the scarlet lory (*Eos reticulata*), honey-eater (*Philemon timorlaoensis*), ground thrush (*Geocichla machiki*), and oriole (*Oriolus decipiens*) Butterflies are numerous, and include *Papilio aberram*, and amongst the beetles is a gorgeous golden-coloured buprestid (*Cyphogastra splendens*)

The estimated population of Timor Laut is about 25,000 The people are undoubtedly a mixed race Some of the men are tall, and handsome-featured, with well-formed bodies, others are short and thick-set, the complexion of nearly all being a rich chocolate brown. Forbes thinks, and the writer, who has studied them, agrees, that they are Malayo-Papuan-Polynesian, the islands being, probably, the last occupied by the Polynesian race during its eastern migration to the remote archipelagoes of the Pacific, some being left behind—to mingle with Papuans and Malays, the former, probably being the aboriginals and the latter settlers There are still many pagans, and a few Mohammedans Christianity is making rapid headway and has succeeded, with direct Dutch rule, in extirpating cannibalism, piracy, slavery, head-hunting and inter-tribal fighting. Male Christians wear cotton coats and short breeches, or *sarong;* the women wear *sarong* and *kebayah,* or bodice.

The pagan costume consists of loin-cloth, with a girdle, and, as full dress, bangles, armlets, ear-rings, necklaces, and a head-dress of bright-coloured cloth with bunches of flowers and bird plumes. The women wear a short *sarong*, suspended from a belt, have necklaces and ear-rings of bone, ebony and ivory, also of gold and silver, many bangles and artistically carved combs. They carry burdens in a basket on the back, suspended from

bands placed around the forehead. The men sometimes dye their hair a golden colour. Tattooing is known. They are a pleasant, trustful and fairly honest people, but the men are indolent, and the women do most of the work. Their artistic ability is high, and their houses of wood and *atap*, sometimes built in closely-packed settlements, generally on piles and entered from underneath, have carved pillars and show much artistry of construction. The men are skilful boat-builders, use the spear and bow and arrow (with which they are adept in shooting fish), hunt, search for trepang and tortoise-shell, are agriculturists, keep pigs and work in iron, copper and gold. The women cultivate the fields after the men have prepared the soil, weave and dye *sarongs*, and plait. Villages own an *Orang kaya*, or head man, but the people are communal and independent A favourite idol is termed *Duadilah*, the Sun-god.

Timor Laut, with two divisions, Larat and Saumlakki, is attached to the residency of Amboyna. The capital of Yamdena is Saumlakki at the south-western end of the island, and of Larat, the town of the same name, on the narrow strait which end, opposite Yamdena

The Timor Laut isles were first visited by Capt. Owen Stanley, in 1839, and became known to Banda traders in 1877. In 1878 H. O. Forbes, with his wife, visited the islands and stayed there three months, being warned before going, by the Dutch authorities, of the hostility and savagery of the inhabitants; for all practical purposes, he appears to have been the first European to have stayed any length of time in Timor Laut. Since his visit, the islands have been opened up by the Dutch, and the people have proved very responsive to outside civilizing influences, whilst trade is improving. (E. E. L.)

TIMOTEAN, a considerable group of tribes of South American Indians, forming an independent linguistic stock The Timotes and related tribes occupied the region about Merida and Truxillo and the valley of the Motatan river in western Venezuela Most of them are now extinct They were in general a warlike people, using javelins, spears and clubs, some also having poisoned arrows. A sedentary, agricultural folk, living in large communal houses, the men wore only a small cloth, the women either a very small apron or a cotton gown, belted at the waist

See P. de Aguado, *Historia de Venezuela* (Madrid, 1918).

TIMOTHEUS, Athenian statesman and general. son of Conon, the restorer of the walls of Athens. From 378–356 B C. he frequently held command in the war between Athens (in alliance with Thebes), and Sparta In 375 Timotheus was sent with a fleet to sail round Peloponnesus by way of demonstration against Sparta He gained over Cephallenia, secured the friendship of the Acarnanians and Molossians, and took Corcyra, but used his victory with moderation. In 373 Timotheus was appointed to the command of a fleet for the relief of Corcyra, then beleaguered by the Spartans. But his ships were not fully manned, and to recruit their strength he cruised in the Aegean. For this delay he was brought to trial, but acquitted. Having been superseded in his command he took service with the king of Persia. We next hear of him about 366, when, having returned to Athens, he was sent to support Ariobarzanes, satrap of Phrygia. But, finding that the satrap was in open revolt against Persia, Timotheus, in conformity with his instructions, abstained from helping him and turned his arms against Samos, then occupied by a Persian garrison, and took it after a ten months' siege (366–65) He then took Sestus, Crithote, Torone, Potidaea, Methone, Pydna and many other cities; but two attempts upon Amphipolis failed. An action was brought against him by Apollodorus, the son of the banker Pasion, for the return of money lent by the father. The speech for the plaintiff is still extant, and is attributed (though not unanimously) to Demosthenes. In the course of the Social War Timotheus was despatched with Iphicrates, Menestheus, son of Iphicrates, and Chares to put down the revolt. The hostile fleets sighted each other in the Hellespont; but a gale was blowing, and Iphicrates and Timotheus decided not to engage. Chares, disregarding their opposition, lost many ships, and in his despatches he complained so bitterly of his colleagues that the Athenians put them on their trial. Timotheus, who had always been disliked for his arrogance, was condemned to pay a very heavy fine. Being unable to pay, he withdrew to Chalcis, where he died soon afterwards. The Athenians showed their repentance by remitting the greater part of the fine to his son Conon. His remains were buried in the Ceramicus and statues erected to his memory in the agora and the acropolis.

See Life by Cornelius Nepos; Diodorus Siculus xv., xvi.; Isocrates, *De permutatione;* Pseudo-Demosthenes, *Adversus Timotheum;* C. Rehdantz, *Vitae Iphicratis, Chabriae, Timothei* (1845); and especially Holm, *Hist. of Greece* (Eng. trans, vol. iii.).

TIMOTHY or **TIMOTHEUS** in the New Testament was one of the younger companions of the Apostle Paul. He was connected with Lystra in Lycaonia, born of a pagan father and of a Jewish mother called Eunice, his grandmother being also a Christian When the apostle came across him at home, he was still uncircumcised, but a full member of the church at Lystra (Acts xvi. 1f., 2 Tim. i 5f.). As the defection of Barnabas and Mark had left St. Paul alone, he took Timotheus with him as a colleague, first of all circumcising him out of respect to the prejudices of the communities in which he was to do mission work This was a matter of convenience, not of principle. He accompanied St. Paul and Silas to Europe, where he was employed by them on various missions, especially among the Macedonian churches which he helped to found. But Corinth as well as Thessalonica and Philippi drew out his activities as an "apostle" in the wider sense of the term (2 Cor. i 19, etc). From Corinth he appears to have accompanied the apostle to Ephesus and Asia Minor (Acts xix. 22, 1 Cor. xvi 10 *seq.*). He is then associated with St Paul in his imprisonment, as the collocation of his name in the titles of Colossians, Philemon and Philippians indicates, whether that imprisonment was at Rome or elsewhere. In the Pastoral Epistles (*q v*) he is absent from his chief, in charge of work at Ephesus, and there is a notice of him in Hebrews (xiii 23), which chronicles his release from imprisonment, though there is no clue to its date or place. Tradition, probably based on inferences from the New Testament, made him bishop of Ephesus, where it is said he was martyred under Domitian, one legend asserting that he was clubbed to death by the mob for protesting against the orgies of Artemis worship. The Greek martyrology celebrates his death on Jan 22, the Latin on Jan. 24. (J. Mof.)

TIMOTHY, EPISTLES TO: *see* Pastoral Epistles.

TIMOTHY, SECOND EPISTLE TO: *see* Pastoral Epistles.

TIMPANI (It.), in music, the Italian name for kettledrums. (*See* Drum.)

TIMŪR (*Timur i Leng*, the lame Timūr), commonly known as Tamerlane, the renowned Oriental conqueror, was born in 1336 at Kesh, better known as Shahr-i-Sabz, "the green city," 50 m. south of Samarkand in Transoxiana. His father Teragai was head of the tribe of Berlas Great-grandson of Karachar Nevian (minister of Jagatai, son of Jenghiz Khan, and commander-in-chief of his forces), and distinguished among his fellow-clansmen as the first convert to Islamism, Teragai might have assumed the high military rank which fell to him by right of inheritance; but like his father Burkul he preferred a life of retirement and study. At the age of twenty Timūr had not only become an adept in manly outdoor exercises but had earned the reputation of being an attentive reader of the Koran.

About 1358, however, he came before the world as a leader of armies. His career for the next ten or eleven years may be thus briefly summarized from the *Memoirs*. Allying himself both in cause and by family connection with Kurgan, the dethroner and destroyer of Kazan, chief of the western Jagatai, he was deputed to invade Khurasan at the head of a thousand horse. This was the second warlike expedition in which he was the chief actor, and the accomplishment of its objects led to further operations, among them the subjection of Khwarizm and Urganj. After the murder of Kurgan the contentions which arose among the many claimants to sovereign power were arrested by the invasion of Toghluk Timūr of Kashgar, a descendant of Jenghiz. Timūr was despatched on a mission to the invader's camp, which led to his appointment to the government of Māwarā-'lnahr (Transoxiana).

By the death of his father Timūr was also left hereditary head of the Berlas. The exigencies of his quasi-sovereign position compelled him to have recourse to his formidable patron, whose reappearance on the banks of the Sihon created a consternation not easily allayed. Māwarā'lnahr was taken from Timūr and entrusted to a son of Toghluk; but he was defeated in battle by the bold warrior he had replaced at the head of a numerically far inferior force. Toghluk's death facilitated the work of reconquest, and a few years of perseverance and energy sufficed for its accomplishment, as well as for the addition of a vast extent of territory. During this period Timūr and his brother-in-law, Hosain—at first fellow-fugitives and wanderers in joint adventures full of interest and romance—became rivals and antagonists. At the close of 1369 Hosain was assassinated and Timūr proclaimed sovereign at Balkh, mounted the throne at Samarkand.

The next thirty years or so were spent in various wars and expeditions. Timūr not only consolidated his rule at home by the subjection of intestine foes, but sought extension of territory by encroachments upon the lands of foreign potentates. His conquests to the west and north-west led him among the Mongols of the Caspian and to the banks of the Ural and the Volga; those to the south and south-west comprehended almost every province in Persia, including Baghdad, Kerbela and Kurdistan. One of the most formidable of his opponents was Toktamish, who after having been a refugee at the court of Timūr became ruler both of the eastern Kipchak and the Golden Horde, and quarrelled with Timūr over the possession of Khwarizm It was not until 1395 that the power of Toktamish was finally broken. (*See* MONGOLS; GOLDEN HORDE.)

In 1398, when Timūr was more than sixty years of age, Farishta tells us that, "informed of the commotions and civil wars of India," he "began his expedition into that country," and on Sept. 12, "arrived on the banks of the Indus." His passage of the river and upward march along the left bank, the reinforcement he provided for his grandson Pir Mahommed (who was invested in Multan), the capture of towns or villages accompanied, it might be, with destruction of the houses and the massacre of the inhabitants, the battle before Delhi and the easy victory, the triumphal entry into the doomed city, with its outcome of horrors—all these circumstances belong to the annals of India In April 1399, some three months after quitting the capital of Mahmūd Toghluk, Timūr was back in his own capital beyond the Oxus. It need scarcely be added that an immense quantity of spoil was conveyed away According to Clavijo, ninety captured elephants were employed to carry stones from certain quarries for Timūr to erect a mosque at Samarkand.

The war with the Turks and Egyptians which succeeded the return from India was rendered notable by the capture of Baghdad, Aleppo and Damascus, by the great victory over the Turks at Angora (1402), where the Sultan Bayezid I. was captured, and thereafter dragged in the conqueror's train. (*See* TURKEY: *History,* and EGYPT: *History,* Mohammedan period.) This was Timūr's last campaign. Another was projected against China, but he was attacked by fever when encamped on the farther side of the Sihon (Syr-Daria) and died at Atrār (Otrar) on Feb. 17, 1405. Markham, in his introduction to the narrative of Clavijo's embassy, states that his body "was embalmed with musk and rose water, wrapped in linen, laid in an ebony coffin and sent to Samarkand, where it was buried." Timūr had carried his victorious arms on one side from the Irtish and the Volga to the Persian Gulf and on the other from the Hellespont to the Ganges.

Timūr's generally recognized biographies are—'Alī Yazdī, commonly called Sharifu 'd-Dīn, author of the Persian *Zafarnāma,* translated by Petis de la Croix in 1722, and from French into English by J. Darby in the following year; and Ahmad ibn Mohammed ibn Abdallah, al Dimashki, al 'Ajmi, commonly called Ibn 'Arabshāh, author of the Arabic *'Ajaibu 'l Makhlnkāt,* translated by the Dutch Orientalist Golius in 1636.

There are also the *Memoirs* (*Malfūzāt*) and *Institutes* (*Tuzukāt*), of which an important section is styled *Designs and Enterprises* (*Tadbīrāt wa Kangāshahā*). Upon the genuineness of these doubt has been thrown. The circumstance of their alleged discovery and presentation to Shah Jahān in 1637 was of itself open to suspicion

There are supposed likenesses of Timūr in the collections of Oriental mss. and drawings in the British Museum In Marlowe's *Tamburlaine* Timūr is described as tall of stature, straightly fashioned, large of limb, having joints strongly knit, long and sinewy arms, a breadth of shoulders to "bear old Atlas's burden," pale of complexion, and with "amber hair wrapp'd in curls" The outline of this description might be from Sharifu 'd-Dīn, while the colours are the poet's own.

Apart from modern European *savants* and historians, and the more strictly Oriental chroniclers who have written in Persian, Turkish or Arabic, the following authorities may be cited—Laonicus Chalcondylas, Joannes Leunclavius, Joachimus Camerarius, Petrus Perondinus Lazaro Soranzo, Simon Mairlus, Matthew Michiovius. A score or so of other names are given by Samuel Purchas. *See* also Sir Clements Markham's *Clavijo,* in the Hakluyt Society's publications; White's edition of Davy's translation of the *Institutes* (1783), Stewart's translation of the *Malfūzāt;* Malcolm's *History of Persia;* and *Trans Roy Soc.* (1885); Horn, "Gesch Irans in islam. Zeit," in Geiger and Kuhn, *Grundr. der iranisch. Philol.* (1904); works quoted, *s v* MONGOLS. (F. J. G.)

TIN, a metallic chemical element, symbol Sn (Lat. *stannum*) atomic number 50, atomic weight 118 70. Being a component of bronze, it was used as a metal thousands of years prior to the dawn of history; but it does not follow that prehistoric bronzes were made from *metallic tin.* When the unalloyed metal was first introduced cannot be ascertained with certainty. The "tin" of the Bible corresponds to the Hebrew *bedhil,* which is really a copper alloy known as early as 1600 B.C. in Egypt. All we know is that about the 1st century the Greek word *κασσίτερος* designated tin, and that tin was imported from Cornwall into Italy after, if not before, the invasion of Britain by Julius Caesar From Pliny's writings it appears that the Romans in his time did not realize the distinction between tin and lead: the former was called *plumbum album* or *candidum* to distinguish it from *plumbum nigrum* (lead proper) The word *stannum* definitely assumed its present meaning in the 4th century

Grains of metallic tin occur intermingled with the gold ores of Siberia, Guiana and Bolivia, and in a few other localities Of minerals containing this element mention may be made of cassiterite (*q.v.*) or tinstone, SnO_2, and tin pyrites, $Cu_4SnS_4+Fe_2SnS_4$; the metal also occurs in some epidotes, and in company with columbium, tantalum and other metals Of these "tinstone" is of the greatest commercial importance. It occurs in its matrix, either in or closely associated with fissure veins or disseminated through rock masses. It is also found in the form of rolled lumps and grains, "stream tin," in alluvial gravels; the latter are secondary deposits, the products of the disintegration of the first-named primary deposits. Almost everywhere primary deposits of tinstone are in or closely connected with granite or acid eruptive rocks of the same type, its mineral associates being tourmaline, fluorspar, topaz, wolfram and arsenical pyrites, the commonest gangue being quartz An exception to this mode of occurrence, however, is to be found in Bolivia where the tin ore occurs intimately associated with silver ores bismuth ores and various sulphides, whilst the gangue includes barytes and certain carbonates. Over five-sixths of the world's total production is derived from secondary alluvial deposits, but the tin obtained in Cornwall (where the alluvial deposits have been worked out) and Bolivia is from vein mining, while a small portion of that yielded by Australasia comes from veins and from granitic rocks carrying disseminated tinstone.

Production.—During the 18th century the world's supply of tin was mainly from England, Saxony and Bohemia; in 1801 England produced about 2,500 tons, while the supplies of Saxony and Bohemia had been greatly diminished. The English supply then gradually increased to about 10,000 tons in 1860, and this figure was fairly well sustained until about 1890, when a period of depression to about 4,000 tons set in In the opening decades of the 19th century supplies began to be drawn from the island of Banka. Billiton became of note in 1853. The Straits Settlements ranked as an important producer in 1870 and now produce a large part of the world's supply. Australian deposits were worked in 1872, and those of Bolivia somewhat later. The production of Nigeria, though relatively small, shows the greatest proportional increase in the twelve years 1915–1926. The following table shows the output (in tons) of the largest producers and also the total world's output for certain recent years

	1915	1920	1925	1926
Federated Malay States	46,756	34,935	45,925	45,946
Bolivia	21,544	27,821	32,980	32,113
Dutch East Indies	19,255	21,181	32,704	33,006
Nigeria	4,837	5,168	6,175	7,042
China	7,095	10,566	8,789	6,538
Siam	8,998	6,201	6,802	6,978
Total (all countries) .	126,872	122,097	145,437	143,968

Properties.—An ingot of tin is pure white (except for a slight tinge of blue); the colour depends, however, upon the temperature at which it is poured—if too low, the surface is dull, if too high, iridescent. It exhibits considerable lustre and is not subject to tarnishing on exposure to normal air. The metal is fairly soft and easily flattened out under the hammer, but almost devoid of tenacity. That it is elastic, with narrow limits, is proved by its clear ring when struck with a hard body in circumstances permitting of free vibration The specific gravity of cast tin is 7 29, of rolled tin 7·299 and of electrically deposited tin 7 143 to 7·178 A tin ingot is distinctly crystalline; hence the characteristic crackling noise, or "cry" of tin, which a bar of tin gives out when being bent. This structure can be rendered visible by superficial etching with dilute acid; and as the minuter crystals dissolve more quickly than the larger ones, the surface assumes a frosted appearance (*moirée métallique*) The metal is bimorphous by cooling molten tin at ordinary air temperature tetragonal crystals are obtained, while by cooling at a temperature just below the melting point rhombic forms are produced. When exposed for a sufficient time to very low temperatures (to —39° C for 14 hours), tin becomes so brittle that it falls into a grey powder, termed the *grey modification,* under a pestle; indeed, when kept in cold climates for several years, it sometimes crumbles into powder spontaneously (*see* ALLOTROPY). At ordinary temperatures tin proves fairly ductile under the hammer, and its ductility seems to increase as the temperature rises up to about 100° C. At some temperature near its fusing point it becomes brittle, and still more brittle from —14° C downwards. Iron renders the metal hard and brittle; arsenic, antimony and bismuth (up to 0 5%) reduce its tenacity; copper and lead (1 to 2%) make it harder and stronger but impair its malleability; and stannous oxide reduces its tenacity. Tin fuses at about 230° C; at about 1,600° C it begins to volatilize slowly; at about 2,270° C it boils The hot vapour produced combines with the oxygen of the air into white oxide, SnO_2. Its coefficient of linear expansion between 0° and 100° is 0·002717; its specific heat 0 0562; its thermal and electrical conductivities are 145 to 152 and 114 5 to 140·1 respectively, compared to silver as 1,000. The metal is scarcely affected by dilute hydrochloric or sulphuric acids; very dilute nitric acid slowly dissolves it, but strong acid converts it to β-stannic acid (*see* below); concentrated hydrochloric acid attacks it fairly readily, and concentrated sulphuric acid when hot.

Industrial Applications.—Commercially pure tin is used for making such apparatus as evaporating basins, infusion pots, stills, etc. It is also employed for making two varieties of tin-foil—one for the silvering of mirrors (now superseded) the other for wrapping up chocolate, toilet soap, tobacco, etc The mirror foil must contain some copper to prevent it from being too readily amalgamated by the mercury. For making tin-foil the metal is rolled into thin sheets, pieces of which are beaten out with a wooden mallet. As pure tin does not tarnish in the air and is proof against acid liquids, such as vinegar, lime juice, etc., it is utilized for culinary and domestic vessels. But it is expensive, and tin vessels have to be made very heavy to give them sufficient stability of form; hence it is generally employed merely as a protecting coating for utensils made of iron usually. (*See* TIN-PLATE.) Rolled plates of mild steel are "pickled" in dilute hydrochloric or sulphuric acid, annealed, cold rolled, re-annealed at a lower temperature, again pickled in weaker acid, and washed with water They are then tinned by passing through a bath of the molten metal which is divided into two sections and so arranged that the plate passes through a flux of molten zinc chloride floating on the metal in the first section, and emerges through a coating of grease floating on the metal in the second section; they are then rolled in order to remove excess of tin and to impart polish to the surface

By far the greater part of the tin produced metallurgically is used for making alloys. Ordinary solder is a mixture of equal parts of tin and lead; pewter (*q.v*) is 3 parts of tin to 1 part of lead. Locomotive bearings are a lead-copper alloy containing about 8% of tin. Bronze (*q v*) is an alloy of tin with copper, and the properties differ greatly from those of either metal separately. Coinage bronze contains 5% of tin (with the addition of about 1% of zinc); bronzes containing 9–10% of tin are used as gun-metal, those having 10–12% are used as engineers' brasses, those with 12–15% for bearings and those with 16–24% for bells, the precise proportion depending upon the type of bell required Speculum metal contains 33% of tin and 67% of copper. All the properties of these alloys are, however, considerably modified by the rate of cooling, and processes such as hammering and cold working.

COMPOUNDS OF TIN

Tin forms two well-marked series of salts, in one of which it is bivalent, these salts being derived from stannous oxide, SnO, in the other it is quadrivalent, this series being derived from stannic oxide, SnO_2.

Stannous Oxide, SnO, is obtained in the hydrated form $2SnO\,H_2O$ from a solution of stannous chloride by addition of sodium carbonate; it forms a white precipitate, which can be washed with air-free water and dried at 80° C without much change by oxidation; if it be heated in carbon dioxide the black SnO remains Precipitated stannous hydrate dissolves readily in caustic potash; if the solution is evaporated quickly it suffers decomposition, with formation of metal and stannate,

$$2SnO + 2KOH = K_2SnO_3 + Sn + H_2O.$$

If it is evaporated slowly, anhydrous stannous oxide crystallizes out in forms which are combinations of the cube and dodecahedron. Dry stannous oxide, if touched with a glowing body, catches fire and burns to stannic oxide, SnO_2 Stannous oxalate when heated by itself in a tube leaves stannous oxide

Stannic Oxide, SnO_2—This, if the term is taken to include the hydrates, exists in a variety of forms (1) *Tinstone* (*see* above and also CASSITERITE) is proof against all acids. Its disintegration for analytical purposes can be effected by fusion with caustic alkali in silver basins, with the formation of soluble stannate, or by fusion with sulphur and sodium carbonate, with the formation of a soluble thiostannate (2) A similar oxide (*flores Jovis*) is produced by burning tin in air at high temperatures or exposing any of the hydrates to a strong red heat. Such *tin-ash,* as it is called, is used for the polishing of optical glasses; "putty powder" is another name for a similar preparation used for polishing. *Flores stanni* is a finely divided mixture of the metal and oxide obtained by fusing the metal in the presence of air for some time (3) *Metastannic acid* (generally written $H_{10}Sn_5O_{15}$, to account for the complicated composition of metastannates, *e g*, the sodium salt $H_8Na_2Sn_5O_{15}$) is the white compound produced from the metal by means of nitric acid. It is not the true meta-acid, however, and is therefore better called β-stannic acid (*see* below). It is insoluble in water and in nitric acid and apparently so in hydrochloric acid; but if heated with this latter for some time it passes into a more soluble compound, which is a basic chloride, β-stannyl chloride. β-stannic acid is distinguished from ortho- or α-stannic acid by its insolubility in nitric and sulphuric acids. The salts are obtained by the action of alkalis on the acid. (4) Orthostannic acid, so-called, is really the meta-acid and is better called α-stannic acid; it is obtained as a white precipitate on the addition of sodium carbonate or the exact quantity of precipitated calcium carbonate to a solution of the chloride. This acid, H_2SnO_3, is readily soluble in acids forming stannic salts, and in caustic potash and soda, with the formation of metastannates. Of these sodium stannate, Na_2SnO_3, is produced industrially by heating tin with Chile saltpetre and caustic soda, or by fusing very finely powdered tinstone with caustic soda in iron vessels. A solution of the pure salt yields

fine prisms of the composition $Na_2SnO_3+10H_2O$, which effloresce in the air. The salt is used as a mordant in dyeing and calico-printing, being called "preparing salts" in the latter industry Alkaline and other stannates when treated with aqueous hydrofluoric acid are converted into fluostannates or stannifluorides (*e.g.*, K_2SnO_3 into K_2SnF_6), which are closely analogous to, and isomorphous with, fluosilicates or silicifluorides.

A colloidal or *soluble stannic acid* is obtained by dialysing a mixture of tin tetrachloride and alkali, or of sodium stannate and hydrochloric acid. On heating it is converted into colloidal β-stannic acid A hydrated *tin trioxide*, $2SnO_3 \cdot H_2O$, has been described by Spring

Stannous chloride, $SnCl_2$, can only be obtained pure by heating pure tin in a current of pure dry hydrogen chloride. It is a white solid, fusing at 250° C to an oily liquid which boils at 606°, and volatilizing at a red heat in nitrogen, a vacuum or hydrogen chloride, without decomposition The vapour density below 700° C is somewhat high. but above 800° C corresponds to nearly $SnCl_2$ The chloride readily combines with water to form a crystallizable hydrate $SnCl_2 \cdot 2H_2O$, known as "tin salt" or "tin crystals" This salt is also formed by dissolving tin in strong hydrochloric acid and allowing it to crystallize, and is industrially prepared by passing sufficiently hydrated hydrogen chloride over granulated tin contained in stoneware bottles and evaporating the concentrated solution produced in tin basins over granulated tin The basin itself is not attacked The crystals are very soluble in cold water, and if the salt is really pure a small proportion of water forms a clear solution, but on adding much water most of the salt is decomposed, with the formation of a precipitate of oxychloride, $2Sn(OH)Cl \cdot H_2O$. The same oxychloride is produced when the moist crystals are exposed to the air Hence all tin crystals as kept in the laboratory give with water a turbid solution, which contains stannic in addition to stannous chloride The complete conversion of stannous into stannic chloride may be effected by a great many reagents—for instance, by chlorine (bromine, iodine) readily, by mercuric chloride, with precipitation of calomel or metallic mercury; by ferric chloride on warming, with formation of ferrous chloride; by arsenious chloride in strong hydrochloric acid solutions, with precipitation of brown metallic arsenic. All these reactions are available as tests for "stannosum" or, alternatively for the respective agents A strip of metallic zinc when placed in a solution of stannous chloride precipitates the tin in crystals and takes its place in the solution Stannous chloride is largely used in the laboratory as a reducing agent, in dyeing as a mordant

Stannic chloride, $SnCl_4$, named by Andreas Libavius in 1605 *Spiritus argenti vivi sublimati* from its preparation by distilling tin or its amalgam with corrosive sublimate, and afterwards termed *Spiritus fumans Libavii*, is obtained by passing dry chlorine over granulated tin contained in a retort; the tetrachloride distils over as a heavy liquid, from which the excess of chlorine is easily removed by shaking with a small quantity of tin filings and redistilling. It is a colourless fuming liquid of specific gravity 2·279 at 0° C; it freezes at $-33°$, and boils at 113·9°. The chloride unites energetically with water to form crystalline hydrates (*e g*, $SnCl_4 \cdot 3H_2O$), easily soluble in water With one-third its weight of water it forms the so-called "butter of tin" It combines readily with alkaline and other chlorides to form double salts, *e g*, M_2SnCl_6, analogous to the chloroplatinates; the salt $(NH_4)_2SnCl_6$ is known industrially as "pink salt" on account of its use as a mordant to produce a pink colour. The *oxymuriate of tin* used by dyers is $SnCl_4 \cdot 5H_2O$. The plain chloride solution is similarly used. It is usually prepared by dissolving the metal in aqua regia (*q.v.*).

Stannous fluoride, SnF_2, is obtained as small, white monoclinic tables by evaporating a solution of stannous oxide in hydrofluoric acid in a vacuum. *Stannic fluoride*, SnF_4, is obtained as white hygroscopic crystals from stannic chloride and anhydrous hydrofluoric acid at a high temperature; it forms a characteristic series of salts, the stannifluorides, M_2SnF_6, isomorphous with the silici-, titani-, germani- and zirconi-fluorides *Stannous bromide*, $SnBr_2$, is a light yellow substance formed from tin and hydrobromic acid. *Stannic bromide*, $SnBr_4$, is a white crystalline mass, melting at 33° and boiling at 201°, obtained by the combination of tin and bromine, preferably in carbon bisulphide solution *Stannous iodide*, SnI_2, forms yellow red needles, and is obtained from potassium iodide and stannous chloride *Stannic iodide*, SnI_4, forms red octahedra and is prepared similarly to stannic bromide. Both iodides combine with ammonia

Stannous sulphide, SnS, is obtained as a lead-grey mass by heating tin with sulphur, and as a brown precipitate by adding sulphuretted hydrogen to a stannous solution; this is soluble in ammonium polysulphide, and dries to a black powder. *Stannic sulphide*, SnS_2, is obtained by heating a mixture of tin, mercury, sulphur and sal-ammoniac (in the proportions 12, 6, 7 and 6 respectively) in the beautiful form of *aurum musivum* (mosaic gold)—a solid consisting of golden yellow, metallic lustrous scales, and used chiefly as a yellow "bronze" for plaster-of-Paris statuettes, etc The yellow precipitate of stannic sulphide obtained by adding sulphuretted hydrogen to a stannic solution readily dissolves in solutions of the alkaline sulphides to form *thiostannates* of the formula M_2SnS_3; the free acid, H_2SnS_3, may be obtained as an almost black powder by drying the yellow precipitate formed when hydrochloric acid is added to a solution of a thiostannate

Organic Compounds of Tin.—Numerous organic compounds of tin are known, such as tin tetraethyl, $Sn(C_2H_5)_4$ Where the four radicals are different, the compound can exist in enantiomorphous forms (*see* STEREOCHEMISTRY); thus W J. Pope and his collaborators (1900–1902) resolved methylethylpropyl tin iodide, $Sn(CH_3)(C_2H_5)(C_3H_7)I$, into dextro- and laevo-modifications. Compounds of tin with β-diketones (*see* KETONES) are also known The simplest is stannic bisacetylacetone dichloride, $Sn(C_5H_7O_2)_2Cl_2$ (W. Dilthey, 1902), and G T Morgan and H D K Drew (1920) showed that in all such compounds with univalent β-diketones tin has a co-ordination number of 6, *i e*, the constitution is $[R_2SnX_2]$, X being a halogen atom, and the same co-ordination number is found in "pink salt" (*see* above), $[SnCl_6](NH_4)_2$ A co-ordination number of 8 is, however, indicated in tetra-aquabisacetylacetone stannibromide $[Sn(C_5H_7O_2)_2, 4H_2O]SnBr_6$

Methyl stannic iodide (stanniform), CH_3SnI_3, a yellow crystalline substance melting at 87° C, has been applied in therapeutics (1929) as antiphlogistic, analgesic and antiseptic, it combines the usefulness of tin in staphylococcic infections with the powerful germicidal properties of iodine

Hydrides.—A hydride, SnH_4, of melting point $-150°$ C, has been obtained by electrolysis of a stannous sulphate solution between lead electrodes, a trace of colloids (*e g*, 0·5% of dextrin) being used as a stabilizer; it forms only about 0·01% of the resulting gas and is separated from this hydrogen by condensation in liquid air. A second hydride, Sn_2H_2, is said to be produced as a grey powder by immersing aluminium foil in an alkaline solution of potassium stannite

Analysis.—Tin compounds when heated on charcoal with sodium carbonate or potassium cyanide in the reducing blowpipe flame yield the metal and a scanty ring of white SnO_2 Stannous salt solutions yield a brown precipitate of SnS with sulphuretted hydrogen, which is insoluble in cold dilute acids and in real sulphide of ammonium $(NH_4)_2S$; but the yellow, or the colourless reagent on addition of sulphur, dissolves the precipitate as a salt of SnS_2 The solution on acidification yields a yellow precipitate of this sulphide Stannic salt solutions give a yellow precipitate of SnS_2 with sulphuretted hydrogen, which is insoluble in cold dilute acids but readily soluble in sulphide of ammonium, and is re-precipitated therefrom as SnS_2 on acidification. Only stannous salts (not stannic) give a precipitate of calomel in mercuric chloride solution. A mixture of stannous and stannic chloride, when added to a sufficient quantity of solution of chloride of gold, gives an intensely purple precipitate of gold purple (purple of Cassius). The test is very delicate, although the colour is not in all cases a pure purple Tin is generally quantitatively estimated as the dioxide or electrolytically

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tion, etc., *see* Bernard Neumann, *Die Metalle* (1904); A. Rossing, *Geschichte der Metalle* (1901). For its chemistry *see* J. A. N. Friend, *Text-book of Inorganic Chemistry*, vol 5, by R. M. Caven (1914); J. W. Mellor, *Comprehensive Treatise on Inorganic and Theoretical Chemistry*, vol. 7 (1922). For statistics, advances in technology, etc., *see* G. A Roush and A. Butts, *The Mineral Industry* (annual).
(A. D. M.)

PRODUCTION

Although deposits of tin are very widely distributed, the two areas which are of principal importance are the Asiatic deposits, comprising Malaya, Siam and China, and those of Bolivia. These two areas provide about 85% of the world's total output. Until 1916 the British Empire production exceeded that of foreign countries; but since that date, owing to the enlarged output from Bolivia and the Dutch East Indies, the production of other countries has been the larger. In 1925 the world's most important producer of tin was still the Federated Malay States where the alluvial deposits of the Kinta valley form the richest tinfield. The only tin-ore known in Malaya is the dioxide, cassiterite. The methods of working are ground sluicing and hydraulic mining, open cast-workings; underground workings and dredging In Burma the most important occurrences of tinstone are in the Bawlake State of Karenni, at the Mawchi Mines, in the Amherst district (*a*) at Belugyum, (*b*) east and west of the Seludang range; and in the Thaton, Tovoy and Mergui Districts.

The Burmese mineralized belt continues southwards through the F.M.S to the islands of Singkef, Banka and Billiton in the Dutch East Indies, thus forming the world's richest tin-producing area. In 1924 it supplied over 60% of the world's total output; and the Dutch East Indies alone contributed no less than 23·2% of the world's production. It was, however, stated in 1925 that within 12 years the bulk of the rich secondary deposits of Dutch East Indies, of Malaya, of Siam and of Lower Burma will have been exhausted. Other Asiatic occurrences of tin are those of French Indo-China in the province of Tongking; in China, in the provinces of Yunnan, Kwangsi, Hanan, Kwangtung and Fukien; and in Japan in (*a*) the Akenob district, Tajima province, (*b*) the Taniyama mine, Satsuma province, (*c*) the Kiura mine, Bungo province, (*d*) mines near Takayama and Hirukawa.

In North and central America cassiterite is known to occur in very small quantities, also in Canada, United States, Mexico and British Honduras. The most important producer in South America is Bolivia, whose tinfields supplied 21 4% of the world's total output in 1924. The chief mines occur in La Paz, Cochabamba, Oruro and Potosi. The most important point about the Bolivian deposits is that they are primary, and lode-mining is much more likely to yield larger outputs over a longer period of future years than is the case with the Asiatic deposits. Tin is widely distributed in Australasia—all the States of the Commonwealth of Australia and also New Zealand produce the mineral—but in 1923 the whole area yielded only 2½% of the world s total.

In the continent of Africa the most important tin producer is Nigeria. The tinstone occurs in the granites of the Younger Intrusive Series and in the tourmaline pegmatites of a somewhat earlier age. The pegmatites are found in all the crystalline areas of the Protectorate, but carry tinstone only in a few widely separated localities In the Transvaal, cassiterite occurs in pipe-like ore-bodies and veins in the Bushveld granite and overlying quartzites. In south-west Africa alluvial and detrital deposits have been worked hitherto, but many lodes occur and may be worked in future. In Swaziland tin-ore occurs both in alluvial deposits and veins. Most of the concentrates from Swaziland and the Union are shipped to the Straits Settlements for smelting. Other contributing countries are the Gold Coast, Nyassaland, Belgian Congo, Portuguese East Africa, South West Africa and Rhodesia. In 1924 the continent of Africa produced 5·47% of the world's production of tin for that year, mainly contributed by Nigeria.

In Europe the chief producing countries are Great Britain, Czechoslovakia, Germany, Portugal and Spain. With regard to the mines in Cornwall and Devon, during the 50 years ending 1800 the output varied between 2,000 and 3,500 tons a year. The maximum output during the World War was 6,537 in 1914. By 1922, when so few mines were working, the production was only 370 tons. By 1924, owing to the greatly improved conditions, the figure had risen to 1,725. In 1925 about 95% of the production occurred in the Camborne-Redruth area. Tin-smelting is an important industry in the United Kingdom, ores from Nigeria, Bolivia and other countries being treated in addition to domestic ores

The following table gives the world's production, in long tons, of tin ore for 1918, 1923 and 1925

	1918	1923	1925
Great Britain	3,954	1,021	2,339
Nigeria	5,004	5,860	6,256
Swaziland	358	107	277
Union of S. Africa	1,422	918	1,157
India (Burma)	647	1,400	1,300
Federation of Malay States	37,369	37,643	45,926
Unfederated Malay States	2,720	1,727	2,145
Australia	4,747	3,283	3,016
Approx total	57,100	52,000	62,600
Bolivia	29,104	29,767	32,074
Dutch East Indies	10,200	31,019	32,749
Siam	8,835	6,334	8,062
China	8,730	8,727	8,500
Other countries	226	1,740	2,000
Approx. total	66,100	78,600	83,400
World's total (approx)	123,200	130,600	146,000

The 1924 total was approximately 137,860 long tons.

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(N M. P.)

TINAMOU, the name of a group of birds peculiar to South America, having some superficial resemblances to the partridge.

A RUFOUS TINAMOU OF GUIANA

The elongated bill, small head and slender neck are diagnostic. The plumage is some shade of brown, variously barred with darker tints. The wings are short and rounded and the male incubates the highly-burnished eggs. They are exceedingly stupid but are excellent to eat. Over 60 species are recognized. They are considered a group of palaeognathine birds and form the family *Tinamidae*. The little tinamou (*Crypturus pileatus*) ranges from the Amazon to Mexico, while the rufous tinamou (*Phychotus rufescens*) inhabits southern Brazil and Paraguay.

TINDAL, MATTHEW (d. 1733), English deist, the son of a clergyman, was born at Beer Ferrers (Ferris), Devonshire, probably in 1653. He studied law at Lincoln college, Oxford, under the high churchman George Hickes, dean of Worcester; in 1678 he was elected fellow of All Souls college. About 1685 he became a Roman Catholic, but returned to the Church of England at Easter, 1688. His early works were an *Essay of Obedience to the Supreme Powers* (1694); an *Essay on the Power of the Magistrate and the Rights of Mankind in Matters of Religion* (1697); and *The Liberty of the Press* (1698). The first of his two larger works, *The Rights of the Christian Church associated against the Romish and all other priests who claim an independent power over it*, pt. i., appearing anonymously in 1706 (2nd ed., 1706; 3rd, 1707; 4th, 1709), is a forcible defence of

Erastianism. Author, publisher and printer were prosecuted, but this did not prevent the issue of a fourth edition and gave the author the opportunity of issuing *A Defence of the Rights of the Christian Church,* in two parts (2nd ed., 1709). The book was, by order of the House of Commons, burned, along with Sacheverell's sermon, by the common hangman (1710) It continued to be the object of denunciation for years, and Tindal scented in a pastoral letter by Dr. Gibson, bishop of London, a charge of having undermined religion and promoted atheism and infidelity. He replied in the anonymous tract, *An Address to the Inhabitants of London and Westminster* (2nd ed, 1730). In this tract he defends the deists, and anticipates here and there his *Christianity as Old as the Creation; or, the Gospel a Republication of the Religion of Nature* (London, 1730, 2nd ed., 1731; 3rd, 1732; 4th, 1733), which was regarded as the "Bible" of deism. He died at Oxford on Aug. 16, 1733.

TINEO, a town of Spain, in the province of Oviedo; on a tributary of the Narcea, among the northern outliers of the Cantabrian mountains, and on the high road from Cangas de Tineo to the Biscayan port of Cudillero Pop. (1920), 22,009. Mining, agriculture and stock-rearing are the principal industries.

TINGUIAN, a tribe of north Luzon, in the Philippines, of Malayo-Indonesian stock More brachycephalic, and probably belonging to a later wave of immigration than the Igorot (*q.v.*) group, and showing stronger traces of Indian influence on culture probably traceable to Sumatran origin. The same influence appears in rice-cultivation methods, and irrigated terraces are less elaborate than those of the Igorot, who do not use the buffalo Marriage restrictions are based on blood-relationship only, not on clan, and the polity is democratic. A Creator is believed in, and spirits of various functions good and bad, some of which inhabit guardian stones The home of the dead, where life goes on as on earth, is sometimes placed in a mountain. The dead are dried before burial. Mediums, usually female, communicate with spirits.

See Cole, *The Tinguian* (1922).

TINNÉ, ALEXANDRINE PETRONELLA FRANCINA (1839–1869), Dutch traveller in Africa, born at The Hague on Oct 17, 1839, was the daughter of Philip F. Tinné, a Dutch merchant who settled in England during the Napoleonic wars Her father died when she was five years old, leaving her the richest heiress in the Netherlands. After travelling in Norway, Italy and the East, and visiting Egypt, when she ascended the Nile to near Gondokoro, Miss Tinné left Europe again in 1861 for the Nile regions. Accompanied by her mother and her aunt, she set out from Cairo on Jan. 9, 1862. After a short stay at Khartum the party ascended the White Nile to a point above Gondokoro, and explored a part of the Sobat, returning to Khartum in November. Baron Theodor von Heuglin (*q v*) and Dr. H. Steudner having meantime joined the ladies at Khartum, the whole party set out in Feb 1863 for the Bahr-el-Ghazal

Ascending the Bahr-el-Ghazal the limit of navigation was reached on March 10 From Meshra-er-Rek a journey was made overland, across the Bahr Jur and south-west by the Bahr Kosango, to Jebel Kosango, on the borders of the Niam-Niam country. During the journey all the travellers suffered severely from fever. Steudner died in April and Madame Tinné in June, and after many fatigues and dangers the remainder of the party reached Khartum in July 1864, where Miss Tinné's aunt died Miss Tinné returned to Cairo by Berber and Suakin In Jan. 1869 she started from Tripoli with a caravan, intending to proceed to Lake Chad, and thence to the upper Nile On Aug 1, however, on the route from Murzuk to Ghat, she was murdered, together with two Dutch sailors, by Tuareg who believed that her iron water tanks were filled with gold

See John A. Tinné's *Geographical Notes of an Expedition in Central Africa by three Dutch Ladies* (Liverpool, 1864), and Sir H. H. Johnston, *The Nile Quest,* ch. xvi. (London, 1903).

TINNED FOODS: *see* FOOD PRESERVATION.

TINNEVELLY, a town and district of British India, in the Madras presidency. The town is on the left bank of the Tambraparni river, on the other side of which is Palamcottah, the administrative headquarters of the district. Pop. (1921) 53,783. It is on the South Indian railway, 444 m. S.W. of Madras. A branch line was opened to Tiruchendur in 1923. Its most noteworthy building is a beautifully sculptured temple of Siva.

The DISTRICT OF TINNEVELLY has an area of 4,325 sq m. It is for the most part a plain with an average elevation of 200 ft., sloping to the east with slight undulations. It is watered by numerous short streams, the principal being the Tambraparni with a length of 80 m The chief irrigation work is the Srivaikuntam anicut or dam on this river. In the north the scenery is unattractive and the soil poor; in the south red sandy soil prevails in which little save the Palmyra palm will grow. This palm yields toddy as well as a coarse sugar. Along the banks of the rivers are rice-fields, cotton, millet, pulse and oil-seeds are grown, and cloth, mats, lace and sugar manufactured There is a trade in cotton stuffs, and fishing is carried on. The district contains many ancient and magnificent buildings. In 1921 the population was 1,901,396. The number of Christians was 192,350, Tinnevelly being the most Christian district in India. The Society for the Propagation of the Gospel and the Church Missionary Society have important stations at Tinnevelly town and Palamcottah, as also have the Jesuits It was here that St Francis Xavier began his preaching in India

The early history of Tinnevelly is mixed up with that of Madura and Travancore. Down to 1781 it is a confused tale of anarchy and bloodshed. In that year the nawab of Arcot assigned the revenues to the East India Company, which then undertook the internal administration Several risings subsequently took place, and in 1801 the whole Carnatic, including Tinnevelly, was ceded to the British

TIN-PLATE AND TERNE-PLATE. Tin-plate is a sheet of iron or steel which has been thinly coated with tin by being dipped in a molten bath of that metal Terne-plate is a sheet of iron or steel coated with a lead-tin alloy containing about 85% lead and 15% tin. The word terne was applied to this plate because of its dull appearance due to the large proportion of lead in the coating. The purpose of the tin in terne-plate coating is to act as a binder between the lead and the iron, which do not alloy

There are two processes for tinning In the "palm-oil" process, which is the older, the plates, after being properly annealed, are scoured with sand and water and pickled in dilute sulphuric acid alternately until they are perfectly clean and bright They are then washed in water, and after being boiled in palm oil to remove all traces of acid and water are dipped into a bath of molten tin covered with oil to prevent oxidation. They are then taken to a second bath containing purer tin than the first. After this they are scoured with a hempen rubber and dipped in a third bath containing the purest tin of all; then they are passed through rolls to finish the surface and regulate the thickness of the coating In the "acid process" only a single bath of tin is required The molten metal is covered with a layer of muriate of zinc, which acts as the flux, and by means of rolls the plates are passed through this down into the tin, to be brought out at another point in the bath where there is a layer of oil on the surface

The process of coating terne-plate is very similar to the galvanizing (*q v*) process The sheets, after having been pickled, are placed in the same kind of an acid solution, except the acid is somewhat weaker. The sheets first pass into a neutralized solution of zinc chloride. This flux enables the lead-tin mixture to adhere better to the base metal. Burners located under the intake side of the "kettle" keep its temperature at about 700 to 725° F The metal passes through the lead-tin alloy, under the flux, at the bottom of the kettle As the sheets emerge through the exit rolls, they pass through palm oil The rolls serve to pull the sheets through, and, together with the oil, they wipe off the excess metal and produce a smooth coating. This entire process is now completed by one machine; formerly it was necessary to dip and redip the sheets by hand Tongs are used to push the sheets down through the flux box until they are gripped and pulled out by the rolls. As the sheets leave the oil bath, an air spray cools them. They then pass through a set of flannel disk rolls that squeeze off the excess oil, and on to a conveyor They pass from the conveyor to cleaning machines, consisting of flannel disk rolls and

brushes, using sawdust, peanut hulls, meal or bran further to absorb and to clean off the oil The weight of coating is more difficult to control than it is in galvanizing It is affected by the heat of the bath. speed of the machine, the kind of rolls used and the surface of the sheet coated The temperature limits of the operation are very narrow.

The sheets employed in the manufacture of tin-plate and terneplate are known as "black plates" Formerly iron alone was used, and was of two grades, coke-iron and charcoal-iron, the latter being the better, received a heavier coating of tin, and this circumstance is the origin of the terms "coke-plates" and "charcoal plates" by which the quality of tin-plate is still designated Later steel was used but it was found that iron plate was more durable. Now both iron and steel plates are available. (*See* SHEETS, IRON AND STEEL.) It has been attempted to lower the price of terneplate by using coatings entirely too light Although much of this light-coated terne-plate is still used, high grade plate, properly coated, is obtainable. The service pure iron renders will, no doubt, cause more and more of this product to be used as the base for terne roofing plate as well as long ternes Two different types of finishes are obtainable; "bright dry" or "dark oil" These different effects are imparted as it travels through the machine

Long ternes are similar to terne-plates except that the sheets are larger, and the tin content usually runs about 12½%. The lead in the lead-tin alloy makes long terne-plate ideal for fabrication into caskets, automobile gasolene tanks and other products in the manufacture of which deep drawing and stamping (*see* PRESSED METAL) is necessary. The lead serves as a lubricant in forming operations, causing the sheets to flow uniformly under the dies. (B CHA)

TIN PRINTING: *see* LITHOGRAPHY

TINTAGEL (tĭn-tăj'ĕl) or **TREVENA,** village, Cornwall, England, 4½ m N W. of Camelford Pop (1921) 1,307. It stands on a bare upland, close to the sea; and below it is Tintagel Haven, or Porth, a small cove surrounded by cliffs of almost black slate Ruins of a castle are built partly on the mainland, partly on a rugged promontory, Tintagel Head, united by a narrow peninsula to the shore The Norman walls are so darkened and weathered that, from a little distance, they seem a part of the rock itself The cruciform parish church of St Marcelliana stands on a high cliff, west of the castle Although restored, it retains traces of Saxon workmanship in the chancel, besides two Norman doorways, a font of the same period, a stone altar bearing five crosses and a fine 15th-century brass In the churchyard the graves are buttressed, storms being frequent and violent. For a time the church belonged to Fontevrault abbey in Normandy; but it was made over by Edward IV to the collegiate church of Windsor. A 9th-century roodstone stands in the village. Portions of the vicarage date from the 14th century.

Tintagel (Tintajol, Dundagel) is a parish a portion of which appears in the Domesday Survey as Bossincy (Botcinnu). The castle probably existed in pre-Saxon times, and under the Norman earls of Cornwall was rebuilt, embattled and furnished with munitions of war It was in a ruinous condition in Leland's time (*c.* 1540). The borough of Bossiney, which apparently owed its existence to the castle, shared its fortunes. Its charter was surrendered to Charles II and a new one obtained from his brother in 1685 Provision was made for the administration of the borough. Bossiney acquired the right of electing two members of parliament in 1553. In 1784 the vicar of Tintagel, as mayor and only qualified elector, enjoyed the probably unique privilege of returning two members to the House of Commons. In 1832 there were ten resident legal voters within the borough and nine out-voters. The Reform Act transferred their votes to the county.

TINTERN ABBEY, in Monmouthshire, one of the most famous ecclesiastical ruins in England, on the River Wye. The abbey was founded by Walter de Clare in 1131 for Cistercian monks. The existing church, however, dates from the latter part of the 13th century; it is unroofed, and the nave is imperfect, but many of the finest details of a style transitional from Early English to Decorated are preserved. The church is cruciform. Cloisters and other monastic buildings, of which there are considerable remains, lay to the north of the church. The foundation was dissolved by Henry VIII.

TINTOMETER, a commercial instrument which makes it possible to register colours (*e.g.*, of oils) by matching them against the light transmitted by one or more of a set of coloured glasses, each glass being of a slightly different tint from those on either side of it in the set. (*See* COLOUR)

TINTORETTO, JACOPO ROBUSTI (1518–1594), one of the greatest painters of the Venetian school, was born in Venice in 1518, though Ridolfi says in 1512. His father, Battista Robusti, was a dyer, or "tintore", hence the son got the nickname of "Tintoretto," little dyer. His father, noticing his artistic bent, took him to the studio of Titian. Ridolfi is our authority for saying that Tintoretto had only been ten days in the studio when Titian sent him home once and for all. The reason, according to the same writer, is that the great master observed some very spirited drawings by the boy and it is inferred that he became at once jealous of so promising a scholar. This, however, is mere conjecture. From this time forward the two always remained upon distant terms—Robusti being indeed a professed and ardent admirer of Titian, but never a friend, and Titian turning the cold shoulder to Robusti, who sought for no further teaching, but studied on his own account with laborious zeal from casts, bas-reliefs etc. He placed over his studio the inscription "Il disegno di Michelangelo ed il colorito di Tiziano" (Michelangelo's design and Titian's colour) He is said to have studied more especially from models of Michelangelo's "Dawn," "Noon," "Twilight" and "Night," and from Sansovino's statues, and to have modelled in wax and clay small figures, which he suspended in a box with an aperture for a candle Thus, according to Ridolfi, Robusti's art was self-taught. More recent criticism, however, has averred that he probably proceeded to some other painter's studio on leaving Titian's Berenson and Thode have suggested that Bonifazio may have been his master while Hadeln thinks Bordone more likely However, he had a hard struggle to obtain recognition He assisted Schiavone in his studio and undertook every commission which offered itself One of Tintoretto's early pictures still extant is in the church of the Carmine in Venice, the "Presentation of Jesus in the Temple" In 1547 he painted the "Last Supper" in the Church of S Marcuola. The "Christ Washing the Apostles' Feet" painted for the same church is now in the Escorial. For the Scuola della Trinità he painted four subjects from Genesis Two of these, now in the Venetian Academy, are "Adam and Eve" and the "Death of Abel," both noble works of high mastery, which leave us in no doubt that Robusti was a consummate painter

In 1548 he was commissioned for four pictures in the Scuola di S. Marco—the "Finding of the body of St Mark in Alexandria" (now in the Brera, Milan), the "Saint's Body brought to Venice," the "miraculous preservation of a Saracen sailor at sea by the Saint" (these two are in the library of the royal palace, Venice), and the highly and justly celebrated "Miracle of the Slave." These works were greeted with general applause, including that of Titian's intimate, the too potent Pietro Aretino The painter's straits and obscure endurances were over. He married Faustina de' Vescovi, daughter of a Venetian nobleman, and settled in a house in the Fondamenti de Mori near the church of the Madonna dell' Orto. Here he painted three of his leading works—"The Worship of the Golden Calf," "The Presentation of the Virgin" and the "Last Judgment"

The next conspicuous event in the professional life of Tintoretto is his enormous labour and profuse self-development on the walls and ceilings of the Scuola di S. Rocco, a building which may now almost be regarded as a shrine reared by Robusti to his own genius. The building had been begun in 1524 by Sante Lombardi, after the design of Bart. Buono and was very deficient in light, so as to be particularly ill-suited for any great scheme of pictorial adornment. The painting of its interior was commenced in 1560. In that year five principal painters, including Tintoretto and Paul Veronese, were invited to send in trial-designs for the centre-piece in the smaller hall named Sala dell' Albergo, the subject being S. Rocco received into Heaven. Tintoretto produced not a sketch but

a picture, and got it inserted into its oval. The competitors remonstrated, not unnaturally; but the artist, who knew how to play his own game, made a free gift of the picture to the saint, and, as a by-law of the foundation prohibited the rejection of any gift, it was retained *in situ*—Tintoretto furnishing gratis the other decorations of the same ceiling. (This is one version of the anecdote. there is another version, which has the like general bearing.) In 1565 he resumed work at the scuola, painting the magnificent "Crucifixion," for which a sum of 250 ducats was paid In 1576 he presented gratis another centre-piece—that for the ceiling of the great hall, representing the "Plague of Serpents"; and in the following year he completed this ceiling with pictures of the "Paschal Feast" and "Moses striking the Rock." Robusti next launched out into the painting of the entire scuola and of the adjacent church of S Rocco. He offered in November 1577 to execute the works at the rate of 100 ducats per annum, three pictures being due in each year. This proposal was accepted and was punctually fulfilled, the painter's death alone preventing the execution of some of the ceiling-subjects. The whole sum paid for the scuola throughout was 2,447 ducats. Disregarding some minor performances, the scuola and church contain fifty-two memorable paintings, which may be described as vast suggestive sketches, with the mastery of finished pictures, "Adam and Eve," the "Visitation," the "Adoration of the Magi," the "Massacre of the Innocents," the "Agony in the Garden," "Christ before Pilate," "Christ carrying His Cross" and the "Assumption of the Virgin" are leading examples in the scuola; in the church, "Christ curing the Paralytic"

It was probably in 1560, the year in which he began working in the Scuola di S Rocco, that Tintoretto commenced his numerous paintings in the ducal palace, he then executed there a portrait of the doge, Girolamo Priuli Other works which were destroyed in the great fire of 1577 succeeded—the "Excommunication of Frederick Barbarossa by Pope Alexander III." and the "Victory of Lepanto" After the fire Tintoretto started afresh, Paul Veronese being his colleague In the Sala dello Scrutinio Robusti painted the "Capture of Zara"; in the hall of the senate, "Venice, Queen of the Sea" and two others; in the Sala del Collegio 4 pictures among which the "Espousal of St. Catherine"; in the Sala dell' Anticollegio, four decorative masterpieces—"Bacchus, with Ariadne crowned by Venus," the "Three Graces and Mercury," "Minerva discarding Mars," and the "Forge of Vulcan"—which were painted towards 1578; in the Antichiesetta, "St George and St. Louis, with St Margaret," and "St. Jerome and St. Andrew"; in the hall of the great council, nine large compositions, chiefly battle-pieces. We here reach the crowning production of Robusti's life, the last picture of any considerable importance which he executed, the vast "Paradise," in size 74 ft. by 30, reputed to be the largest painting ever done upon canvas. It is a work so stupendous in scale, so colossal in the sweep of its power, so reckless of ordinary standards of conception, so pure an inspiration of a soul burning with passionate visual imagining and a hand magical to work in shape and colour, that it has defied the connoisseurship of three centuries, and has generally (though not with its first Venetian contemporaries) passed for an eccentric failure All Venice applauded the superb achievement Robusti was asked to name his own price, but this he left to the authorities Robusti died on May 31, 1594. The register of deaths in S. Marciliano states that Tintoretto died of fever, aged seventy-five years, eight months and fifteen days—thus bringing us to Sept. 16, 1518 as the true date of his birth. He was buried in the church of the Madonna dell' Orto by the side of his favourite daughter Marietta (*c.* 1556–1590?) who had herself been a portrait-painter of considerable skill, as well as a musician, vocal and instrumental. In 1866 the grave was opened, and the remains were moved to the chapel on the right of the choir.

Tintoretto painted his own portrait at least twice (Uffizi, Florence and Louvre, Paris). It is a face somewhat blunt and rugged, but yet refined—concentrated and resolute, its native ardours of frankness and energy welded down into lifelong laboriousness, with a pent look as of smouldering fire. The eyes are large, dark and round; the grizzled hair close and compact.

In 1574 he obtained the reversion of the first vacant broker's patent in a fondaco, with power to bequeath it—an advantage granted from time to time to pre-eminent painters. For his phenomenal energy in painting he was termed "Il Furioso." An agreement is extant showing that he undertook to finish in two months two historical pictures each containing twenty figures, seven being portraits. The number of his portraits is enormous; their merit is unequal, but the really fine ones cannot be surpassed. The Venetians said that he had three pencils—one of gold, the second of silver and the third of iron. The only pictures (if we except his own portrait) on which he inscribed his name are the "Miracle of Cana" in the church of the Salute (painted originally for the brotherhood of the Crociferi), the "Miracle of the Slave," and the "Crucifixion" in the Scuola di S Rocco; the last was engraved in 1589 by Agostino Caracci

Of pupils Robusti had very few, his two sons and Martin de Vos of Antwerp were among them Domenico Robusti (1560–1635) whom we have already had occasion to mention, frequently assisted his father in the groundwork of great pictures. Some of his works are to be seen in the academy at Venice and in S Maria degli Angeli at Murano.

We conclude by naming a few of the more striking of Tintoretto's very numerous works not already specified in the course of the article In Venice (S Giorgio Maggiore), a series of his later works, the "Gathering of the Manna," "Last Supper," "Entombment," "Resurrection"; (S Cassiano) a "Crucifixion," the figures seen from behind along the hill slope; (St Mark's) a mosaic of the "Baptism of Christ." In Milan (the Brera), "St Helena and other saints." In Florence (Uffizi) three fine portraits including that of the sculptor Jac Sansovino, (Pitti Gallery), "Venus," "Vulcan" and "Cupid." In Dresden "The Rescue" In Cologne (Wallraff-Richarts Museum), "Ovid and Corinna" In Munich (Pinakothek) eight paintings executed (1579–1580) for the Duke of Mantua, illustrating historical scenes—one of the siege of a fortified town is astonishingly fine In England (Hampton Court), "Esther and Ahasuerus," and the "Nine Muses"; (the National Gallery), "The Origin of the Milky Way," a memorable *tour de force*, "Christ washing Peter's Feet," also a spirited smallish work, "St George and the Dragon" A fine portrait of a Doge has recently been acquired by the Melbourne Gallery from Prince Lichnowski's collection In the Ca d'oro museum, Venice, are a number of distinguished portraits of Venetian Senators Tintoretto's unparalleled mastery of the human form is revealed in his drawings of which a volume has recently been published (D. von Hadeln, *Handzeichnungen des Tintoretto*, 1922)

See C. Ridolfi, *Meraviglie dell Arte* (ed by D v. Hadeln 1924); Ruskin, *Stones of Venice* (1863); F Preston Stearns, *The Life and Genius of T.* (1894), H Thode, *Tintoretto* (Leipzig, 1901), J B. Stoughton Holborn, *Jacopo Robusti* (1903), E M Phillipps, *Tintoretto* (1911); F. P. B Osmaston, *The Art and Genius of Tintoret* (1915); Ev. d. Becken und A. L. Meyer, *Jacopo Tintoretto* (Munich 1923). (W M R; X)

TIPASA, a town and commune on the coast of Algeria, in the department of Algiers, 30 m W of the capital The modern village (pop 753, of which 618 are Europeans), founded in 1857, is remarkable chiefly for its pleasant situation and sandy beach The roadstead is exposed to the north-east and north-west There is a mole about 90 ft long and anchorage in six fathoms The Roman city of Tipasa was built on three small hills which overlooked the sea. Of the houses, most of which stood on the central hill, no traces remain; but there are ruins of three churches—the Great Basilica and the Basilica Alexander on the western hill, and the Basilica of St. Salsa on the eastern hill—two cemeteries, the baths, theatre, amphitheatre and nymphaeum.

Tipasa was founded by the Phoenicians, was made a Roman military colony by the emperor Claudius, and afterwards became a municipium Christianity was early introduced, and in the third century Tipasa was a bishop's see. In 484 the Vandal king Huneric (477–484) sent an Arian bishop to Tipasa; whereupon a large number of the inhabitants fled to Spain, while many of the remainder were cruelly persecuted. After this time the city disappears from history.

See S Gsell, *Promenades archéologiques aux environs d'Alger* (1926);

Id. *Les monuments antiques de l'Algérie*, 2 vol. (1901); Id. *Atlas Archéologique de l'Algérie* (1911).

TIPPERA, a district of British India, in the Chittagong division of Bengal. Area, 2,560 sq m ; pop. (1921) 2,743,073. The administrative headquarters are at Comilla (pop. 25,914). The district has a flat and open surface, with the exception of the isolated Lalmai hills (100 ft), and is for the most part laid out in well-cultivated fields, intersected by rivers and creeks. The principal rivers are the Meghna, or estuary of the Brahmaputra, the Gumti, Dakatia and Titas

Tippera formed part of the Tripura State (*q v.*) till 1733 when it was conquered and annexed to the Mogul empire by the nawal of Bengal When it came under the East India company in 1765, more than a fifth of its present area was under the immediate rule of the raja of Tripura, who paid a tribute of ivory and elephants Since then nothing has disturbed the peace of the district with the exception of a serious raid in 1860 by the Kukis or Lushais, who burnt down 15 villages, killed 185 persons, and carried off 100 prisoners

TIPPERARY, a county of Ireland in the province of Munster, bounded north-west by Galway, north-east by Offaly County, east by Leix County and Kilkenny, south by Waterford, and west by Cork, Limerick, Clare and Galway The county is the sixth in size of the Irish counties, having an area of 1,062,963 acres, or about 1,661 sq m Pop (1926) 140,946 Sandstone heights stand out above the limestone plain The Knockmealdown Mountains on the southern border reach an elevation of 2,609 ft To the north of this range are the Galty or Galtee Mountains (Galtymore 3,015 ft) To the east, bordering Kilkenny, are the Slievear-dagh Hills, and near Templemore the Devil's Bit Mountains (1,583 ft) with a curious gap on the summit In the north-west is Keeper Hill, 2,278 ft The folded character of the Carboniferous limestone is seen in the anticlinal boss on which stands the acropolis of Cashel The Suir has its source in the Devil's Bit Mountains, and flows southward and eastward by Templemore, Thurles, Caher, and Clonmel The Nore, which also rises in the Devil's Bit Mountains, soon passes into Leix County, and the Shannon forms part of the western border The Mitchelstown stalactite caverns were discovered accidentally in 1833 They are in the extreme south-west of the county; take their name from the neighbouring town of Mitchelstown, 6 m distant in County Cork; and were explored by M Martel in 1895.

Tipperary is one of the counties generally considered to have been formed by King John in 1210; in 1328 Edward III made it a county palatine in favour of the earl of Ormonde; and, though the king shortly afterwards resumed his regal prerogative, the county was regranted in 1337 In 1372 the grant was confirmed to James Butler, earl of Ormonde, the lands belonging to the Church retaining, however, a separate jurisdiction, and being known as the county of Cross Tipperary, or the Cross of Tipperary In 1621 James I took the county palatine into his own hands It was, however, restored in 1664 to James, 12th earl and 1st duke, whose regalities were further made to include the county of the Cross. On the attainder of James, 2nd duke, in 1715, the jurisdiction reverted to the Crown, and the last Irish palatinate thus ended.

The subsoil in the lower grounds is limestone, which is overlaid by a rich calcareous loam. The Golden Vale, the most fertile district in Ireland, stretches from Cashel to the town of Limerick. There is some mining The lead ore mined for many centuries at Silvermines south of Nenagh is silver-bearing, and is associated with zinc blende Indications of ore have been traced along the junction of the limestone with the older rocks Good slates are quarried in the Silurian area in Clashnasmuth townland on Slieve-naman There is a considerable number of meal and flour mills.

Communications are supplied by the Great Southern railway, the main line of which crosses the county from north-east to south-west by Templemore and Thurles The Ballybrophy (Leix County) and Limerick branch from this line serves the north of the county by Roscrea (junction for Birr) and Nenagh The Waterford and Limerick line passes through the south of the county by way of Clonmel and Tipperary, crossing the main line at Limerick Junction. The two lines are also connected by the Thurles, Fethard and Clonmel branch.

The county will benefit considerably from the electricity power stations in process of construction along the lower Shannon.

The administrative Counties of Tipperary North Riding and Tipperary South Riding together return 7 members to Dáil Eireann.

TIPPERARY, a town of Co. Tipperary, Ireland, near the Slieve na muck or Tipperary hills, a branch of the Galtee range, on the Great Southern railway, 3 m. S E of Limerick Junction and 110¼ S.W of Dublin Pop. (1926) 5,554. Its butter market ranks next to that of Cork. Condensed milk is manufactured. The town first acquired importance through the erection of a castle by King John, of which there are no remains A monastery founded for Augustinians by Henry III. gave a second impulse to its growth The gatehouse is all that remains of this foundation. Formerly Tipperary was a corporation from a grant made in 1310 by Edward II. New Tipperary was founded outside the town in 1890.

TIPPOO SAHIB (1753–1799), sultan of Mysore, son of Hyder Ali (*q.v*), was born in 1753. He was instructed in military tactics by French officers in the employment of his father. In 1767 in the invasion of the Carnatic he commanded a corps of cavalry, and fought in the Mahratta War of 1775–79. On the outbreak of the first Mysore War in 1780 he was put at the head of a large body of troops, and defeated Brathwaite on the banks of the Coleroon in Feb 1782. He succeeded his father in Dec. 1782, and in 1784 concluded peace with the British, and assumed the title of sultan. In 1787–88 he subjugated the Nairs of Malabar, and in 1789 provoked British invasion by ravaging the territories of the raja of Travancore When the British entered Mysore in 1790, he retaliated by a counter-invasion, but was compelled by Cornwallis's victory near Seringapatam to cede half his dominions (March 16, 1792) When the British renewed hostilities in March 1799, he was shut up in Seringapatam and finally killed during the storming (May 4, 1799).

See L B Bowring, *Haidar Ali and Tipu Sultan* (1893).

TIPTON, an urban district in the Wednesbury parliamentary borough, Staffordshire, England, 1½ m N of Dudley, served by the L M S and G W. railways Pop (1921), 34,130 It has important coal mines and ironworks, numerous furnaces and rolling mills. Its principal products are heavy iron goods, including anchors and cables. The modern town sprang up round Tibbington, mentioned in Domesday.

TIRAH, a mountainous tract of country on the Peshawar border of the North-west Province of India. It lies between the Khyber pass and the Khanki valley, and is inhabited by the Afridi and Orakzai tribes It is chiefly notable as the scene of the Tirah Campaign of 1897 It is a cul-de-sac in the mountains, lying off all the roads to India, and comprises an area of some six to seven hundred square miles and includes the valleys lying round the source of the Bara river. The five chief valleys are Maidan, Rajgul, Waran, Bara, Mastura The chief passes are Sampagha pass (6,500 ft), separating the Khanki valley from the Mastura valley; the Arhanga pass (6,995 ft), separating Mastura valley from Maidan, Saran Sar (8,650 ft), leading from the Zakka Khel portion of Maidan into the Bara valley; the Tseri Kandao (8,575 ft.), separating Maidan from the Waran valley, and the Sapri pass (5,190 ft.), leading from the east of the Mastura valley into the Bara valley in the direction of Mamanai. The whole of Tirah was thoroughly explored and mapped at the time of the Tirah campaign.

Tirah Campaign, an Indian frontier war in 1897–98. The Afridis had for 16 years received a subsidy from the Indian Government for the safeguarding of the Khyber pass, in addition to which the Government had maintained for this purpose a local regiment entirely composed of Afridis, who were stationed in the pass. Suddenly, however, the tribesmen rose, captured all the posts in the Khyber held by their own countrymen, and attacked the forts on the Samana ridge near Peshawar. It was estimated that the Afridis and Orakzais could, if united, bring from 40,000 to 50,000 men into the field. The preparations for the expedition occupied some time, and meanwhile the Mohmand rising north-west of the Khyber pass was first dealt with (*see* MOHMAND).

The general commanding was Gen. Sir William Lockhart (*q v.*), commanding the Punjab army; he had under him 34,882 men, British and native, in addition to 20,000 followers. The frontier post of Kohat was selected as the base of the campaign, and it was decided to advance along a single line On Oct. 18 the operations commenced, fighting ensuing immediately The Dargai heights, which commanded the line of advance, were captured without difficulty, but abandoned owing to the want of water. On the 20th the same positions were gallantly stormed by the Gordon Highlanders and 3rd Sikhs, with a loss of 199 killed and wounded. The progress of the expedition, along a wretched track through the mountains, was obstinately contested on Oct. 29 at the Sampagha pass leading to the Mastura valley, and on the 31st at the Arhanga pass from the Mastura to the Tirah valley. The force, in detached brigades, now proceeded to traverse the Tirah district in all directions, and to destroy the walled and fortified hamlets of the Afridis. The two divisions available for this duty numbered about 20,000 men. A force about 3,200 strong, commanded by Brig -Gen. Westmacott, was first employed to attack Saran Sar, which was easily carried, but during the retirement the troops were hard pressed by the enemy and the casualties numbered sixty-four On Nov. 11 Saran Sar was again attacked by the brigade of Brig -Gen. Gaselee Experience enabled better dispositions to be made, and the casualties were only three The traversing of the valley continued, and on Nov. 13 Brig -Gen Kempster's brigade visited the Waran valley via the Tseri Kandao pass Little difficulty was experienced during the advance, and several villages were destroyed; but on the 16th, during the return march, the rearguard was hotly engaged all day and had to be relieved by fresh troops next morning The casualties numbered seventy-two. Almost daily the Afridis, too wise to risk general engagements, waged a perpetual guerrilla warfare, and the various bodies of troops engaged in foraging or survey duties were constantly attacked On Nov 21 a brigade under Brig -Gen Westmacott was detached to visit the Rajgul valley The road was exceedingly difficult and steady opposition was encountered The objects were accomplished, and the casualties during the retirement alone numbered twenty-three The last important work undertaken was the punishment of the Chamkannis, Mamuzais and Massozais. This was carried out by Brig -Gen Gaselee, who joined hands with the Kurram movable column ordered up for the purpose The Mamuzais and Massozais submitted immediately, but the Chamkannis offered resistance on Dec 1 and 2, the British casualties numbering about thirty The Kurram column then returned to its camp, and Sir W Lockhart prepared to evacuate Tirah, despatching his two divisions by separate routes—the 1st under Maj -Gen. W. Penn Symons to return via the Mastura valley, destroying the forts on the way, and to join at Bara, within easy march of Peshawar, the 2nd division under Maj.-Gen. Yeatman Biggs, and accompanied by Sir W. Lockhart, to move along the Bara valley. The base was thus to be transferred from Kohat to Peshawar. The return march began on Dec 9 The cold was intense, 21 degrees of frost being registered before leaving Tirah The movement of the 1st division though arduous was practically unopposed, but the 40 miles to be covered by the 2nd division were contested almost throughout The actual march down the Bara valley (34 miles) commenced on the 10th, and involved four days of the hardest fighting and marching of the campaign The road crossed and recrossed the icy stream, while snow, sleet and rain fell constantly On the 10th the casualties numbered about 20. On the 11th some 50 or 60 casualties were recorded among the troops, but many followers were killed or died of exposure, and quantities of stores were lost On the 12th the column halted for rest. On the 13th the march was resumed in improved weather, though the cold was still severe The rearguard was heavily engaged, and the casualties numbered about sixty. On the 14th, after further fighting, a junction with the Peshawar column was effected. The 1st division, aided by the Peshawar column, now took possession of the Khyber forts without opposition Negotiations for peace were then begun with the Afridis, who, under the threat of another expedition into Tirah in the spring, at length agreed to pay the fines and to surrender the rifles demanded. The expeditionary force was broken up on April 4, 1898. A memorable feature of this campaign was the presence in the fighting line of the imperial service native troops under their own officers, while several of the best known of the Indian princes served on Sir W. Lockhart's staff. (C. J B)

TIRANA, the capital of Albania, lies at the southern end of the plain of Kroya (Albanian, *Kruja*). Pop. (1924) about 18,000, including the troops, the civilians numbering only 3,600. Nearly three-quarters of the total are Muslims, and the remainder divided between Orthodox and Roman Catholics. Tirana is beautifully situated at the foot of the richly wooded highlands inhabited by the Mirdite Albanians It is a picturesque town, with many mosques, gardens and olive groves.

Tirana was founded early in the 17th century, and was long the seat of a Greek bishop, although the majority of its inhabitants are Muslims.

TIRARD, PIERRE EMANUEL (1827–1893), French politician, was born of French parents at Geneva on Sept 27, 1827. In 1869 he was elected mayor of the 11th arrondissement of Paris and deputy for the Seine. In 1871 he sat among the extreme Left in the National Assembly at Versailles. In 1876 he was returned for the 1st arrondissement of Paris to the Chamber of Deputies He held office in a series of ministries between 1870 and 1885, and when Carnot became president of the Republic in 1887 he asked Tirard to form a ministry. He had to deal with the Wilson scandal which had led to President Grévy's downfall, and with the revisionist agitation of General Boulanger His refusal to proceed to the revision of the constitution of 1875 led to his defeat on March 30, 1888. He returned to power next year, and decided to bring Boulanger and his chief supporters before the High Court, but Boulanger fled. He also arrested Philip, duke of Orleans, who had visited France in disguise He resigned office on March 15, 1890 on the question of the Franco-Turkish commercial treaty He replaced M. Rouvier in the Ribot cabinet (1892–1893) as minister of finance, and died in Paris on Nov 4, 1893

TIRE (RUBBER) MANUFACTURE: *see* TYRE.

TIRHUT, a division of British India, in Behar and Orissa, situated between Nepal and the Ganges. The name was formerly applied only to a single district, which in 1873 was divided into the two districts of Darbhanga and Muzaffarpur In 1908 the four northern districts of Darbhanga, Muzaffarpur, Saran and Champaran were detached from the Patna division and formed into a new division, to which the name of Tirhut was officially given Total area, 12,598 sq m ; total pop (1921), 9,949,268 It is a continuous alluvial plain, traversed by many rivers and supporting a dense population Tirhut is a corruption of Tirabhurti, meaning the river-side country, a name which has been found on seals of the 4th or 5th century A D, discovered at Basarh in Muzaffarpur district. In its present limits it corresponds roughly with the ancient kingdom of Mithila (*q v.*)

TIRIDATES or TERIDATES, a Persian name, given by Arrian in his *Parthica* (preserved by Photius, *cod.* 58, and Syncellus, p 539 *seq*) to the brother of Arsaces I , the founder of the Parthian kingdom, whom he is said to have succeeded. But Arrian's account seems to be quite unhistorical. (*Cf* PARTHIA)

The king commonly called TIRIDATES II. was set up by the Parthians against Phraates IV. in 32 B C., but expelled when Phraates returned with the help of the Scythians (Dio Cass li 18; Justin xlii. 5 *seq.; cf.* Horace, *Od.* i. 26). Tiridates fled to Syria, where Augustus allowed him to stay, but refused to support him. During the next years Tiridates invaded Parthia again; some coins dated from March and May, 26 B C, with the name of a king "Arsaces Philoromaios," belong to him; on the reverse they show the king seated on the throne, with Tyche stretching out a palm branch towards him. He was soon expelled again, and brought a son of Phraates into Spain to Augustus. Augustus gave the boy back to his father, but declined to surrender "the fugitive slave Tiridates" (Justin xlii. 5; Dio liii. 33; cf *Mon. Ancyr.* 5, 54; in li. 18 Dio wrongly placed the son's surrender in 30 B.C).

TIRIDATES III , grandson of Phraates IV , lived as a hostage in Rome and was educated there When the Parthians rebelled against Artabanus II in A D. 35 they applied for a king to

Tiberius, who sent Tiridates. With the assistance of L. Vitellius Tiridates entered Seleucia, but could not maintain himself long (Tacitus, *Ann.* vi. 32 *sqq.;* Dio Cass lviii 26). (Ed. M)

TIRLEMONT (Flemish *Thienen*), a town in the province of Brabant, Belgium, 11 m. S E of Louvain Pop. (1925) 20,346. It still preserves its enceinte, 6 m in circumference The principal church, Notre Dame du Lac, begun in the 12th century and enlarged in the 15th, is still unfinished The church of St. Germain, also 12th century, contains a fine altar-piece by Wappers.

TIRMIDHI [Abū 'Isā Mohammed ibn 'Isā ut-Tirmidhi] (d 892), Arabian traditionalist, was born at Tirmidh on the Jiḥūn He travelled through Khurasan, Iraq and Hejaz His *al-Jāmi' us-Ṣaḥīh* (published at Bulaq, 1875) is one of the six canonical collections of traditions. He included every tradition that had ever been used to support a legal decision He also wrote the *Kitāb ush-Shama'il* (printed at Calcutta, 1846) on the character and life of Mohammed

TIROL, an Austrian province comprising an area of 4,882 sq.m of almost wholly mountainous country elongated in an east-west direction to which rock formations and human activities are also oriented Three distinct lithological belts exist The northern third of the province is a limestone zone, including the Lechtal and N Tirol Alps, which forms a series of parallel ranges that sink from heights exceeding 9,000 ft (Parseier Spitz—9,963 ft) northwards and eastwards The porosity of this rock and the resultant steep slopes hinder tree growth and cultivation, so that more than half is either poor pasture or barren land. Only on old glacial deposits in the valleys do conditions improve and the deep groove of the Inn valley is therefore a striking contrast Although the unifying thread of the human life of the province, it is throughout its longitudinal course a geological boundary and is floored with mixed débris derived from the flanking limestone to the north and the crystalline or schistose belts to the south. As a result there is on its alluvial fans and drained lower terraces an intensive cultivation, helped by the *fohn* winds, and a number of settlements; nevertheless, the chief interests of its inhabitants are pastoral In the cultivated districts maize, rye and fruit predominate in the west, rye and wheat in the lower valley.

South of the Inn valley, the twofold crystalline zone of the Central Alps appears, part granite and gneiss, part schist and slates, forming the main chain and including from west to east the glaciated Ötztal, Stubai and Zillertal Alps, and continues east of the transverse course of the river in the lower, unglaciated, slaty Kitzbühl Alps. In this zone *Almen* or summer mountain pastures, often above the tree line, dominate human life, 50% of the productive surface being so utilized, and numbers of cattle are exported to South Germany both for breeding and killing Horse breeding, too, is common, the favourite breed being the Noric type for farm and other hard work Forestry is not so important here as in the limestone zone where some 60% of the productive surface is forested, while, generally, methods are less scientific than elsewhere in Austria.

TOBLACHER SEA, IN THE VALLEY OF THE RIENZ, ONE OF THE MANY BEAUTIFUL LAKES IN TIROL

Industries.—Once an important mining centre for copper and rare metals, Tirol now raises only 1½% of the Austrian output Salt takes first place and is worked at Hall being conducted in the form of brine by a leat from the Salzberg, 5½ m. distant. The raising of lignite, zinc ores (Imst), and oil shale (Kufstein), and the preparation of cement (Lower Inn valley) complete the list of important mineral interests

In the development of manufactures Tirol is aided by its rich supplies of water power Large electrical power stations exist at Landeck, Matrei, Wiesberg, etc , in some cases associated with the extraction of aluminium and the preparation of calcium carbide. Cotton manufacturing has spread across from Vorarlberg (*q.v*) to the Western Tirol, woollen goods are important in Innsbruck and the Ziller valley, paper, wood pulp and cellulose works are found near and along the Inn, while small iron goods and metal wares are widely manufactured, the former in the Stuba valley. the latter principally at Innsbruck and Schwaz; in addition saw mills and breweries are widespread.

BY COURTESY OF THE AUSTRIAN TOURIST OFFICE

BOY IN TYPICAL COSTUME OF AUSTRIAN TIROL

Population.—The population of Tirol—314,836 (1923)—is almost entirely German in speech, Roman Catholic in religion and advanced in education, having at Innsbruck (*q v.*) one of the three universities of Austria The greatest density of settlement is found along the great longitudinal trade route of the Inn, with a concentration at Innsbruck, where it is crossed by the transverse route from Germany to Italy by the Brenner Pass. The limestone zone is very scantily peopled in contrast to the well-watered crystalline belt on which isolated farms and small towns in the valleys are more common The old isolation of these mountain valleys is fast disappearing under the swelling annual tide of tourists and, with its passage go many of the old customs and picturesque peculiarities of costume The province, like all others in the Federal Republic of Austria, has a large measure of local autonomy, centred at Innsbruck, but matters such as national defence, legal administration, foreign affairs, etc , are handled by the National parliament to which it sends representatives

See *Austria;* A Steinitzer, *Geschichtliche und Kulturgeschichtliche Wanderungen durch Tirol und Vorarlberg* (Innsbruck, 1905), and M Steinitzer, *Das Land Tirol* (Vienna, 1923) (W S L)

HISTORY

In 15–14 B C the country, later known as the Tirol then inhabited by the Rhaetians (probably a Celtic race), was conquered by Drusus and Tiberius The frontier of Italy was then advanced to a line running approximately from Gargazon to the Klausen Pass, the country north of this being organized into the province of Rhaetia After 500 years of Roman rule, during which the country was probably almost completely Romanized, it fell a prey to the Teutonic invasions The rich valleys of the upper Adige were colonized by Ostrogoths, from whom the present inhabitants are descended A little later the Germanic Bajuvarii conquered and occupied the whole northern district, which was quickly Germanized The Lombards, who entered the country almost simultaneously from the south, establishing a duchy in Trent, came in smaller numbers, and were absorbed in the Latin population; from this difference sprang the later ethnographical and political controversy Lombardy became part of the Frank empire of the Carolingians in A D 774, Bavaria definitively in 788, but the Imperial administrative system developed with time into the feudal rule of semi-independent counts In 1004 the emperor Henry II. granted the county of Trent to the bishop of Trent In 1027 Conrad II. enlarged this fief by the counties of Bozen and Vintschgau, bestowing the counties north of this line on the bishop of Brixen

Unable themselves to exercise temporal authority, the bishops delegated their governmental powers to lay lords. The most powerful of these was a family deriving its name from the castle of Tirol, near Meran, who as early as 1150 were counts and bailiwicks of Trent, acquired extensive lands from the bishop of Brixen in 1248, and by 1271 had practically replaced the ecclesiastical power by their own throughout Tirol. This family became extinct with the famous Margaret Maultasch, and Tirol passed by arrangement to Duke Rudolph IV. of Austria (1363). From this date until 1918 Tirol formed part of the Habsburg monarchy. At first Tirol was held as an appanage of a junior branch of the family, but was finally united with the main Austrian possessions in 1665

Tirol's geographical situation, the highway over the Brenner from northern to southern Europe, and the Arlberg route from east to west meeting at Innsbruck, gave it a great strategic importance, since command of the Brenner dominates the gate to Italy. Tirol was therefore frequently the theatre of severe fighting. Its sturdy population, however, guarded its liberties well The spread of Protestantism in Germany occasioned a great peasants' rising in 1525, which forced concessions from the emperor. Although the Counter-Reformation afterwards made of Tirol the most wholly Catholic of all Austrian crownlands, the estates (in which, alone in Austria, the peasants were represented), always preserved an unusual degree of liberty, and Tirol always cherished a strong feeling of unity and local patriotism. The most famous incident in the stormy history of the Tirolese was their insurrection in 1809 against the French and Bavarian rule established by Napoleon after the treaty of Pressburg (1805) Led by Andreas Hofer, the sturdy peasants frequently defeated numerically superior forces; but, after the disastrous peace of Schonbrunn (1809) had given Tirol (except its southern fringe, assigned to Italy) definitely to Bavaria, the revolt was ruthlessly crushed by weight of numbers Hofer was arrested, and finally shot at Mantua by Napoleon's express order (Feb 10, 1810) The Treaty of Paris (1814) reunited Tirol and restored it to Austria

BY COURTESY OF THE AUSTRIAN TOURIST OFFICE

COSTUME OF THE PUSTERTAL

The South Tirol Question.—During the World War the valleys of the South Tirol were the scene of fierce fighting, and the Tirolese poured forth their blood and their money in defence of the Habsburg monarchy Nevertheless they were doomed to suffer even more severely at the hands of the victorious Allies than did their Austrian rulers An irredentist agitation for the annexation of the Italian-speaking Trentino had begun in Italy even before 1848, growing stronger as time went on From the commencement of the war the Italian Government negotiated with both Austria and the Allies for a price for the co-operation of Italy in the struggle The Austrian cabinet agreed to cede the Trentino, but refused to yield to any further Italian demands Italy therefore concluded the Treaty of London (May, 1915) with the allied powers by which she was promised, among other rewards, the Brenner frontier, which she claimed on strategical grounds The Treaty of St Germain (*q v*) handed over to Italy not only the Italian-speaking Trentino but also the Upper Adige, inhabited by a population of purely German origin and speech, and numbering about 215,000 souls. As there were some 13,500 Germans in the Trentino, the total German population included within the new Italy amounted to approximately 229,000 This departure from the principle of national self-determination elicited strong but fruitless protests from the Tirolese communes That a miscarriage of justice had been committed was subsequently acknowledged by one—President Wilson—of the statesmen responsible for it If Italy could put forward a case for her acquirement of the Brenner frontier, based on strategical necessity, she could not honestly advance any racial or political claims to the Upper Adige; nor, indeed, did she advance such claims until the advent of the Fascist Government

At the Peace Conference, Italy was not required to sign any treaty safeguarding the rights of minorities within her frontiers (*See* MINORITIES) Signor Tittoni, however, on December 27, 1919, declared publicly that Italy was under a moral obligation to apply the provisions of the Minorities Treaties towards her own minorities. Similar declarations were made on several occasions by responsible Italian statesmen, and the policy of the Italian Government towards their new subjects was at first not illiberal. Unhappily, both for Italy and the German minority itself, this policy was abandoned by the Fascists in favour of one of Italianization, inaugurated in July 1923—a policy that succeeded only in arousing a spirit of intense resentment and irredentism among the liberty-loving Tirolese

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TIRPITZ, ALFRED VON (1849–), German admiral, was born on March 19, 1849, at Kustrin, the son of a high Prussian magistrate, and in 1865 he entered the Prussian navy, the training for which followed the British model In 1869 he became an officer, in 1888 postcaptain, in 1895 rear-admiral; in 1899 vice-admiral; in 1903 admiral, in 1911 Admiral of the Fleet In 1897 he became secretary of state for naval affairs, and then, to his regret, had no further chance of practical service at sea On March 15, 1916, for political reasons, he resigned all his offices

From his 29th year he was employed only in important positions of organisation or leadership His creative talents were first utilised when torpedoes developed into an arm suitable for war, in building torpedo boats and in working out a tactical system for their mass employment His work during this period proved of great value to him later when constructing a fleet of great battleships Here, and in constructing the fleet, he accomplished model work with a minimum of expense After practical service at sea as captain, he became chief of staff of the Supreme Naval Command in 1892, and began the preliminary work for his plan of fleet construction by profound studies in the history and practice of naval warfare The idea of the offensive use of arms was the guiding note of all Tirpitz's work His memoranda, designed to educate the naval officers in modern ideas of their profession, fell into British hands and in this way influenced British tactical ideas also. He combined practical operations with model squadrons of useless ships with the elaboration of his tactical ideas Simultaneously with this went on the transformation of the modern ship of war, with its technical complications, into an apparatus which worked with mechanical perfection He encouraged the education of crews to independent action in all emergencies His tactical memorandum, No 9 (printed in *Nauticus, Jahrbuch fur Deutschlands Seeinteressen*, 1926), afterwards served to convince the reluctant Reichstag of the necessity of forming a German fleet according to definite laws.

General Policy.—As a statesman, Tirpitz aimed at securing the growing maritime interests of the German people He felt the building of a fleet to be a necessity and no luxury, since it made Germany a more acceptable ally and helped to create a sort of balance of power at sea. He considered that it was an economic and a social necessity that the working German people should gain greater independence from all political eventualities. He further saw in Germany the power of the future on which the smaller European powers might lean at sea In view of the formation of great self-sufficient economic units in the world, he probably considered his ideas to be a consistent continuation of Bismarck's train of thought, and perhaps thought of a kind of economic Pan-Europa under a wise German leadership

Tirpitz opposed the suggestion that Germany might annex Holland, one reason being that he was always anxious to spare the small Nordic states. He would also have been prepared to make the Danes concessions in Schleswig in order to win their friendship, and was anxious for Italy to have a considerable fleet. Tirpitz never asked for war and always believed that a war could only interrupt Germany's rise, but he supported a rapprochement with Russia as Bismarck wished it, and a German-Russian-Japanese understanding He disapproved of the German Baghdad policy because it infringed simultaneously on the Russian and British spheres of influence He was against irritating America in any way and disapproved both of the German intervention in Manila and of the British-German blockade of Venezuela. Moreover he saw clearly that in forming Germany into a sea power he would have to reckon with the opposition of Great Britain. He believed firmly, however, that it must be possible, if Germany proceeded with caution, to pass through the danger zone of the time of fleet construction without war, and that, finally, an honest understanding between Germany and Great Britain could only be advanced if Germany was a real power on sea as on land. Summing up British psychology and British love for everything straight and strong, he reckoned that Germanic England, whose statesmanship and power at sea he rated very highly, would in the end prefer a rapprochement with a strong Germany to any other political combination It was only unwillingly and with hesitation that he adopted "the idea of risk" aimed at Great Britain in his naval estimate of 1900.

Even after the outbreak of the World War, Tirpitz did not change his opinion that, taking all in all, the rapprochement between Germany and Britain was advanced rather than hindered by the construction of the fleet, and that only the outbreak of the War, which was most unwelcome to him, had prevented the last maturing of his political aims His naval programme always aimed at leaving Britain a sufficient superiority He considered that the formula of the respective strengths of three to two suggested by Lloyd George, which Churchill later, although with reservations, altered to 16 to 10 or eight squadrons to five, gave Britain sufficient protection against aggressive German intentions

The Naval Programme.—In organising the construction of the German fleet, Tirpitz thought out each step to its last consequences. He refused flatly to construct the greater cruiser fleet which the Emperor was anxious to have when he was appointed secretary of state, in view of the experience of the past with cruiser warfare and the lack of German foreign bases His aim was and remained the formation of a battle fleet. His naval estimates carefully avoided votes for new constructions of ships which depended on the momentary humour of the deputies He aimed at securing legal authority for the number of ships of the fleet to be built, for their regular replacement and maintenance. Inevitably a certain stiffness thus came into the naval programme, which was at times a little inconvenient during the critical years. Tirpitz feared that his successor would abandon important principles of his programme He believed that the diplomats did not grasp the real idea of his programme The squadron of eight ships as a tactical unit was the base of his naval programme. The first law of 1898 approved a double squadron of ships of the line with the necessary cruisers The law of 1900 doubled the battle fleet. Supplementary laws of 1904, 1906 and 1908 reduced the maximum age of ships and thereby altered the plan of new construction. The foreign cruiser fleet and the torpedo-boat forces were increased, and account was taken of the British dreadnought programme The Kiel Canal was widened to take battleships. The supplementary bill which Tirpitz introduced after Agadir in 1912 only increased the number of ships to be constructed by a little, but increased the strength of the active fleet. The supplementary law of 1912 was to be the last bill of the naval programme. The fleet of 1920 was to consist of one flagship of the fleet, five squadrons of battleships of eight ships each, 12 cruisers for home service, eight large cruisers for foreign service and 40 small cruisers, including 10 for foreign service. Three squadrons of ships of the line with the necessary cruisers were to be always ready as a battle fleet. His construction programme was reduced after the negotiations with Haldane in 1912, and only provided for three new ships to be distributed over several years. Taking 61 great battleships and a life of 20 years, three large ships would be launched regularly every year on this plan.

If Britain had really recognised German sea-power, Tirpitz would probably have agreed to some arrangement on the lines of the later Washington agreement of 1922, dealing with the proportionate strength of the two Powers Tirpitz only became deeply interested in the construction of submarines after the Diesel engines were perfected for service in 1908 The ultimate strength of submarines was then fixed at 72. There was never any idea of mercantile submarine warfare. Tirpitz considered the battle fleet to be the best protection for the extensive German coast line, and spent little money on its fortification. But he modernised Heligoland, and expanded it into a fortified harbour. Parallel with the construction of the fleet, the state wharves were systematically expanded and grew to be industrial implements of the first order

Political Relations.—Tirpitz's relations with the Emperor were peculiar. The Emperor could not do without him to organise the expansion of the fleet, although not really liking his rather stiff manner. Tirpitz energetically opposed fantastic plans of naval construction. He often was hampered by William II.'s political ways, but so long as he controlled the construction of the fleet he held firmly to his real aim Tirpitz was a convinced Monarchist and remained so after the War Up to the outbreak of the World War, Tirpitz enjoyed a steadily increasing popularity The circle of his real co-workers and colleagues was, however, always small. The number of his personal friends was even smaller. He was a good judge of men and exploited the special talents of his subordinates ruthlessly He himself always retained his wide general view and never lost himself in details In the corps of naval officers his aims were not always fully understood He probably never revealed his ultimate aims to any of his friends, and, like all great men, was often compelled to stand alone He was careful to keep up relations with deputies and with the press He recognised very early the importance of publicity Before the War Tirpitz exercised but little influence on the Admiralty staff. But he controlled the construction of the ships The orders to the fleet and army at the outbreak of War were not known to him. Before the War he purposely paid little attention to the mobilization plans of the fleet

In politics Tirpitz seldom played an active part. He knew nothing of the British offer of an alliance at the close of the 19th century. Although he offered his advice to the chancellor von Bethmann Hollweg he was not consulted when important political measures were taken; for example, when a cruiser was sent to Agadir in 1911. At the end of 1911, he could have become chancellor of the Reich, but he never desired this office During the critical time of Lord Haldane's visit in 1912, Tirpitz stated that he would have given up his supplementary naval estimate completely for a real neutrality agreement with Britain. He did not entirely approve of the measures taken by the German Government after the murder in Sarajevo (1914) and was for avoiding the threatened war at all costs Tirpitz did not share the opinion that Britain would stand out of the war, and foresaw that the sympathies of America would be on the side of Britain. He was in favour of a short war, and for putting the German fleet to a decisive battle. He believed that the intervention of America would in any case prevent a complete victory, but thought that if Germany exercised all her forces, the German Reich could remain a really great power, and at the worst acknowledge defeat whilst her forces were still unexhausted. He was also against any form of annexation but was only anxious lest the Belgian coast should pass into the possession of Britain In general, he saw the War as the last struggle of freedom against the world capitalism of the Anglo-Saxons.

At the beginning of the War Tirpitz offered to take over the entire control of the navy, including the military control, but this was refused. His advice was hardly listened to by the politicians and hardly ever taken. The naval battle for which he wished was not fought. He early recognised the importance of the new

U-boats for the issue of the War, but was against employing U-boats too early in the commercial War, and named the spring of 1916 as the right moment. He disapproved of the attitude of the German Government during the exchange of Notes with America on the occasion of the sinking of the "Lusitania" and the "Sussex," regarding it as weak. Tirpitz was not implicated in the declaration of the U-boat warfare in 1917, and later stated that had he guessed Russia's coming collapse and known of President Wilson's efforts for peace, he would probably have used his influence against U-boat warfare in 1917.

Post-War Activities.—After leaving his post in 1916, Tirpitz entered politics and helped to found the *Vaterlandspartei;* and after the War had ruined his life's work, he entered the Reichstag in 1921 as German National Deputy. He generally remained in the background in plenary sittings, but he played an influential part behind the scenes. He spoke in favour of the Dawes Plan and against the Pact of Locarno

See article in Nov. 1925 issue of *Sud-deutsche Monatshefte* on attempts at a naval agreement with Great Britain, and Ulrich von Hassel, *Admiral von Tirpitz* For his own statement of the case *see* his *Erinnerungen* (1918) and *Politische Dokumente; der Aufbau der deutschen Weltmacht* (1924). (C Hol ; X)

TIRSO DE MOLINA, the pseudonym of Gabriel Tellez (1571–1648), Spanish dramatist Born at Madrid, he professed in the Order of Mercy on Jan. 21, 1601 Sent by his superiors on a mission to the West Indies in 1615, he returned to Europe in 1617, and resided at the Mercenarian monastery in Madrid His first publication, the incomplete *Cigarrales de Toledo* (1621?), is a miscellany, containing short tales, novels, verses and three plays; one of the novels, *Los Tres maridos burlados,* probably derived from Il Cieco da Ferrara's *Mambriano,* and the play entitled *El Vergonzoso en palacio* are admirable examples of witty contrivance The preface to the *Cigarrales de Toledo* (the second part of which was never printed) states that Tirso de Molina had already written 300 plays, and at this period of his career he was second only to his friend Lope de Vega in popularity. He rose to important positions in his order, became superior of the monastery at Trujillo in 1626, was elected later to the posts of reader in theology and *definidor general,* and in May 1632 was appointed chronicler of the Order of Mercy His *Deleitar aprovechando* (1635) is a devout counterpart of the *Cigarrales de Toledo,* much inferior to its predecessor in interest; a sequel was promised to this collection of pious tales, pious lyrics and *autos,* but, as in the case of the *Cigarrales de Toledo,* the continuation never appeared. A first part of Tirso's plays was published in 1627, the third part (before the second) in 1634, the second and fourth in 1635, and the fifth in 1636 A sixth volume of dramatic pieces, consisting of light comedies, was announced; but the project was abandoned As official chronicler of his order, Tirso compiled the elaborate *Historia de la merced,* which occupied him till Dec 24, 1639, and still survives in manuscript, and on Sept. 29, 1645, he became superior of the monastery at Soria He died there on March 12, 1648.

Only a fraction of his plays have been preserved In 1624 he had written 300 plays, and in 1634 he stated that he had composed 400 within the previous 20 years; of this immense production not more than 80 plays are in existence Tirso de Molina is universally known as the author of *El Burlador de Sevilla y convidado de piedra,* the piece in which Don Juan is first presented on the stage; but *El Burlador de Sevilla* represents only one aspect of his genius. No less remarkable than his representation of perverse depravity in *El Burlador de Sevilla* is his dramatic treatment of a philosophical enigma in *El Condenado por desconfiado* Though manifestly attracted by exceptional cases, by every kind of moral aberration, by the infamous and the terrible, his range is virtually unlimited. He reveals himself as a master of historical interpretation in *La Prudencia de la mujer,* and of tragical pathos in *La Venganza de Tamar;* his sympathetic, malicious wit finds dramatic expression in *El Vergonzoso en palacio* and *Don Gil de las calzas verdes,* and the fine divination of feminine character in *Averígüeló Vargas* and *La Villana de Vallecas* is incomparable. Tirso de Molina has neither Lope de Vega's inventive resource, nor his infinite seduction; he has neither Calderon's idealistic visions, nor his golden music; but he exceeds Lope in massive intellectual power and in artistic self-restraint, and he exceeds Calderon in humour, in creative faculty, and in dramatic intuition That his reputation extended beyond the Pyrenees in his own lifetime may be gathered from the fact that J Shirley's *Opportunity* is derived from *El Castigo del penséque;* but he was neglected in Spain itself during the long period of Calderon's supremacy, and his name was almost forgotten till the end of the 18th century, when some of his pieces were timidly recast by Dionisio Solis and later by Juan Carretero. The renaissance of his fame, however, dates from 1839–42, when an incomplete but serviceable edition of his plays was published. He is now accepted as among the greatest dramatists of Spain.

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TIRUPATI, a town of British India, in the North Arcot district of Madras, with a station on the Madras and Southern Mahratta railway, 84 m N E of Madras city Pop (1921), 17,434 It is famous for a temple on the neighbouring hill of Tirumala, 2,500 ft above the sea, which is one of the most frequented places of pilgrimage in southern India The town is noted for its brass-work and wood-carving

TIRYNS (Gr. *Tē-runs,* anglicized *ti-rinz*), a prehistoric fortress and afterwards a small Greek city, on an isolated ridge of rock near the east side of the plain of Argos in Peloponnese, about 3 m from the coast, and from the port of Nauplia. There is a railway station close to the site In Greek legend it was founded by Proetus, brother of Acrisius, king of Argos His successor, Perseus, founded Mycenae some 10 m further inland Later, Heracles here served Eurystheus in many "labours," and Tydeus and his son Diomedes held it. After the Dorian conquest (*q v*) Tiryns, like Mycenae, declined as Argos grew, it sent its small contingent to fight at Plataea (*q v*) in 479; but about 460 it was destroyed by the Argives Pausanias (*c* A D 170) was shown here the "palace of Proetus," and the "chambers of his daughters," and wondered at the "Cyclopean" walls, the τίρυνς τειχιόεσσα of Homer *Il* ii 559 The same walls in 1884 attracted the attention of Heinrich Schliemann, the excavator of Troy (1871) and Mycenae (1875), who uncovered, with W Dörpfeld, a prehistoric "palace" remarkable for many points of resemblance to the "House of Odysseus" in the *Odyssey;* but made only a few soundings into the stratified remains under its floors These were carefully examined from 1908 onward by members of the German Archaeological Institute in Athens, and though their conclusions are not yet fully published, the following outline of the archaeology of Tiryns is assured

The natural ridge on which Tiryns stands is about 330 yd from north to south, and 112 at widest from east to west; the greater height of its southern half now is mainly due to superstructures From about 2000 B C a small unfortified settlement can be traced on, and also around this ridge, with three superposed layers of mud-brick houses; on what was probably the summit (under the later *megaron*) was a remarkable round building, nearly 90 ft. across, also of mud brick but roofed with slates and tiles, probably for some public or official use

About 1600 B C. the southern half of the ridge was heavily fortified with rude but massive walls, to protect a new "palace" of which the plan is obscure (for it lies underneath its successor), but the arts and industries are derived, like those of the contemporary "shaft graves" at Mycenae, from the "Middle Minoan" culture of Crete (*q v*) The settlement which it dominated extended some hundreds of feet to south and east of the ridge Communication was by a gateway in the east wall, underneath the later "propylaea." About ½ m away, on the hill called St. Elias,

cist graves and rock-chambers are found, of various dates, and on the same hill is a ruinous "beehive tomb" like those at Mycenae, Heraeum and Midea, and probably contemporary with them, but nothing has survived from its contents

The "early palace" perished by violence and was succeeded, about 1300 B C, by another, which occupied the whole area of the early citadel, and was in turn defended by the massive but rudely-fashioned walls which are now conspicuous. These considerably enlarge the area of the fortress and enclose also the whole of the northern half of the ridge The latter, however, was not occupied by buildings (except a pot kiln and some workshops) but was levelled upwards with debris as a place of refuge for dependants and their cattle The same principal entrance, heavily fortified, in the middle of the east side, served both this "lower citadel" and the "upper" section south of it, which was further protected by an inner gate with bolted doors, as at Mycenae, within which a covered porch (*propylaea*) panelled with wood above a stone plinth, gave access to a level outer court occupying the whole of the south end, and sustained by very thick substructures These contain, on their east and south frontages, the famous "galleries" which served as store rooms in peace, and as casemates in war. As the "later palace" within these fortifications was not itself designed for defence, its construction was slighter, and it has perished above plinth level Its plan, however, which has attracted the attention of commentators on Homer, since Schliemann's time, is completely traceable The outer court gives access, through a second porch, to an inner one, about 53 ft by 70 ft., containing a domestic altar, furnished to east and west by colonnades, and giving access northward through a deep portico with two columns to a vestibule (with three doors outward and one inward) and so to a great hall to which the Homeric name *megaron* is commonly applied This hall, about 40 ft by 30 ft., has a central hearth, between four column bases, which supported a roof with some kind of louvre or clerestory to let out the smoke. On the cement floor, which is ornamented with painted panels of octopus and dolphins, a space is marked out between the hearth and the east wall, as the place of honour, but there is neither dais nor any other doorway but that of the vestibule. From the latter a small door leads west to a bathroom, of which the floor is a single limestone slab draining to the main sewer, as at Cnossus (*q.v*); in this room were found the remains of a clay bath-tub

This "later palace" also perished by violence, and parts of its mud-brick walls were so calcined that at first sceptical scholars acclaimed them as Byzantine, and there was, in fact, a small Byzantine church (now removed), with a graveyard near the south end of the site As it evidently lay long desolate, little remains of its decorative splendour except fragments of fresco, and of an alabaster frieze inlaid with blue enamel like the θριγκὸς κυάνοιο of *Od.* vii. 87. The pottery is of degenerate Late Mycenaean style

The frescoes of the "earlier palace," with rich spiral and floral designs, resemble those of contemporary Cnossus (*L M*, i. ii); those of the "later" included a majestic procession of women bearing offerings, an elaborate hunting scene, in which a boar is attacked by hounds and men, and other animals are represented, an assault on a palace; a chariot procession; and bull-baiting gymnastic of the Cnossian kind. A small painted plaque shows the worship of an armed goddess; and a fragment with ass-headed personages may be a masquerade

To the centuries after the destruction of the palace belong a series of graves with pottery of "geometrical" style, safety pins, and other objects of the Early Iron age In the 7th century a temple was dedicated to Hera on the site of the Mycenaean *megaron*, and furnished with rude terracotta offerings.

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TISA (Ger. *Theiss*), tributary of the Danube, rises in the north-eastern Carpathian mountains in Ruthenia at a height of about 6,300 ft, and is formed by two streams, the Black Tisa (Cerna Tisa) and the White Tisa (Bilá Tisa) which unite above Rachovo where the mountain valley begins to widen A few miles below Rachovo the river takes a generally westerly direction and makes a great curve around the Nyirség plateau entering Hungary near the top of the curve and then continuing south-west to Szolnok From here its course across the Hungarian plain is parallel to the Danube, which it enters near the small plateau of Titel, 20 m. east of Novisad The winding course is about 870 m. long and the basin, covering an area of 56,600 sq m., is shared by Czechoslovakia, Hungary, Rumania and Yugoslavia Two of its tributaries, the Szamos and Maros, coming from the impermeable rocks of Transylvania, bring a great volume of water, but these and the main stream quickly lose their velocity on reaching the plain where the fall is less than 3 cm per km. Two periods of high water occur on the middle and lower Tisa, one in spring due to snow melting, the other in June following the summer rain; to this the Körös is a big contributor The spring flood coincides with that of the Danube which, having a quicker flow, dams back the Tisa and causes extensive flooding sometimes felt as far as Szolnok Huge canalisation and diking works have been undertaken to protect the surrounding lowland. The Tisa is navigable for steamers as far as Szolnok, 197 m., or as far as Tiszafured, 255 m, depending upon the stage of the water, and for rafts and floating timber almost anywhere. It is joined to the Danube by the Francis Joseph canal and its tributary, the Béga, and is canalised to Timisoara

See W. D Hines, "*Report on Danube Navigation*" (League of Nations, Geneva, 1925); R Milleker, *Mitteilungen der Kommission fur Heimatkunde: I Die Hydrologie des Alfold*, and *II Die hydrotechnischen Arbeiten in Alfold* (Debreczen, 1925)

TISCHENDORF, LOBEGOTT FRIEDRICH KONSTANTIN VON (1815–1874), German biblical critic, the son of a physician, was born on Jan 18, 1815, at Legenfeld, near Plauen, in the Saxon Vogtland He was educated at the gymnasium of Plauen and the university of Leipzig, where he qualified as a lecturer in 1840 with a dissertation on the recensions of the New Testament text. These studies convinced him of the absolute necessity of new and exacter collations of mss. From October 1840 till January 1843 he was in Paris, studying in the great library, eking out his scanty means by working for other scholars and for the publisher Didot The great triumph of these laborious months was the decipherment of the palimpsest *Codex Ephraemi Syri Rescriptus*, abandoned as illegible by earlier collators The New Testament part was printed before he left Paris and the Old Testament in 1845. From Paris he had paid short visits to Holland (1841) and England (1842). In 1843 he visited Italy, and after a stay of thirteen months went on to Egypt, Sinai, Palestine and the Levant, returning by Vienna and Munich. (*See* his *Reise in den Orient* [Leipzig, 1845–46]) From Sinai he brought a great treasure, forty-three leaves of what is now known as the *Codex Sinaiticus* He kept the place of discovery a secret, and the fragments were published in 1846 as the *Codex Friderico-Augustanus*, a name given in honour of the king of Saxony. He now became professor extraordinarius in Leipzig, and married (1845). In the same year he began to publish an account of his travels in the East (2 vols, 1845–1846). In 1850 appeared his edition of the *Codex Amiatinus* and of the Septuagint version of the Old Testament; in 1852, amongst other works, his edition of the *Codex Claromontanus*. In 1853 and 1859 he made a second and a third voyage to the East. In the last of these, in which he had the active aid of the Russian government, he at length got access to the remainder of the precious Sinaitic codex, and persuaded the monks to present it to the tsar, at whose cost it was published in 1862 (in four folio volumes). In 1859, he had been made professor of theology and biblical palaeography. The mss. brought to Europe on the first two journeys are catalogued in the

Anecdota sacra et profana (Leipzig, 1855, enlarged 1861). *See* also the *Monumenta sacra inedita* (Leipzig, 1846), and *Nova collectio* of the same (1855–1869). The 3rd volume of the *Nova collectio* gives the results of his last Eastern journey. Side by side with his industry in collecting and collating mss, Tischendorf pursued a constant course of editorial labours, mainly on the New Testament, until he was broken down by overwork in 1873. He died on Dec. 7, 1874, at Leipzig.

Four main recensions of Tischendorf's text of the New Testament may be distinguished, dating respectively from his editions of 1841, 1849, 1859 (*ed. vii.*), 1869–72 (*ed. viii.*) The edition of 1849 may be regarded as historically the most important from the mass of new critical material it used; that of 1859 is distinguished from Tischendorf's other editions by coming nearer to the received text; in the 8th edition the testimony of the Sinaitic ms received great (probably too great) weight

His edition of the Roman text, of the *Septuagint*, with the variants of the Alexandrian ms, the Codex Ephraemi and the Friderico-Augustanus, was of service when it appeared in 1850, but, being stereotyped, was not greatly improved in subsequent issues. Besides this may be mentioned editions of the New Testament Apocrypha [*De Evangeliorum apocryphorum origine et usu* (1851), *Acta Apostolorum apocrypha* (1851); *Evangelia apocrypha* (1853; 2nd ed, 1876); *Apocalypses apocryphae* (1866)] and various minor writings, in part of an apologetic character, such as *Wann wurden unsere Evangelien verfasst?* (1865, 4th ed, 1866), *Haben wir den echten Schrifttext der Evangelisten und apostel?* (1873), and *Synopsis evangelica* (7th ed, 1898).

See in addition to the handbooks on New Testament criticism, Carl Bertheau's article on Tischendorf in Herzog-Hauck, *Realencyklopadie* (3rd ed, 1907).

TISI, BENVENUTO (1481–1559), commonly called Il Garofalo, one of the most distinguished painters of the Ferrarese school, was born at Ferrara His father, Pietro Tisi, head of the shoemakers' guild in that city, originally came from Garofalo, a village in the Polesine According to Vasari, the boy first studied with Domenico Panetti, and then went to an uncle at Cremona, where he frequented the workshops of Boccaccio Boccaccino In 1499 he proceeded to Rome and remained 15 months with Giov. Baldini, a Florentine painter. Family affairs caused his return to Ferrara in 1501 Soon afterwards he may have worked under Lorenzo Costa in Mantua. In 1504 he was again at Ferrara, where he became friendly with the two brothers Dossi. Towards the close of 1509 he returned to Rome and made the acquaintance of Raphael and saw Michelangelo's frescoes on the vault of the Sistine chapel just completed After 1512 we find him settled at Ferrara, never quitting the city for any length of time until his death in 1559 His earlier works recall the style of Panetti and Boccaccino In his middle period he was influenced by his association with Dossi Then Raphael's and Michelangelo's influence made itself felt. He was a prolific artist and almost every church of Ferrara was supplied with a picture from his brush Garofalo's earliest dated picture, "The Minerva and Neptune" of 1512, in the Dresden gallery, displays the influence of Lorenzo Costa. His paintings in the Borghese and Doria collections are probably earlier, being in the manner of Dossi and Boccaccino. Other important works are "The Immaculate Conception" (1514) and "The Madonna del Pilastro" in the pinacoteca at Perugia and "The Mater Dolorosa" at Dresden He did not always confine himself to sacred subjects, and one of his finest works dealing with mythology is "The Sacrifice to Ceres" in the National Gallery (Mond collection). He was also employed in decorating palaces of Ferrarese nobles His paintings in monochrome in the Seminario at Ferrara are fine and well preserved, and those in the ceiling of one of the rooms recall Mantegna's ceiling in the Camera du Sposi at Mantua He continued constantly at work until, in 1550, blindness overtook him

See G. Morelli, *Italian Painters, The Borghese and Doria Galleries* (1892–93); J. E. G. Gardner, *The Painters of the School of Ferrara* (1911).

TISSAPHERNES (Pers. *Cithrafarna*), Persian soldier and statesman, son of Hydarnes. In 413 he was satrap of Lydia and Caria, and commander in chief of the Persian army in Asia Minor (Thuc. viii. 5). When Darius II. ordered the collection of the outstanding tribute of the Greek cities, he entered into an alliance with Sparta against Athens, which in 412 led to the conquest of the greater part of Ionia. But Tissaphernes was unwilling to take action and tried to achieve his aim by astute and often perfidious negotiations; Alcibiades persuaded him that Persia's best policy was to keep the balance between Athens and Sparta, and rivalry with his neighbour Pharnabazus of Hellespontic Phrygia still further lessened his energy When, therefore, in 408 the king decided to support Sparta strenuously, Tissaphernes was removed from the generalship and limited to the satrapy of Caria, whereas Lydia and the conduct of the war were entrusted to Cyrus the Younger On the downfall of Athens, Cyrus and Tissaphernes both claimed jurisdiction over the Ionian cities, most of which acknowledged Cyrus as their ruler; but Tissaphernes took possession of Miletus, where he was attacked by Cyrus, who gathered an army under this pretence with the purpose of using it against his brother Artaxerxes II. The king was warned by Tissaphernes, who took part in the battle of Cunaxa, and afterwards tried to destroy the Greek mercenaries of Cyrus by treachery He was then sent back to Asia Minor to his old position as general in chief and satrap of Lydia and Caria He now attacked the Greek cities, to punish them for their allegiance to Cyrus This led to the war with Sparta in 399 Tissaphernes, who once again had recourse to subtle diplomacy, was beaten by Agesilaus on the Pactolus near Sardis (395); and at last the king yielded to the representations of Pharnabazus, strongly supported by the chiliarch (vizier) Tithraustes and by the queen-mother Parysatis, who hated Tissaphernes as the principal cause of the death of her favourite son Cyrus Tithraustes was sent to execute Tissaphernes, who was lured to Colossae and slain in 395 (Ed M)

TISSERAND, FRANÇOIS FÉLIX (1845–1896), French astronomer, was born at Nuits-Saint-Georges, Côte d'Or, on Jan 13, 1845 He entered the École Normale Supérieure in 1863, and in 1866 became *astronome adjoint* at the Paris observatory In 1868 he took his doctor's degree with a brilliant thesis on Delaunay's method He went to Malacca to observe the solar eclipse of Aug 1868 In 1873 he became director of the Toulouse observatory, and while there published *Recueil d'exercices sur le calcul infinitésimal.* He went with the French expedition of 1874 to Japan, and of 1882 to Martinique, to observe the transits of Venus In 1878 he became a member of the Académie des Sciences, and of the Bureau des Longitudes, and in 1883 he obtained the chair of celestial mechanics at the Sorbonne In his principal work, *Traité de mécanique céleste* (4 vols, 1888–96), he coordinated the researches of Laplace and of subsequent workers in the same field, and gave a *résumé* of the state of knowledge in that department of astronomy at the end, as Laplace's *Mécanique céleste* did for the beginning of the 19th century In 1892 he became director of the Paris observatory. He died suddenly on Oct 20, 1896

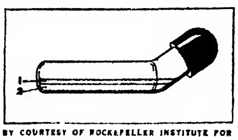
TISSOT, JAMES JOSEPH JACQUES (1836–1902), French painter, was born at Nantes on Oct 15, 1836 He studied at the École des Beaux Arts in Paris under Ingres, Flandrin and Lamothe In 1861 he showed "The Meeting of Faust and Marguerite," which was purchased by the state for the Luxembourg Gallery. He fought in the Franco-German War, and, falling under suspicion as a Communard, left Paris for London Here he studied etching with Sir Seymour Haden, drew caricatures for *Vanity Fair,* and painted portraits as well as *genre* subjects It was many years before he turned to the chief work of his career—the production of a series of 700 water-colour drawings to illustrate the life of Christ and the Old Testament He disappeared from Paris, whither he had returned after a stay of some years in England, and went to Palestine In 1895 the series of 350 drawings of incidents in the life of Christ was exhibited in Paris, and in 1896 in London They were then published by the firm of Lemercier in Paris. He died at Buillon (Doubs) on Aug 8, 1902

TISSUE CULTURE. The body is composed of countless myriads of cells assembled in tissues and organs. The cells belong to several types: wandering cells such as blood leucocytes and tissue macrophages which roam through the entire organism; epithelial cells, the noblest elements of the body, which form the glands, brain, skin, etc.; connective tissue cells present everywhere under various appearances, etc They are the units of a strictly organized community. Their existence is bound to that of the whole. If the whole is taken apart, its component tissues and

organs die after a short time. The cultivation of tissues consists precisely in maintaining in a condition of active life cells that have been removed from the body. The aim of this method is to study the innate properties of each cell type, and the mechanism of their organization into tissues and organs. Its ultimate purpose is the discovery of the laws which express the relations between the tissues and the body fluids, and the building up of cell sociology.

History.—The method of tissue culture may be considered the indirect outcome of studies made independently by several biologists on the survival of cells outside of the organism However, the first chapter of its history was written in 1907 by R G. Harrison in the beautiful experiments where nerve fibres were caused to grow *in vitro* from fragments of the central nervous system of frog embryos. In 1910, these experiments were extended by other workers to adult and embryo tissues of birds and mammals, which were observed to survive in a drop of plasma But after a few days, degeneration began and death occurred. In these experiments, as well as in those of Harrison, the tissues were not cultivated in the proper sense of the word. They were only in a condition of survival. A second chapter was begun in 1911 when A. Carrel developed a procedure by which the death of the surviving tissues could be indefinitely postponed and found, in 1912, that embryo proteins possess the power of promoting the unlimited proliferation of tissue cells. Then, it became possible really to cultivate cells, that is, to cause them to manufacture new protoplasm from the substances contained in their medium. A long interruption occurred in the progress of these investigations due to the World War. But, in 1921, the development of procedures permitting the main cell types to be obtained in pure cultures opened a third and important period in the history of the method. Blood and tissue macrophages, iris epithelium, cartilage cells, thyroid cells, Malpighian epithelium, lens cells, and several types of malignant cells were isolated from other tissue elements and maintained in a pure state. At the same time, it became possible to measure accurately the rate of growth of the strains of tissue cells. New procedures were perfected by which living tissues could be maintained indefinitely in flasks where they were washed, fed, and measured without being disturbed and without danger of infection from bacteria. These great practical improvements rendered the method of tissue culture very much easier, and widely extended its application to physiological and pathological problems. Although it has not as yet reached its complete development, it may be considered the most powerful instrument now possessed for the investigation of cell physiology.

Technique.—The handling of the delicate and minute structures which compose the tissues demands elaborate techniques and a long apprenticeship for their mastery But the principles of these techniques are very simple The cells are cultivated in flat, round flasks made of pyrex glass and varying in size from 3 to 8cm. in diameter (*see* fig.). The flasks possess a wide, oblique neck 3cm. in length Dust and bacteria from the air do not fall into the flask when it is opened, but remain on the wall of the neck where they are destroyed by flaming. By means of a spatula, the tissue cells are conveniently handled inside the flasks After being flamed, the neck is hermetically sealed with a rubber cap. It is thus possible entirely to protect the tissues against bacteria which are their deadly enemies, and also maintain in the air of the container the proper amount of humidity and of carbon dioxide. Through the bottom of the flask, the tissues may be examined with a microscope at a magnification of about 120 diameters. When the cells must be studied in greater detail, they are removed from the flask with a spatula, placed on a thin cover-glass, and examined while still living, at a magnification of 1,500 diameters.



BY COURTESY OF ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

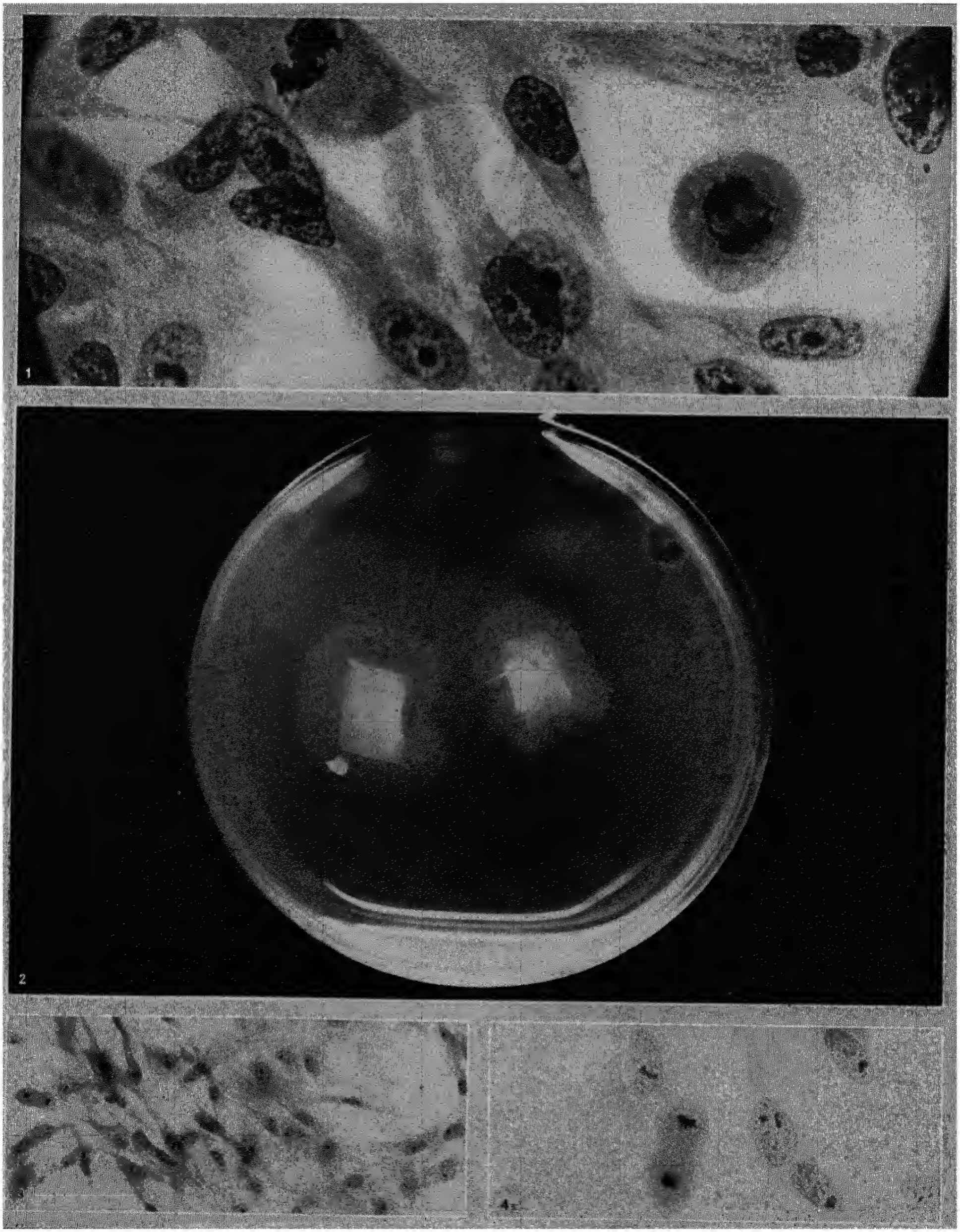
FLAT ROUND FLASK 3.5 CM. IN DIAMETER. FOR CULTIVATION OF TISSUES

1. Solid medium; 2. nutrient fluid medium

On the bottom of the flask is spread the medium which must supply the tissues with a scaffold for their growth and with the substances necessary for the synthesis of new protoplasm. This medium is composed of two parts, one solid and the other fluid (fig 1). The solid part is made of coagulated blood plasma, that is, of a clot of blood from which the red and white corpuscles have been removed. Such a plasma is obtained by freeing blood of its corpuscles by centrifugation. It then becomes a clear, citrin fluid which is introduced into the flask with a pipette. The tissue cells are next deposited by a spatula in this medium which coagulates after a few minutes. Thus they become embedded in a transparent jelly, which they use as a scaffold, but not as a nutrient medium. The fluid medium is placed on the surface of the coagulum. Its rôle is to remove the waste products of the culture, and to supply the tissues with the necessary nutrient substances. Every two or three days, the fluid is removed and replaced by a large amount of a saline solution composed of sodium, potassium and calcium chlorides, sodium phosphate and bicarbonate, and glucose, which is called Tyrode solution. After the tissues have been thoroughly washed, the fluid is removed and replaced by a small amount of nutrient medium. This medium ordinarily consists of embryo proteins, or proteoses and peptones, or blood serum, according to the nature of the tissues. The tissues and fluids are handled with sterile instruments in rooms which are kept strictly clean It is most important that no bacteria be allowed to penetrate into the flasks. If infection of the medium takes place, death of the tissues soon occurs. This accident is almost completely prevented by the recently developed techniques After the preparation of the culture is completed, the flasks are placed in an incubator and maintained at body temperature

Several cell types have so far been obtained in pure state: connective tissue cells or fibroblasts, epithelial cells, blood and tissue macrophages, and the malignant elements of a few tumors. Strains of fibroblasts are cultivated easily from almost every embryo, or adult tissue of human beings, dogs, rats, mice, fowls, etc. They remain packed together while macrophages wander through the medium. In addition, they multiply more rapidly than epithelial cells. Therefore, it is easy to obtain colonies composed exclusively of them Fibroblasts are either polygonal or spindle-shaped with long, sharp processes, and with an oval nucleus which generally contains two smaller nucleoli. They aggregate in a dense tissue which doubles in volume every 48 hours when kept at body temperature in a medium composed chiefly of embryo proteins. They grow indefinitely. A strain of chicken fibroblasts isolated 16 years ago is multiplying to-day at the same rate as at the beginning of its life *in vitro*. When the flasks are taken from the incubator and kept at room temperature, the cells stop multiplying and remain in this condition for three or four weeks without dying. Therefore, living culture cells can be sent for long distances without inconvenience Strains of tissue cells have been exchanged between laboratories located in New York and Berlin and after this long journey have promptly regained their usual rate of growth. Epithelial cells are more difficult to obtain in pure culture. Nevertheless, since Fischer isolated a strain of epithelium from the few cells of the iris which adhere to the lens of the chick embryo, pure cultures of thyroid gland, Malpighian epithelium, lens epithelium and several types of carcinomatous cells have been obtained by Ebeling, Kirby, Fischer and Carrel. Their rate of growth is less than that of the connective tissue cells, but they can be maintained in a condition of active life for several years. They keep their normal characteristics indefinitely. They grow in a thin layer at the surface of the solid medium, and rarely form a dense tissue. They readily digest the coagulum. Leucocytes from the blood and wandering cells from the tissues have also been obtained in pure cultures. They do not aggregate as a tissue, but remain isolated from one another and scatter through the medium. When they accumulate in a large number or are packed together, they generally die or become transformed into fibroblasts. Their growth is slow and they are less resistant than epithelial or connective tissue cells. However, they can live in flasks for several months The malignant elements of sarcomata and carcinomata have also been isolated and maintained alive indefinitely outside of the body.

The rate of growth of the colonies of epithelial cells and of



FIBROBLAST STRAINS

1. A 17 month old strain of Sarcomatous Fibroblast (a cell forming connective tissue) of a rat. 2. Two colonies of 17 month old strain of malignant fibroblasts from a rat sarcoma (tumour of embryonic connective tissue) growing in a flask 3.5" in diameter. 3. Pure strain of normal rat fibroblasts. 4. A 16 year old strain of normal chicken fibroblasts

fibroblasts can easily be ascertained. The measurements are made by placing the flasks on a projectoscope and drawing the outline of the colony immediately after the preparation of the culture and subsequently every two days. The area of the colony at the different stages of its development is measured with a planimeter, and the ratio of the area of new growth to that of the original fragment is calculated. The relative increase of the colony in 48 hours expresses the rate of growth. The curve representing the continuous growth of a colony of epithelial cells or of fibroblasts in a flask containing a nutrient medium is a parabola. If the medium is non-nutrient, the curve is S-shaped. Modifications in the form of this curve indicate whether the medium contains substances that activate or depress the rate of cell multiplication. This method cannot be used for measuring the activity of wandering cells, because they never grow as a tissue, but remain at certain distances from one another and scatter on several planes. Their rate of multiplication can be approximately reckoned by the time taken by the cells to invade the entire area of the flask.

The growth energy of a colony at a given instant is a function of several independent variables: its growth energy at the preceding instant, and the concentration in the pericellular fluid of the substances that increase or decrease cell activity. It could be ascertained by the activity displayed during an instant by the cells in a medium containing neither activating nor retarding substances, if such a measurement were possible. But the residual growth energy, which was found to vary at the same time as the inherent energy, may be used as a measurement of the latter. The residual energy is expressed by the duration of life and the proliferative activity of the cells in Tyrode solution.

The morphology of the tissue cells growing *in vitro* is studied while they are living Fragments of the coagulum containing cells are taken from the flasks and put on thin glass slides. They may also be readily cultivated in glass chambers especially constructed for cytological studies. The living unstained cells are photographed or cinematographed When stained with neutral red, trypan blue, and Janus green, the cytoplasmic structures may be observed while in full activity. Cinematographic records can be taken at such a magnification that the details of the mitochondria, segregation apparatus, and surface membrane of the cells are clearly shown

Mode and Rate of Growth of Tissues.—This method has already supplied some important information regarding the physiological properties of tissue cells, the rôle of blood serum toward the tissues, and the nature of the chemical substances that determine the unlimited multiplication of fixed cells. The rate of growth of connective tissue and of epithelial cells in a nutrient medium of unvarying composition remains uniform indefinitely. Such a law appears to be the expression of one of the more fundamental properties of tissue cells. Since their rate of growth remains unchanged as long as the medium does not vary, the cell colonies may be considered to be immortal. A strain is able to transform an unlimited amount of chemical energy. The energy spent by the cells must arise entirely from the substances contained in the culture medium, and will never be exhausted as long as the same medium is supplied to them. It appears that the potentialities of tissues are much greater than those they display within the normal organism, and that the manifestation of their activity is determined by the physico-chemical conditions of the pericellular fluid. The dependence of cells on the composition of the medium was further emphasized by a study of the rate of growth of colonies of fibroblasts or epithelial cells in media of varying composition. It was found that the activity of the colonies is a function of the concentration of nutrient substances within the medium, when waste products and other inhibiting substances are constantly removed. If cell colonies in different conditions of activity are placed in similar media, their rates of multiplication soon become identical. Fragments of connective tissue of chick embryos and adult chickens cultivated in a nutrient medium grew at first at varying rates, but after a few weeks no difference was observed in the activity of both colonies.

The residual energy of embryo tissues, which is always very large, varies in inverse ratio with the age of the animal from which the tissues have been extirpated. The duration of their survival *in vitro* may extend over a period of three months. On the other hand, the residual energy of the tissues of an adult animal is very small. The connective tissue cells of an old animal are in a dormant condition. If cultivated in a nutrient medium, a long time elapses before they begin to proliferate. Should their resting state be attributed to a factor preventing them from spending their energy, or to a complete lack of energy? An investigation of the behaviour of these tissues in a medium completely lacking in nutrient substances showed that they possess very little residual energy. This means that they have no reserves in store However, they have not lost the power of accumulating the substances which supply them with energy. When they are placed in a nutrient medium, they begin to multiply and to store up reserves. Adult fibroblasts may be compared to a motor which possesses no energy of its own, but runs as soon as it is supplied with fuel.

The persistence of the essential characteristics of cells cultivated *in vitro* has opened a new field to histology. When the rate of growth and the constitution of the medium of a pure strain have been ascertained, the relations existing between the structure of the cells and their physiological state become apparent immediately. Blood monocytes, tissue macrophages and fibroblasts have been studied according to these principles. The appearance of the cells varies greatly with their nutritional condition. The anatomy of a cell type can be modified at will by simple changes in the nature and the concentration of the substances contained in its medium

A profound transformation of classical cytology began when it became possible to identify cells not only by their morphology, but also by their physiological characteristics Through the new techniques, a cell type is defined by the appearance of its colonies, its mode of locomotion as recorded by cinematography, its effect on the medium, its rate of growth, the nature of the substances which inhibit its multiplication, the nature and concentration of the substances required for proliferation, etc. The advantages of this conception of cytology are obvious. If all the manifested and hidden potentialities of every cell type were known, the behaviour of a tissue under given conditions could be predicted. The events in which the tissues take part are determined by the response made to the physico-chemical conditions of the medium by each cell according to its innate qualities. On the mode of response of a cell type to other cells and to the humours depend the characteristics of the community.

Physiological Factors of Growth.—The effect of blood plasma on tissue cells remained unknown until it was tested on pure cultures of fibroblasts and epithelium These experiments showed that, first, blood serum is not a nutrient medium for epithelial cells and fibroblasts; it inhibits their proliferation when added to a nutrient medium. Secondly, blood serum is an excellent nutrient medium for monocytes, tissue macrophages, and sarcomatous macrophages Thirdly, the proteins and amino acids of the blood do not promote the proliferation of connective tissue and epithelial cells. Serum proteins or lipoids possess the property of restraining cell proliferation But blood serum taken from an animal a few weeks old neither stimulates nor inhibits the growth of colonies of fibroblasts. When the age of the animal increases, its serum becomes more and more growth-inhibiting. The progressive increase in the growth-inhibiting properties of blood serum takes place rapidly at the beginning of life and very slowly in old age. The curve expressing this phenomenon resembles that of the decrease in function of the age of the patient in the rate of healing of a wound, as expressed in du Noüy's equation. The age of an animal can be ascertained approximately by the growth index of its serum The inhibiting power of serum is due chiefly to lipoids. After extraction of the lipoids, the remaining proteins are far less inhibiting than the whole serum. On the contrary, the isolated lipoids are toxic. In old age, the inhibiting effect of serum is augmented because both proteins and lipoids are more concentrated.

The nature of the substances responsible for cell multiplication remained unknown until fibroblasts and epithelium were found to multiply with great velocity in the presence of embryo juice.

This juice is a complete food. For 16 years, a strain of fibroblasts has been fed on it, and has built up many thousands of colonies from the substances that it contains. The substance responsible for the unlimited growth of the cells is a protein, which is mixed with a lipoid having some inhibiting power. The primary split products of certain proteins produce as extensive a multiplication of fibroblasts as embryo juice does. The incomplete digests of ox fibrin, casein, egg albumin, liver, testi, thyroid, thymus, pituitary gland, etc, increase the rate of growth of fibroblasts, epithelial cells and macrophages The split products of crystalline egg albumin, on the contrary, possess little growth-promoting power. When the digestion is carried further and the digests are composed chiefly of amino acids, their effect on the growth of tissue cells disappears almost completely It is probable that the proteins of embryo juice are not absorbed as such by the cells after they have been hydrolyzed. The power of tissue juice to cause growth may possibly be attributed to the ease with which its proteins can be transformed into polypeptides by the tissue ferments. Monocytes and macrophages do not require embryo juice or protein split products in their medium in order to proliferate and manifest other forms of activity. They are voracious cells and feed upon red blood corpuscles, protein precipitates and muscle fragments, and also on plasma, embryo juice and protein split products at a low concentration.

Through the method of tissue culture, the fundamental characteristics of the main cell types and the mechanisms that make them an organized whole are being progressively elucidated Although the techniques will be still further improved, they have reached such a degree of development as to permit the construction of a new science of cytology based not only on the morphology, but chiefly on the physiological properties of the cells.

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TISTA, a river of northern India, which rises on the edge of the Tibetan plateau, has a tumultuous course southward through the mountain gorges of Sikkim and Darjeeling and flows through North Bengal and Cooch Behar for another 170 miles till it joins the Brahmaputra in the district of Rangpur In the 18th century its course was due south to join the Ganges; but in 1787 great floods diverted the stream towards the south-east, and it made its way by a new channel into the Brahmaputra

TISZA, ISTVÁN (Stephen), COUNT (1861–1918), Hungarian statesman, was born on April 22, 1861, youngest son of Kálmán Tisza (*q v*) Educated at Berlin, Heidelberg and Budapest, he entered the ministry of the interior, where he specialized in agrarian matters His *Magyar agrárpolitik* (Budapest, 1897), authoritative on its subject, was translated into German the same year. In 1886 Tisza began his long parliamentary career, and on June 17, 1903, he was entrusted with the formation of a ministry of pacification, but was unable to secure a majority On Oct 27, however, with the assistance of the Free Principles Party, he succeeded in composing a cabinet, in which he was minister of the interior as well as premier On Nov. 16–18, to meet the obstruction of the opposition, he introduced new and stringent rules of procedure which he declared adopted, thereupon suspending the session The Andrássy group, however, left him soon after, and after a stubborn battle with anarchical conditions in which legislation was impossible Tisza appealed to the country and was heavily defeated After Count Khuen-Hédervary became prime minister (Jan. 1910) Tisza reorganized the old Liberal party under the name of the National Party of Work with a programme of a return to the strict principles of the compromise of 1867. In the elections of June 1910 this party secured an overwhelming majority, due largely to Tisza's own personal suggestion and unceasing activity. In view of the obstruction of the extreme Left against the army legislation, Tisza, considering that the threat of complications in the Balkans made it essential not to weaken the Austro-Hungarian army, had himself elected president of the Lower House in 1912, introduced new standing orders, and forced the Army bill through, ejecting the opposition from the House. A member fired three times at Tisza, who remained calm in his chair This scene made him very popular. He had to fight some duels with his adversaries, including one with Count Michael Karolyi, which left the two adversaries bitter enemies.

On June 15, 1913, Tisza was for the second time nominated prime minister. In his first memorandum on foreign policy, written after the second Balkan War, he deplores the growth of Serbia and the collapse of Bulgaria, Turkey and later Greece. Rumania, where public opinion was growing hostile to the dual monarchy, should be assured its territorial integrity, but if it abandoned its alliance, Bulgaria should be brought to bear against it. War should be avoided In home politics, Tisza was willing to favour such of the non-Hungarian nationalities as would support the State. He attempted to reach an understanding with the leaders of the Transylvanian Rumanians, but without success.

After the murder of the heir to the throne at Sarajevo, Tisza, in a letter to Francis Joseph (July 1) opposed Berchtold's suggestion for a sudden attack on Serbia. A week later he again urged his view that diplomatic steps were necessary and a severe ultimatum should be sent, but its conditions should not be impossible of acceptance. To avoid the intervention of the Entente, Tisza carried a motion in the council of ministers (July 19) that the integrity of Serbia's territory should be respected even if war was declared Though the war against Serbia was declared, he exerted himself for peace by accepting Sir Edward Grey's last proposal (July 31). Afterwards he was anxious to miss no opportunity of concluding peace. He was opposed to all German aspirations of territorial aggrandizement and to the introduction of unlimited submarine warfare. He was a true partisan of German alliance, but he admitted no interference with Hungary's sovereign rights and was strongly opposed to the German idea of an economic "Mittel Europa"

Tisza had many controversies with the Austrian Supreme Command and general staff He was convinced that the fate of Hungary was bound up with that of the dual monarchy, but equally intent on preserving Hungary's predominance within the monarchy. It was for this reason that he opposed the plans of Conrad von Hotzendorf (*q.v.*) to annex further territory, and advocated moderate peace terms in Serbia and Belgium He refused, however, to make any territorial concessions to Rumania, such as might have kept her from joining the war against the Central Powers His influence was immense so long as Francis Joseph lived. It was he who forced Berchtold to leave the foreign ministry although he refused himself to become foreign minister.

King Charles, however, was under the influence of Tisza's Austrian and Hungarian enemies. Their rancour was fostered by the participation of Tisza, a Calvinist, with the primate of Hungary in the act of coronation. The pretext for Tisza's dismissal in June 1917 was his refusal to grant the suffrage to soldiers at the front and his opposition to the demands of the Socialists.

The new cabinet had but a minority in parliament. Tisza, now chief of the opposition and in the majority, framed a resolution in which he affirmed the necessity of the German Alliance and pointed out the ambiguous behaviour of the Czechs in the Reichsrath. Finding his position difficult, he went to the front. In the Bukovina and in Italy he commanded a regiment with distinction. During this time his only political action was his mission to Croatia and Bosnia (Sept. 1918). Returning to Budapest, he declared (Oct 17) "We have lost the war," and thus gave the signal for the collapse. He wanted a peace with honour, not a treacherous one. His last two weeks he spent in attempting to unite different parties; he was even ready to accept Karolyi's leadership in order to save the country and to procure a good peace Too proud and too conscientious to allow the publication of his pacific endeavours, he was set as a mark for the defeatist soldiers and the mob. Though warned of his grave danger, he remained in Budapest, working until his last moment to unite the historical parties. He was killed by soldiers on Oct. 31, 1918, the first day of Count Karolyi's revolution. His last words were, "It had to be."

See István Tisza, *Ossres Munke*, 2 vol., 1925 (Personal Recollections,

letters June to end of Dec. 1914, pub. by the Hungarian academy). The first volume of the letters was translated into German by O. von Wertheimer, *Graf Stefen Tisza; Briefe* (1928).

TISZA, KÁLMÁN [Koloman] (1830–1902), Hungarian statesman, was born at Geszt on Dec 10, 1830, the son of Lajos Tisza and the countess Julia Teleki, and educated at his father's castle. In 1848 he obtained a post in the ministry of instruction of the revolutionary Government. After the war he travelled abroad, afterwards (1855) becoming assistant curator of the Calvinist church at Nagyszalonta He publicly and vehemently opposed the Austrian "Patent" of Sept 1, 1859 and the "October Diploma" of 1860 In Aug. 1860 Tisza married the countess Helen Degenfeld-Schomburg, a union which brought him into close connection with the Karolyis, the Podmaniczkys and the Odescalchis. He was unanimously elected to represent Debreczen at the 1861 diet, and vice-president of the house at its second session, and became leader of the more radical party on the death of Count László Teleki

From 1867 onwards his influence increased steadily, despite the rupture of his party, which he reconstructed at the conference of Nagyvárad (March 17, 1868), when the famous *Bihari pontok,* or articles of Bihar, were subscribed, which bound the Tisza party to repeal all laws or institutions contrary to, and to promote all measures necessary for, the national independence Thus the delegation system and the common ministries were marked out for attack, while every effort was to be made to procure for Hungary a separate army, a separate diplomacy and a separate financial system. It was chiefly owing to the efforts of Tisza and his party that Austria remained neutral during the Franco-German War. In 1875 his party amalgamated with the followers of Deák into the *Szabadelvu párt* or Free Principles Party, which took office under Bela Wenckheim (1811–1879), whom (Oct. 2) Tisza succeeded as prime minister, a post he held, with a few interruptions, for the next 15 years In 1879 he materially contributed to the formation of the Austro-German alliance. Not till 1888, when the national army bill was introduced, did he encounter any serious opposition, but thenceforth his position became precarious, and he resigned office on March 13, 1890 It was owing to his influence, above all things, that Hungary acquired a consolidated government and a position of predominance in the dual monarchy It is an open secret that, on the retirement of Andrássy, he was offered the chancellorship He refused it because, to use his own expression, "I am as wholly and solely Hungarian as the river (Theiss, Hung *Tisza*) whose name I bear"

See G. Gratz, *Kálmán Tisza* (*Modern Magyar Statesmen,* I) (Hung; 1902); P Busbach, *The Last Five Years* (Hung; 1895).

TITANIC, LOSS OF THE, at 2 20 A M. on April 15, 1912, the White Star liner "Titanic," at that time the largest ship afloat, on her maiden voyage, went to the bottom of the Atlantic after striking at full speed on an iceberg, with a loss of 1,513 souls out of 2,224 on board. The full record of the disaster is contained in the reports of the inquiries held at once in America by a committee of Congress under Senator Smith, and later in London by a special commission presided over by Lord Mersey (report issued July 30)

See British Parliamentary Papers No 2253, *Shipping Casualties* (*Titanic*) 1912 (ed 6352).

TITANIUM (symbol Ti, atomic number 22, atomic weight 48·1). In a substantially pure state, titanium has a very restricted commercial application. The method adopted by Hunter is the standard one for the production of the pure element, but an impure product may be obtained from the dioxide by the application of Goldschmidt's thermit reaction (*see* below) or by reduction with carbon in the electric furnace. Pure titanium is silver-white with a fracture similar to that of steel It is hard and brittle when cold, but at a low red heat it is malleable and can be forged readily like iron. The specific gravity is 4.5 and the melting point, according to Hunter, 1850°C. It is soluble in dilute sulphuric acid, in hot concentrated hydrochloric acid and in *aqua regia,* whilst hydrofluoric acid readily dissolves it. It combines with nitrogen with avidity. With oxygen and the halogens, compounds of quadrivalent titanium are produced.

The existence of the element known as titanium was discovered in 1789 by the Rev. William Gregor during an investigation of a peculiar black sand found at Menachan in Cornwall. This black mineral he called menachanite (or meccanite) and the new element he named menachite Four or five years later, the German chemist, Klaproth, discovered a new metal whilst investigating the composition of the mineral rutile. On account of the strength of the chemical combination in which it was held, he gave to the new element the name titanium—an allusion to the Titans of Greek mythology, the incarnation of natural strength. In 1797 Klaproth investigated the mineral ilmenite—which was identical with menachanite—and recognized that titanium and the menachite of Gregor were identical Nevertheless, titanium is the name which is now universally adopted for the element. Attempts to isolate titanium were first made by Lampadius in 1797 and later by Berzelius and other investigators The metallic-looking products isolated by early investigators were generally nitrides or carbides, for titanium has a pronounced affinity for oxygen, carbon, and nitrogen. In 1895, Moissan published an account of his experiments on the reduction of titanium dioxide with carbon at the temperature of the electric furnace. His final product was free from nitrogen and silicon but contained about 2% of carbon, probably as the carbide This was the purest titanium isolated till the work of Hunter in 1910, who adopted a method previously used, unsuccessfully, by Nilson and Petterssen By heating titanium tetrachloride with sodium in an air-tight steel cylinder, with exclusion of air, Hunter obtained titanium nearly 100% pure.

Although frequently regarded as one of the rare elements, titanium occupies the ninth place in Clarke's table of the estimated abundance of the elements in the earth's crust This table discloses the interesting fact that titanium is more abundant than such common elements as carbon, phosphorus or sulphur, and much more abundant than the useful metals, lead, copper and zinc There is, however, a distinctive difference between the mode of occurrence of titanium and that of these other metals, for whereas the greater part of the titanium is so widely diffused through the earth's crust as to make its recovery economically impossible, the less abundant metals are concentrated in segregated deposits (mineral veins, lodes, etc) capable of satisfactory exploitation Hence, of all the numerous titanium-bearing minerals, only three or, at most, five are entitled to be classed as possible ores of titanium. They are rutile (TiO_2), ilmenite ($FeTiO_3$), titaniferous magnetite (magnetite is Fe_3O_4), and possibly titanite ($CaO{\cdot}TiO_2{\cdot}SiO_2$) and perovokite ($Ca,Fe''$) TiO_3 Rutile occurs in igneous, in metamorphic, and in sedimentary rocks, and its mineral associates include a wide range of species Although widespread in occurrence, deposits of commercial importance are few in number and, so far, restricted to certain localities in the United States, Canada, Norway and South Australia Rutile crystallizes in the tetragonal system, commonly as short, stout prisms or elongated prisms frequently showing striated prism faces. It is normally reddish-brown to red, the specific gravity of the ordinary red variety being 4 18 to 4 25 Titanium dioxide contains 60% of titanium and 40% of oxygen Actually, the mineral usually contains from 54 to 59% of titanium with minute quantities of vanadium and iron Rutile is infusible before the blowpipe and insoluble in acids, but fused alkalis and alkali carbonates bring it into solution Ilmenite crystallizes in the hexagonal system as rhombohedra, but it is rarely seen as good megascopic crystals. Commonly it occurs as embedded grains and masses, whilst it may also be found as a sand. The mineral is iron-black with a metallic lustre. Although it is customary to assign to it the formula $FeTiO_3$, numerous analyses indicate the formula $FeTiO_3,xFe_2O_3$ whilst others correspond to neither formulation. Ilmenite is both cheaper and more plentiful than rutile, and probably the most extensive deposits of the mineral are those of the province of Quebec, Canada, and the Ekersund-Soggendal district of Sweden Other important deposits are found in the United States and South Australia, whilst ilmenite is a by-product from the crude monazite sands of Ceylon and Travancore, India. For industrial purposes the only distinction between ilmenite and titaniferous magnetite is in the titanium

content. Ore, classed as ilmenite, has a titanium content of 18 to 24% or more, whilst titaniferous magnetite seldom carries more than 15% of titanium.

Although titanium is unimportant commercially, yet when alloyed with other elements it forms a number of useful products. Four of these alloys—ferrocarbon titanium, carbon-free ferrotitanium, cuprotitanium, and manganotitanium—are in commercial use Ferrocarbon titanium is made by reduction of ilmenite with coke in an electric furnace, or by charging rutile mixed with carbon into an electric furnace containing molten iron or steel. The alloy so produced has a high carbon content (5 to 8%) but this can be reduced below 1% by remelting with rutile Ferrocarbon titanium normally contains Ti 15—18, C 7, Si 1·5%, the rest being iron and small quantities of impurities. The carbon-free ferrotitanium is produced by the thermit process. The finely-powdered ilmenite (or oxides of iron and titanium) mixed with aluminium powder, in the correct proportions, is ignited by means of a fuse. A rapid reaction takes place in which the oxides are reduced to the elemental condition and an alloy of the following composition is produced: Fe, 67—69; Ti, 25; Al, 5—6; Si, 1—1 05; P, 0 05; S, 0.01%. Cuprotitanium is made by the alumino-thermic reduction of rutile to which copper has been added, and manganotitanium is similarly produced by the reduction of rutile to which manganese or its oxide has been added. Titanium in the form of its alloys acts as a final deoxidizer and denitrogenizer for metals The addition of the ferro-alloys to steel yields a cleaner and sounder product, whilst the cuprotitanium and manganotitanium are used as deoxidizers in brass and bronze practice Titanium in the form of its compounds finds many useful applications Ilmenite and rutile, as well as artificial titanium dioxide, have been used in the making of arc-lamp electrodes. Titanium compounds have proved of value as pigments in the paint industry, dyes and mordants in the textile and leather industries, refractory colouring materials for use in ceramics and in the manufacture of artificial teeth. Titanium white, TiO_2, is put on the market as a pigment to compete with white lead and zinc white.

Titanium forms a wide range of salts in which it exhibits valencies of 4, 3, and 2. Titanium tetrachloride, $TiCl_4$, which may be conveniently prepared by passage of chlorine over heated titanic oxide (TiO_2) and carbon, is a colourless liquid boiling at 136·4° C. It fumes excessively in the air and was used as a smoke-screen during the World War By electrolytic reduction of a solution of the tetrachloride in hydrochloric acid, a violet solution of titanium trichloride is obtained. This compound has pronounced reducing properties and has been utilized for many useful volumetric processes (Knecht and Hibbert, *New Reduction Methods in Volumetric Analysis,* 1910). Salts of quadrivalent titanium are normally colourless, but the titanous salts, containing tervalent titanium, are generally violet or green, and include some powerful mordants which produce brilliant and stable colours, *e.g*, $Ti_2(SO_4)_3,Na_2SO_4,5H_2O$. Hydrogen peroxide gives with titanium salts a yellow to brown coloration due to the formation of pertitanic acid, TiO_3,xH_2O

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TITANOTHERIA, an extinct family of hoofed, herbivorous mammals remotely allied to the horses, tapirs and rhinoceroses and ranging from the Lower Eocene to the close of the Lower Oligocene in North America, to the Middle or Upper Oligocene in Mongolia. The earlier members of the group were small and hornless but these gradually gave rise to huge animals surpassing the existing rhinoceroses in size and characterized by the presence of a transversely placed pair of large horn-like outgrowths above the nose. For the origin of the group, *see* PERISSODACTYLA.

TITANS, in Greek mythology, the children of Uranus (Heaven) and Ge (Earth). The Greek name is Τιτᾶνες, the etymology of which is uncertain According to Hesiod (*Theog.,* 133), the male Titans were Oceanus, Cocus, Crius, Hyperion, Iapetus and Cronus; the female, Thea, Rhea, Themis, Mnemosyne, Phoebe and Tethys. Later authors add other names. After the rebellion of Cronus and the birth of Zeus (*see* CRONUS), a struggle ensued between Zeus and Cronus in which the Titans nearly all sided with the latter, but were finally defeated, and imprisoned in Tartarus (Hesiod, *Theog.,* 153–210, 617 et seq.).

The standard work on the subject is M. Mayer, *Die Giganten und Titanen in der antiken Sage und Kunst* (1887); *see* also the classical dictionaries *s.v.*

TITCHENER, EDWARD BRADFORD (1867–1927), Anglo-American psychologist, was born on Jan. 11, 1867, in Chichester, England, possibly a descendant of John Tychenor (1532) of Chichester. For four years he attended Malvern college in Worcestershire, and then at the age of 18 (1885) he became a member of Brasenose college at Oxford. Here for four years more he was senior scholar in classics and philosophy and senior Hulmean exhibitioner. In his fifth year at Oxford he was a research student in physiology under Burdon-Sanderson, to whom he later acknowledged an intellectual debt. At this time physiological psychology as a laboratory science was just becoming established in Germany and America, and Titchener, trained in philosophy and physiology, turned to the new science and went to Wundt (*q.v*), the "founder" of experimental psychology, at Leipzig, where was the first and the leading psychological laboratory Here he received his Ph.D. degree in 1892 Then, with the Wundtian impress upon him, in the days when psychological laboratories were still rare, he accepted the post in the laboratory at Cornell university, Ithaca (N.Y), where he remained until his death 35 years later His chief work is the *Experimental Psychology,* the most thorough and extensive encyclopaedic handbook of experimental psychology that has been written in English. The first two volumes, covering qualitative psychology, appeared in 1901; the third and fourth volumes, treating of quantitative psychology or psychophysics, were published in 1905

In America, Titchener always represented the Wundtian traditions, he never became part of the American trend in psychology, a trend that emphasizes individual differences among persons and the application of psychology to human welfare Titchener stood for the "pure" scientific psychology of the generalized, normal, adult mind In the early days he thus became the exponent of the school of structural psychology which opposed functional psychology; in later times he represented the opposition to behaviourism and to the psychology of mental tests His systematic contributions to theoretical psychology are to be found in his *Lectures on the Elementary Psychology of Feeling and Attention* (1908), *Lectures on the Experimental Psychology of the Thought-Processes* (1909), *Text-book of Psychology* (1910) and, to a less extent, in his *Beginner's Psychology* (1915) He died in Ithaca (N Y), Aug. 3, 1927

See the biographical sketches, under the title "Edward Bradford Titchener," by H C Warren, in *Science,* vol. lxvi. (1927), and by E G Boring in *The American Journal of Psychology,* vol. xxxviii. (1927); also "Titchener at Leipzig," by Frank Angell, in *The Journal of General Psychology,* vol. 1 (1928). (E G. BOR)

TITE, SIR WILLIAM (1798–1873), British architect, the son of Arthur Tite, a Russian merchant, was born in London in Feb. 1798, and died on April 20, 1873. The rebuilding of the Royal Exchange, opened in 1844, was Tite's greatest undertaking He was M P. for Bath (1855–73) and president of the Royal Institute of British Architects (1861–63 and 1867–70).

See *Journal, Royal Institute of British Architects,* pp. 209–212 (London, 1873–74).

TITHES, a form of tribute consisting of a tenth of a man's property or produce, connected politically with taxation, and religiously with the offering of "firstfruits" to deity. This custom was almost universal in the ancient world, and can be traced in Babylonia, Persia, Arabia, Egypt, Greece, Rome and even in China. The tax probably originated in a tribute laid by a conqueror or ruler on his subjects; and we may assume that the custom of dedicating a tenth of the spoils of war to the gods led to a religious extension of the term, the original offerings to deity being "firstfruits." Among the early Hebrews, for example, the king could exact a tithe from cornfields, vineyards, and flocks

(1 Sam. viii. 15, 17); and on the religious side the oldest laws (*e.g.*, Exod. xxxiv. 26) speak of bringing the firstfruits of the land to the house of Yahveh By the 7th century (Deuteronomy) the word "tithe" has come to be used regularly for religious dues. But the analysis of tithe-legislation in the books ascribed to Moses is a complicated problem, owing to the way in which strata of legislation belonging to different periods are combined in the Pentateuch as we now have it; and for detailed investigation reference should be made to the works mentioned below. Ultimately the tithe system became a means of contributing to the regular support of the priests, as ministers of the public ritual.

Tithes in Christendom.—The earliest authentic example of anything like a law of the State enforcing payment appears to occur in the capitularies of Charlemagne at the end of the 8th or beginning of the 9th century. Tithes were by that enactment to be applied to the maintenance of the bishop and clergy, the poor, and the fabric of the church. In course of time the principle of payment of tithes was extended far beyond its original intention. Thus they became transferable to laymen and saleable like ordinary property, in spite of the injunctions of the third Lateran Council, and they became payable out of sources of income not originally tithable.

The Council of Trent definitely enjoined payment of tithes, and excommunicated those who withheld them (Sessio xxv. 12). In England the earliest example of a legal recognition of tithes appears to be in a decree of a synod in 786 (quoted by Selden, *History of Tithes*, ch viii. 2) Other examples before the conquest occur in the laws of Alfred, Athelstane, Edgar, and Canute. It was Selden's denial of the divine right of tithes which brought down the wrath of the Star Chamber upon his head (1618), and he was forced to retract his opinion.

Tithes in English Law.—Two chronological divisions may conveniently be made

(i.) Before the Commutation Acts (1836 *sqq.*). Tithes were classified by origin, as "praedial," or arising immediately from the ground, *e.g.*, grain of all sorts, hay, wood and the like; "mixed," or arising from things immediately nourished by the ground, *e g.*, colts, lambs, eggs and the like; or "personal," namely, of profits arising from the honest labour and industry of man, and being the tenth part of the clear gain, *e g.*, fishing, mills and the like; or according to value, as great, *e g.*, corn, hay and wood; or little, which embraced all others. Of common right tithes were only payable of such things as yield a yearly natural increase and generally only once a year. They were recoverable by a writ against the owner of the tithable property usually brought in the ecclesiastical courts, the jurisdiction of which in this respect was confirmed by the statutes *Circumspecte agatis* (13 Edw. I), *Articuli cleri* (9 Edw II.), and others of Henry VIII. and Edward VI; and an act 2 and 3 Edw VI. made any person refusing to set out tithes liable to pay double the value in the ecclesiastical court or treble in a common law court. At the time of the Commutation Acts, it was common for a tithe-owner to accept a fixed sum of money or fixed quantity of the goods tithable in place of the actual tithes, whether in respect of a whole parish or only of particular lands within it; and this could be sued for in the ecclesiastical courts. In the City of London there were customary tithes; in other towns and places there were compositions for tithes which were confirmed by local acts of parliament; and according to a return presented to the House of Commons in 1831, there were passed between 1757 and 1830 no less than 2,000 local acts containing commutation clauses.

(ii.) The principle of the Tithe Commutation Acts (1836–1860) is to make permanent and general the system which had been only partial or temporary (in most cases), and to substitute a corn rent (known as a tithe rent charge), permanent in quantity and payable in money, but fluctuating in value, for all tithes, whether payable under a *modus* or composition or not, which may have heretofore belonged either to ecclesiastical or lay persons (Phillimore, *Eccles. Law*, ii. 1161). Commissioners (now the board of agriculture) are appointed to execute the acts; a rent charge on all lands liable to tithes at the time of the passing of the first act is substituted for those tithes, of which the gross amount is ascertained either by voluntary parochial agreement, or, failing that, by compulsory award confirmed by the commissioners, and the value of the tithes is fixed in the latter case by their average value in the particular parish during the seven years preceding Christmas 1835, without deduction for parochial or county and other rates, charges and assessments falling on tithes, the rent charge being liable to all the charges to which tithes were liable The rent charge is apportioned on all the lands liable in the parish, and such apportionment may be altered or a new one made, and the value of the rent charge is fixed at the value (at the time of confirmation of the apportionment) of the number of imperial bushels and decimal parts of bushels of wheat, barley and oats as the same would have purchased at the prices so ascertained by the advertisement (of prices of corn) to be published immediately after the passing of the act 6 and 7 Will IV c 71, in case one-third part of such rent charge had been invested in the purchase of wheat, one-third part in the purchase of barley, and the remaining third part in the purchase of oats; and the respective quantities of wheat, barley, and oats so ascertained shall be stated in the draft of every apportionment The price at which the conversion from money into corn is to be made at the time of confirmation of such apportionment, according to the provisions of the said act, are 7s $0\frac{1}{4}$d. for a bushel of wheat, 3s $11\frac{1}{2}$d for a bushel of barley, and 2s. 9d for a bushel of oats (7 Will IV and 1 Vict c 69); the average price of the bushel of each grain is now computed by substituting for the "advertisement" above the statement of the septennial average price of the imperial bushel of British corn made under the Corn Returns Act, 1882; and thus the value of the statutory amount of corn is now fixed for each year at the beginning thereof at the average price of the three components of corn for the previous seven years

The method of recovering rent charge under the Commutation Acts was distraint where the rent charge is in arrear for 21 days after the half-yearly days of payment, and entry and possession with power of letting if it is in arrear for 40 days. This power of distress and entry extends to all lands occupied by the occupier of the land whose tithe is in arrear as owner or under the same landlord; but no action lies against the owner or occupier of the land personally. If a tenant quits leaving tithe unpaid, the landlord may pay it and recover it from him. The tithe-owner cannot recover damages from the tithe-payer for not cultivating the land Special provision is made for the recovery of the rent charge in railway lands.

The act of 1891 shifted the responsibility from the occupier to the landowner by making the latter solely responsible The landowner became liable to pay the rent charge in spite of any contract to the contrary between him and the occupier; the rent charge if in arrear for three months is recoverable by an order of the county court, whatever its amount may be; if the land is occupied by the owner, the order is executed by the same means as those prescribed in the Tithe Acts; but if it is not, then by a receiver being appointed for the rents and profits of the land Appeal lies to the High Court on points of law, and a remission of rent charge may be claimed when its amount exceeds two-thirds of the annual value of the land. The act does not apply to the particular kinds of rent charges mentioned above.

The Tithe Acts do not apply to the city of London, which has always had its own peculiar customary payment regulated by episcopal constitutions of 13 Hen III and 13 Ric. II and statutes of Henry VIII confirming a decree of the privy council, under which the rate of tithes was fixed at $16\frac{1}{2}$d for every 10s rent, and at 2s. 9d for every 20s rent of houses, shops and the like by the year Provision was made by statute after the fire of London for certain annual tithes to be paid in parishes whose churches had been destroyed, and there have been local acts from time to time with regard to particular parishes therein

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TITHING. Formerly throughout England, except in the north and west, every man had to be enrolled in a group of ten men, called a tithing, who were responsible for his appearance in court if he were accused of any offence This was known as the system of frankpledge (*q v.*) If the offender was not forthcoming, enquiry was made whether he was in frankpledge; if he were not, and had no right of exemption, the township was amerced, but if he were in a tithing, then it was upon the tithing that the amercement fell South of the Thames the tithings were districts normally identical with the township which discharged the duties of the frankpledge. Some townships, however, contained more than one tithing There are also indications that in the ancient kingdom of Mercia the tithing was originally a district and not a mere association of persons.

TITHONUS was, in Greek legend, according to Homer, the son of Laomedon, king of Troy and husband of Eos (the Dawn) In the Homeric *Hymn to Aphrodite* Eos is said to have carried him off because of his great beauty. She entreated Zeus that he might live for ever, this was granted, but she forgot to ask for immortal youth for him. He became a hideous old man; Eos then shut him up in a chamber; his voice "flowed on unceasingly," but his limbs were helpless.

A later development is the change of Tithonus into a grasshopper, after Eos had been obliged to wrap him like a child in swaddling-clothes and to put him to sleep in a kind of cradle In some versions she is said to have carried him away to the land of Ethiopia near the ocean streams

See O. Gruppe, *Griechische Mythologie*, i 313, n. 16, who attributes a Milesian origin to the story; also the classical dictionaries

TITI, a name properly applied to the small South American monkeys of the genus *Callicebus*. The titis, of which there are numerous species, inhabit the forests of Brazil and the neighbouring countries and feed on fruits, insects and even small birds. The tail is long and bushy, and is not prehensile They are very vociferous, though less so than the howler monkeys (*q v.*) of the same region. The name titi (also spelt teetee) is also sometimes used for the spider-monkeys (*Saimari*), small, richly coloured, largely insectivorous forms, inhabiting Central and South America. (*See* SPIDER-MONKEY.)

TITIAN (*c.* 1477–1576), Tiziano Vecellio, or Vecelli, one of the greatest representatives of the Venetian school of painting. The house at Pieve di Cadore where he was born is now a small museum. Titian, one of a family of four, was the son of Gregorio Vecelli, a distinguished councillor and soldier, and of his wife Lucia. The date of his birth is generally given as 1477. Vasari in one passage (at variance with Ridolfi) says that Titian was born in 1480; while Titian himself, writing to Philip II. in 1571, professed to be ninety-five years old.

He was still a child when sent by his parents to Venice, to an uncle's house There, according to Lodovico Dolce, he was placed under Sebastiano Zuccato, a mosaicist and painter He next became a pupil of Gentile Bellini, and then of Giovanni Bellini. The youth was a contemporary of Giorgione and Palma Vecchio, who influenced him at first; when his period of pupilage expired, he is surmised to have entered into a sort of partnership with Giorgione. A lost fresco of "Hercules" on the Morosini Palace is said to have been one of his earliest works. In 1507–1508 Giorgione was commissioned by the state to execute frescoes on the re-erected Fondaco de' Tedeschi (warehouse for the German merchants). Titian worked along with him, as is known to us only by engravings. Towards 1511, Titian went to Padua, and painted in the Scuola di S. Antonio a series of frescoes, representing the life of the saint. Another fresco, dated 1523, is "St. Christopher carrying the Infant Christ," at the foot of the staircase in the ducal palace of Venice. From Padua Titian in 1512 returned to Venice; and in 1513 he obtained a broker's patent and became superintendent of the government works, being charged to complete the paintings left unfinished by Giovanni Bellini in the hall of the great council in the ducal palace (destroyed by fire). He set up an atelier on the Grand Canal, at S. Samuele. It was not until 1516, upon the death of Bellini, that he came into actual enjoyment of his patent, which yielded him an annuity of 120 crowns—and exempted him from certain taxes—he being bound in return to paint likenesses of the successive doges of his time at the fixed price of eight crowns each The actual number which he executed was five. The year 1516 witnessed Titian's first journey to Ferrara. Two years later was completed, for the high altar of the church of the Frari, one of his most world-renowned masterpieces, the "Assumption of the Madonna." It excited a vast sensation.

Titian was now at the height of his fame; and in 1525, he married a lady of whom only the Christian name, Cecilia, has come down to us; he hereby legitimized their first two children Pomponio and Orazio. Pietro Aretino, the literary bravo, of influence and audacity, arrived in Venice in March 1527 and soon became intimate with Titian who sent a portrait of him to Gonzaga, duke of Mantua, in June 1527 In 1530 he painted in Bologna a portrait of the emperor Charles V, and was created in 1533 a count palatine and knight of the Golden Spur, his children also being made nobles of the empire—for a painter, honours of an unexampled kind.

The Venetian government, dissatisfied at Titian's neglect of the work for the ducal palace, ordered him in 1538 to refund the money which he had received for time unemployed; and Pordenone, his formidable rival of recent years, was installed in his place At the end of a year, however, Pordenone died; and Titian was reinstated after having applied himself diligently to painting in the hall Barbarossa's Victory at Spoleto, erroneously referred to as Battle of Cadore. This great picture, which was burned with several others in 1577, represented in life-size the moment at which the Venetian captain, D'Alviano, fronted the enemy, with horses and men crashing down into the stream Fontana's engraving, and a small copy in the gallery of the Uffizi in Florence, record the energetic composition A visit was paid to Rome in 1546, when he obtained the freedom of the city and painted the portrait groups of Pope Paul III and his two grandsons, the Cardinal Alessandro and the duke Ottavio Farnese. The picture now at Naples was left unfinished and Titian returned to Venice in the same year. In Jan. 1548 and again in 1550–51 he went to Germany to paint Charles V. and others, in Augsburg He executed the portraits of the elector of Saxony (Vienna) and of Philip II. (now lost; copy in Madrid), which was sent to England and proved a potent auxiliary in the suit of the prince for the hand of Queen Mary. In 1554 his beloved daughter Lavinia, whom he painted various times, married Cornelio Scarcinelli of Serravalle; she had succeeded her aunt Orsa, now deceased, as the manager of the household, which, with the lordly income that Titian made, was placed on a corresponding footing. She died in childbirth in 1560. With his European fame, Titian is the last man one would suppose to have been under the necessity of writing letters for payment, especially when the defaulter addressed was lord of Spain and of the American Indies; yet he had constantly to complain that his pictures remained unpaid for and his pensions in arrear, and in the very year of his death (February) he recites the many pictures which he had sent within the preceding twenty years without receiving their price In fact, there is ground for thinking that all his pensions and privileges, large as they were nominally, brought in but precarious returns. It has been pointed out that in the summer of 1566 (when he was elected into the Florentine Academy) he made an official declaration of his income, and put down the various items apparently below their value, not naming at all his salary or pensions. Possibly there was but too much reason for the omission.

In September 1565 Titian went to Cadore and designed the decorations for the church at Pieve, partly executed by his pupils. One of these is a Transfiguration, another an Annunciation (now

in S. Salvatore, Venice). He continued to accept commissions to the last. He had selected as the place for his burial the chapel of the Crucifix in the church of the Frari; and, in return for a grave, he offered the Franciscans a picture of the "Pietà." This work he nearly finished; but some differences arose regarding it, and he then settled to be interred in his native Pieve. Titian was about ninety-nine years of age when the plague, which was then raging in Venice, carried him off on Aug 27, 1576. He was buried in the church of the Frari, as at first intended, and his "Pietà" (now in the Venice Academy) was finished by Palma Giovane, who at that time was his assistant. He lies near his own famous painting, the "Madonna di Casa Pesaro." No memorial marked his grave, until by Austrian command Canova executed a monument. Immediately after Titian's own death, his son and assistant Orazio died of the same epidemic His sumptuous mansion was plundered during the plague by thieves

Titian's portrait of himself in the sixties is at Berlin; Madrid has his portrait as an old man of 80. He was highly distinguished, and a fine speaker, enjoying (as is said by Vasari, who saw him in the spring of 1566) health and prosperity unequalled. He was patronised by the Estes, the Gonzagas, the Medicis, the Farneses. He was favoured by Charles V and by Philip II He gave splendid entertainments; and it is related that, when Henry III. of France passed through Venice on his way from Poland to take the French throne, he called on Titian with a train of nobles, and the painter presented him as a gift with all the pictures of which he inquired the price He was not a man of universal genius, like Leonardo da Vinci and Michelangelo; his one great and supreme endowment was that of painting. He carried to its acme the great colourist conception of the Venetian school.

Titian's pictures abound with memories of his home-country and of the region which led from the hill-summits of Cadore to the queen-city of the Adriatic. He was almost the first painter to exhibit an appreciation of mountains, mainly those of a turreted type, exemplified in the Dolomites. Indeed he gave to landscape generally a new and original vitality, expressing the quality of the objects of nature and their control over the sentiments and imagination with a force that had never before been approached. The earliest Italian picture, expressly designated as "landscape" was one which Titian sent in 1552 to Philip II His productive faculty was immense, even when we allow for the abnormal length of his professional career

The later pictures were painted loosely, telling well from a distant view He himself averred that after his visit to Rome in 1546 he had greatly improved in art; and in his very last days he said that he was then beginning to understand what painting meant In his earlier pictures the gamut of colour rests mainly upon red and green, in the later ones upon deep yellow and blue. Palma Giovane records that Titian would set pictures aside for months, and afterwards, examining them with a stern countenance, as if they were his mortal enemies, would set to work upon them like a man possessed, also that he kept many pictures in progress at the same time, turning from one to the other, and that in his final operation on pictures of the last period he worked far more with finger than with brush Michelangelo's verdict after inspecting the picture of "Danae in the Rain of Gold," during Titian's stay in Rome, "That man would have had no equal if art had done as much for him as nature," has often been quoted He was thinking principally of draughtsmanship, for he added, "Pity that in Venice they don't learn how to draw well." However, as a draughtsman of the human figure Titian was competent and fine, and he is reported to have studied anatomy. His rendering of the nude was lifelike. He distanced all predecessors in the study of colour.

Titian's son, Orazio, born before 1525, who assisted Titian professionally, became a portrait-painter of mark. He executed a picture in the hall of the great council, destroyed by fire. Several other artists of the Vecelli family followed in the wake of Titian. Francesco Vecelli, his brother (d. 1560), was introduced to painting by Titian, and painted in the church of S. Vito in Cadore a picture of the titular saint armed. But he was diverted from painting to mercantile life. Marco Vecelli, called Marco di Tiziano (1545–1611), a distant relation, was constantly with the master, and learned his methods of work. He has left some able productions—in the ducal palace, the "Meeting of Charles V. and Clement VII. in 1529", in S. Giacomo di Rialto, an "Annunciation", in SS Giovani e Paolo, "Christ Fulminant." A son of Marco, named Tiziano (or Tizianello), painted early in the 17th century. There was another relative, Girolamo Dente, who, being a scholar and assistant of Titian, was called Girolamo di Tiziano Various pictures of his were touched up by the master. Apart from members of his family, the scholars of Titian were not numerous; Paris Bordone and Bonifazio were the two of superior excellence. It is said that Titian engraved on copper and on wood, but this may well be questioned He provided drawings for engravers In 1508 according to Vasari appeared the series of woodcuts "Trionfi della Fede" designed by Titian (facsimile reproductions P. Kristeller, Berlin, 1906) A few bold and sketchy pen drawings are extant (Louvre, Uffizi).

We must now briefly advert to Titian's individual works, taking them in approximate order of time, and merely dividing portraits from other pictures. The earliest works which we proceed to mention may date towards 1505 In the chapel of S. Rocco, Venice, is his "Christ Carrying the Cross," now greatly dilapidated; it was an object of so much popular devotion as to produce offerings which formed the first funds for building the Scuola di S Rocco. in the scuola is his "Man of Sorrows" The "Tribute Money" ("Christ and the Pharisee"), now in the Dresden Gallery, dated towards 1508 In the church of S Marcuola, Venice, is the "Christ Child between St Andrew and St Catherine"; in S Marziale the "Tobias and the Angel"; in the Capitoline Museum Rome, "The Baptism of Christ", in the Antwerp Museum, "Pope Alexander VII. presenting Jacopo Pesaro to St. Peter"; in the church of the Salute, Venice, St Mark enthroned, along with SS Sebastian, Roch, Cosmo and Damian Somewhat later, painted after Giorgione's death in 1510 is the famous picture in the Villa Borghese, Rome, commonly named "The Sacred and Profane Love" (c. 1510–12). Towards 1512 was painted the "Three Ages," now in Bridgewater House—a woman guiding the fingers of a shepherd on a reed-pipe, two sleeping children, a cupid, an old man with two skulls, and a second shepherd in the distance—one of the most poetically impressive among all Titian's works, copies of which are in the Doria and Borghese galleries in Rome. Two of the pictures in the National Gallery, London—the "Holy Family With Adoring Shepherd" and the "Noli me tangere"—and the "Salome with the head of the Baptist" in the Doria Gallery, Rome, were going on at much the same time. The great Assumption in the Frari, Venice, painted in 1518, constitutes a landmark in Titian's work Then followed three pictures painted for Duke Alphonso of Ferrara the "Worship of Venus" showing the statue of Venus, two nymphs and many cupids, the "Bacchanal," with Ariadne dozing over her wine-cup, both now in Madrid, and the famous "Bacchus and Ariadne" in the National Gallery, completed in 1522. The "Resurrection of Christ" in S Nazaro e Celso, Brescia, is dated 1522. The "Flora" of the Uffizi and the lovely "Venus Anadyomene" of the Bridgewater Gallery may date a year or so earlier. Another work of 1523 is the stupendous "Entombment of Christ" in the Louvre The picture comes from the Gonzaga collection and from the gallery of Charles I in Whitehall In 1530 Titian completed the "St Peter Martyr" for the church of SS. Giovanni e Paolo; for this work he bore off the prize in competition with Palma Vecchio and Pordenone Of all his pictures this was the most daring in design of action. A fire destroyed it in 1867; the copy of it by Cardi da Cigola has taken its place. To 1530 belongs also the "Madonna del Coniglio" (Louvre), painted for Gonzaga; to 1533 the "St. John the Almsgiver" for San Giovanni Elemosinario, Venice; to about 1538 belongs the "Venus" in the Uffizi, Florence; and the "Venus of Florence"; the portraits of the "Twelve Caesars," for Gonzaga, no longer extant; the "Presentation of the Virgin in the Temple"—one of the conspicuous examples in the Venetian Academy, was finished in 1538. About 1540 were done the forcible paintings for S. Spirito, Venice, now in the church of the Salute—"Cain Killing Abel," the "Sacrifice of Abraham" and "David and Goliath"; in 1543 the "Ecce Homo" of the Vienna Gallery

where Aretino figures as Pilate. The "Venus and Cupid" of Florence, the "Venus" of Madrid and the "Supper of Emmaus" in the Louvre were still in hand, or just completed, when Titian was summoned to Augsburg in 1547. Probably in the forties he also painted the "St John the Baptist" of the Academy at Venice, an impressive figure, classic in conception. In 1554 he sent to Philip II in England a second "Danae" and a "Venus and Adonis." About the same time he sent to Charles V. a "Trinity" (or, as Titian himself termed it, "Last Judgment"), which represented the emperor, with his family and others, all in shrouds, praying to the Godhead. This was the object upon which Charles continued to keep his eyes fixed until the film of death closed on them. A sketch of this picture ascribed to Titian has recently been acquired by the National Gallery, London. Later pictures, from 1558 onwards, are the "Martyrdom of St Lawrence," "Christ Crowned with Thorns" (Louvre), "Diana and Actaeon," "Diana and Callisto," "Jupiter and Antiope," the "Magdalene," "Christ in the Garden," and "Europa"—the last six for Philip II; the two Diana subjects are now in Bridgewater House, "The Europa" in the Gardner collection, Boston The "Jupiter and Antiope," is commonly called "La Vénus del Pardo," having at first been in the Pardo Palace. It was presented to Charles I of England and is now in the Louvre. In 1564 Titian offered to Philip II. his "Last Supper," which had been in hand for six years; it was cut down in the Escorial to suit a particular space The "St. Jerome" of the Brera Gallery in Milan, a work of wonderful energy, spirit and force, was probably rather earlier than this. The last "Madonna" painted by Titian is in the National Gallery (Mond Collection). It is enveloped in golden tone and loosely painted with utmost mastery of the brush "The Christ Crowned with Thorns" in Munich and "The Entombment" in Madrid are powerful, emotional works of his last years Here as in his last work, "The Pietà," his work displays a mystic intensity which contrasts with the superb materiality of his middle period Two of the mosaics in St Mark's church, Venice, namely, the Mark in pontificals and the sword sheathing angel on the right of the high altar, were said to have been worked out after Titian's designs.

We now turn to the portraits—works great in style, stately, and simple in perception and feeling. Among the finest examples are Federigo Gonzaga of Mantua (Madrid), "The Lady at her Toilet," commonly called "Titian and his Mistress" or "Laura Dianti" (Louvre); Francis I (Louvre), painted towards 1536, from a medal, for Titian never saw the French king; various likenesses of himself, one of about 1550, and another of 1562; Paul III. (Naples)—done in about four weeks, was presented to the pontiff in May 1543 and cost two gold ducats; Pietro Aretino (Pitti); Titian's daughter Lavinia (Dresden); the Cornaro Family (Alnwick Castle), "L'Homme au Gant," an unknown personage, youthful and handsome (Louvre); Eleonora duchess of Urbino, Francesco duke of Urbino, Caterina Cornaro queen of Cyprus (these three in the Uffizi); Charles V. on horseback after the battle of Mühlberg painted at Augsburg in 1548 (Madrid) and "Charles seated" executed at the same time (Munich); the portrait of a man called Alexander Medici (Hampton Court Palace); the physician Parma (Vienna) The female portraits done by Titian are few, usually of women of exalted rank The beautiful Flora (Uffizi) and the Bella (Pitti) are among the master's most celebrated pictures Of Ariosto the painter is said to have done three portraits Much uncertainty, however, exists regarding these supposed portraits of Ariosto. One of the three appears as a wood-cut in an edition of the *Orlando furioso* A portrait from Cobham Hall in the National Gallery, London, was wrongly identified with Ariosto

See Vasari, *Vite*, ed. Milanesi; L. Dolce, L'Aretino, *Dialogo della Pittura, Rime e Lettere* (Florence, 1910); J. A. Crowe and G. B. Cavalcaselle, *The Life and Times of Titian* (2 vols., 1877); Claude Phillips, *The Earlier Work of Titian* (1897, 2nd ed. 1905), *The Later Work of Titian* (1898); G. Gronau, *Titian* (1900, Eng. trans. A. M. Todd, 1904); O. Fischel, *Tizian* (*Klassiker der Kunst* 1907); C. Ricketts, *Titian* (1910); C. Ridolfi, *Le Maraviglie dell' Arte* (ed. D. v. Hadeln, 1914); D. v. Hadeln, *Titian's Drawings* (1927).

(W M. R; I A R)

TITLE GUARANTEE COMPANIES, the name given to companies which apply the principle of corporate indemnity to the protection of those interested in real estate titles, either as owners or lenders. They are of the class of indemnity companies in which technical skill and experience in investigation of risks are relied upon to protect the guarantor from loss. They are peculiar to countries where the title to real estate is a matter of public record, and where the complexity of the record and the variety of possible liens and encumbrances have made it difficult and expensive to determine whether the title is good. The only country where they have reached large proportions or achieved success as independent business enterprises is the United States In Australia no investigation of a title to real estate is necessary, because before the land passed into individual ownership the government adopted a system of state registration and guarantee of title, so that its certificate of registered title was universally accepted In certain other countries there is neither registration of title nor recording of deeds; the title-deeds are preserved and passed from owner to owner, and are accepted on the authority of the records and opinions of family solicitors. In the United States, however, there have been from the beginning acts providing that all deeds and mortgages be recorded, and the records, when properly made, constitute legal notice to all the world of their contents and claims At the same time, there are other records of wills, suits, judgments, taxes and mechanics' claims which may encumber the title. In the great cities these various records became in course of time so voluminous that the proper investigation of them, and the determination of the validity of the title in view of them, required the best skill of an experienced lawyer and involved very heavy expenses. On a re-sale of the property the new buyer did not rely upon the lawyer who had made the examination for the seller, but felt called upon to employ and pay his own lawyer, who had to go over the same work again, and more, for with each new transaction the history was getting longer The delay and expense involved were great, and yet the owner had little or no protection, for a lawyer is not held to guarantee the correctness of his opinion

The first company actually to undertake the guarantee of real estate titles was formed in Philadelphia, Pennsylvania, in 1876 It differed from the Prussian Mortgage Insurance company (which guaranteed titles merely as an incident in its business as a dealer in, and custodian and guarantor of, mortgages) in that its main business was the issue of a policy of guarantee on a transfer of title to land. The advantages of its method were immediately recognized. Corporations to carry on the business were organized in New York, Washington, Baltimore and Boston, and subsequently in nearly every considerable city in the United States

In order to be independent of the inaccurate and clumsy methods of the public record offices, title guarantee companies generally compile in their own office a copy or digest of all the real estate records of the locality in which they are established, maintaining for this purpose a staff of skilled clerks. To make the necessary examination of a title prior to the issuing of a guarantee, they require continually a body of experienced real estate lawyers. By these means a title can be examined and guaranteed in a week, whereas thirty or forty days was formerly required. This has done much to make real estate available capital, for individual and corporate lenders on mortgage accept the guarantee of the companies as the best evidence of title, and loans can be had without the delay that once prevailed.

The expense of maintaining the staff of clerks and lawyers is great, amounting to half of the gross charges on titles guaranteed. Strictly speaking, the risks outstanding are also large, running up to $100,000,000 a year for a single company in New York city; but in well-managed companies the losses are very small, not exceeding 2% of the gross charges on titles guaranteed, so that the outstanding obligations should scarcely be called risks. In spite of the office expenses, the charges for first bringing a piece of land under the guarantee are no more than owners were in the habit of paying each time for examination and opinion by counsel, amounting to about one-half of 1% on the value of the property or on the amount of the mortgage; and when once the guarantee has been issued, it is re-issued on a subsequent sale or mortgage on short

notice and for a small fee. (C. H. K.)

TITLE INSURANCE or **GUARANTEE OF TITLE,** a term used in the United States for a policy of insurance or a guarantee of indemnity (*see* TITLE GUARANTEE COMPANIES), giving protection and safeguard to an owner of real estate, or a lender of money upon it, against any loss or damage that he might sustain because of any defect in the title prior to the date of the policy, because of the unmarketability of the title or because of any unknown liens or encumbrances against the property, prior to the date of the policy

There are two kinds of property that people use and own—real and personal. Real estate, land, constitutes the real property; stocks, bonds, monies and such movable and chattel holdings are the personal. Personal property can be handled almost at will and in any manner of choice Real estate is immobile. Real property rights and how one may use, own, possess—in fact, employ and enjoy the land he owns, have been safeguarded, restricted and defined in a very prescribed way by law, and custom has also exerted a considerable influence.

In many countries, the ownership of land is restricted to the few There is little incentive and almost no possibility for the general ownership, widespread buying and selling of land. In them, title to real estate is largely a matter of inheritance. Ownership and the matters of title are ascertained from family records, files of title deeds of conveyance, wills and the tradition and general knowledge to be had about the title to the property. Family solicitors have usually handled such matters for generations, taken care of things as they appeared, and upon occasion, given the necessary details and furnished opinions about the title and rights of persons involved In America, however, probably more than in any other country, anyone can acquire land, and the buying, selling and using of real estate as security, are everyday matters.

It is absolutely necessary, however, in any real estate transaction, whether it be a sale, settlement of an estate where there is a division of real property, the lending of money with a real estate mortgage as security, and in fact, in all cases where real estate is involved, to know the condition of the title. It should always be ascertained who owns the property and that there are no adverse claims or owners of interests other than those of the reputed owner, that all taxes are paid or discovered, because any due or unpaid taxes, whether general, State, county, township, or for special purposes such as parks, paving, public improvements, are liens upon the lands against which they are levied; that there are no suits pending, mechanics' liens, judgments rendered in any local court or liens filed by the Federal Government for fines in violation of some Federal statute or unpaid taxes due from the provisions of the Internal Revenue Act which are liens upon the real estate involved; and also that there are no matters in any probate or surrogate court affecting the title It is, therefore, the title to real estate that one acquires or lends money upon, and not the land itself. In order to keep a history or record of the titles to the lands, the United States has what is known as the public recording system. All matters affecting the title to all parcels of land, including transfers, estates, taxes and suits, are entered and recorded in their proper offices and courts of records.

There are two principal kinds of policies, the owner's (or fee) and the mortgagee's policy. The owner's policy guarantees the title to the property and the protection runs to the insured owner or purchaser. The mortgagee guarantees the title to be vested in the mortgagor at the time of making the mortgage; that the indebtedness secured by the mortgage or trust deed is a valid first lien on the property, and upon being transferable to an assignee, insures the validity and genuineness of the assignment of the lien. In case of loss, failure of title or attack it becomes the duty of the title company to indemnify its insured, take over the property or defend the action. The protection of title insurance covers all matters and questions that might be raised about all matters disclosed of record, and in addition things not disclosed or possible to ascertain. These last mentioned include forgeries, frauds, false representations, lost deeds and wills, deeds made by infants, deeds by lunatics, invalid and revoked powers of attorney, claims of undisclosed heirs, mistakes of law, jurisdictional questions, conflict of legal decisions and opinions and many others.

Title insurance is peculiar to the United States because of the facts that the country has a public recording system, that it is not only necessary to ascertain all the minute facts and evidence about the title, but likewise arrive at and secure an opinion as to the sufficiency and legality of each step and matter. Title insurance is a guarantee and protection as to all matters of record, as to the completeness and accuracy of the compiled evidence, as to things not disclosed or ascertainable and the opinion as to their legality and validity. In order to do this, an abstract or history of title is first compiled. This evidence of title is then examined and passed upon by authorities on title law and real estate title matters. Physical examinations and surveys of the premises are also made and the policy then issued. (R B. HA)

TITLES OF HONOUR, "those various names of greatness or eminency, which are the most distinguishing titles of civil dignity" (John Selden, *Titles of Honor*). This definition covers, if we understand "civil" in its proper and widest sense, all titles, whether official or honorary, civil or military, temporal or ecclesiastical In general, however, we now understand by titles of honour what Selden calls "honorary titles," *i e*, distinctive designations implying rank and dignity, not office or vocation. *See* PEERAGE, FORMS OF ADDRESS; EMPEROR; KING; PRECEDENCE, etc.

TITMOUSE (often abbreviated to "tit"), meaning a little mouse, the popular name of any of a number of birds of the genus *Parus*, family *Paridae*, of the order Passeres The genus is usually non-migratory, and is widely spread throughout the world, being found everywhere except in South America and the Australian region east of Flores

The great titmouse or ox-eye (*P maior*) is found all over Europe and north Asia It is conspicuous by its black head, white cheeks and yellow breast with a black band down the centre. Its love-note resembles the noise made in sharpening a saw. Equally widely distributed and even more common is *P coeruleus,* the blue titmouse, with a plumage of blue and yellow Not dissimilar are the coal-titmouse (*P. ater*), distinguished by its black cap and white cheek and nape, and the marsh-titmouse (*P. palustris*), which is more soberly coloured The crested titmouse (*P cristatus*) inhabits the mountain pine-woods of Scotland and Europe generally The most familiar American form is the chickadee (*q v.*) or black-capped titmouse (*P. atricapillus*), but other species of the genus *Parus* and the allied genera *Psaltriparus* and *Auriparus* occur.

During most of the year, the various species associate in family parties, only breaking up into pairs to breed Composite bands of several species are often to be seen during the winter. The nests are placed in hollow stumps, holes in walls or similar situations and have a thick lining of feathers and hair. The eggs, often eight or nine in number, are white, freckled with rust colour. Of a restless disposition, the birds feed largely on insects, but in winter will readily eat suet, coco-nuts and seeds, particularly those of the sunflower. By their destruction of harmful grubs, these birds are of incalculable value to the gardener.

BY COURTESY OF NATIONAL ASSOCIATION OF AUDUBON SOCIETIES

TUFTED TITMOUSE (P BAEOLOPHUS) OF THE UNITED STATES

The allied genus *Acredula* includes the long-tailed titmouse (*A caudata*), which has a tail longer than itself and builds a beautiful oval nest of lichen, moss and wool lined with feathers. Over 2,000 feathers have been taken from one nest When the female is brooding her tail is bent over her back and protrudes at the nest entrance.

The bearded titmouse, reedling or reed-pheasant (*Panurus biarmicus*) inhabits reed-beds. It belongs to a different family, the *Panuridae*.

TITTONI, TOMMASO (1855–), Italian politician, was born in Rome and educated at Naples, Oxford and Liége. In 1886 he was elected deputy for Civitavecchia and in 1902 was raised to the Senate. He was foreign minister for the second Giolitti cabinet (1903), and in this capacity he aimed at improving relations with Austria. On the resignation of Giolitti in March 1905, Tittoni became interim premier for a few days and remained in the Fortis cabinet as foreign minister. His proposed reduction of the duty on Spanish wines in connection with an Italo-Spanish commercial treaty aroused much indignation and caused the fall of the cabinet on Dec 24, 1905 In March 1906 he was appointed ambassador in London, but on the return of Giolitti to power in May, he returned to the *Consulta*, and there continued the policy of improving relations with Austria. In April 1910 he was appointed ambassador in Paris. When the World War broke out, in spite of his Triplicist policy, he openly expressed himself in favour of Italian neutrality. In Nov. 1916 he resigned from the Paris embassy. In June 1919 Nitti chose Tittoni as foreign minister and first delegate at the Peace Conference, but he was forced to resign owing to ill-health in November. He was chosen president of the Senate in December, and was later appointed Italian delegate on the Council and Assembly of the League of Nations, but ill-health again forced him to relinquish the latter appointment. On the advent to power of Fascism he supported the new Government, without joining the Fascist party

TITUS, like Timothy, in the New Testament, is known from allusions in the Acts of the Apostles and the Pauline epistles He was a convert from paganism, and St. Paul refused to allow him to be circumcised (Galatians ii 1 *seq.*) at Jerusalem, when the conservative party demanded this concession to religious feeling. He then appears in connection with the Corinthian church (*see* the Corinthian epistles), where he won the highest praise from the apostle for his upright and loyal services. He was specially entrusted with the business of organizing the collection for the poor Christians of Judaea, in the Achaian churches (2 Cor. viii. *seq.*), and evidently acted as a commissioner of the apostle Paul at Corinth during the dispute which followed According to 2 Tim. iv. 10 he went off subsequently on a mission to Dalmatia, but the Epistle addressed to him implies a tradition that he superintended the work in the island of Crete, as a delegate of his chief. Later tradition made him bishop of Crete. Modern criticism has sometimes identified him with the author of the "We"-journal in Acts, and even thought that he was a brother of Luke (see *Expository Times*, xviii. 285, 335, 380). (J Mof)

TITUS, EPISTLE TO: *see* Pastoral Epistles.

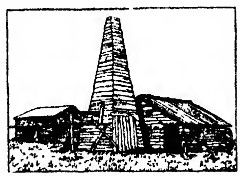
TITUS, FLAVIUS SABINUS VESPASIANUS (A.D. 40 or 41–81), Roman Emperor 79–81, son of the emperor Vespasian, was born on Dec. 30, A.D. 40 (or 41). As a young man he served with credit in Germany and Britain, and had command of a legion under his father in the Jewish War. In 68 he was sent by his father to congratulate the newly proclaimed emperor Galba, but hearing of Galba's death he returned to Palestine. The next year Vespasian, having been proclaimed emperor, went to Italy, leaving Titus to carry on the siege of Jerusalem, which was captured on Sept. 8, 70. On his return to Rome he and his father celebrated a triumph, recorded by the "Arch of Titus." For the rest of Vespasian's reign he was associated with him in the government with the title of Caesar. During this time he was not popular, and he outraged public opinion by his connection with Berenice, sister of Herod Agrippa; both of them came and lived in the palace for a while, but Titus had to send her back. He succeeded his father in 79, and falsified the pessimistic prophecies of his detractors. He put an end to prosecutions for treason, banished the informers, and became *pontifex maximus* to avoid shedding blood. He was notably lenient to Domitian, who plotted against him. The Flavian amphitheatre (Colosseum) was finished in his reign, and he built new baths in Rome. He visited Pompeii when it was destroyed in 79, and contributed to its relief; during his absence there was a three days' fire in Rome, and he again gave his assistance. The empire was peaceful during his reign. The only fighting was in Britain, where Agricola conquered as far as the Tay. Titus died on Sept. 13, 81.

See Suetonius, *Titus;* Dio Cassius lxvi. 18–26; C. Beulé, *Titus et sa dynastie* (1870); L. Double, *L'Empereur Titus* (1877); Merivale, *Hist. of the Romans under the Empire* (ch. 60); H. Schiller, *Geschichte der römischen Kaiserzeit*, i. vol. 2.

TITUS TATIUS, in Roman legend, the Sabine king of Cures, who waged war upon the Romans to avenge the rape of the Sabine women (*see* Romulus). After various indecisive conflicts the latter, who had become Roman matrons, intervened and prevailed upon the combatants to cease fighting. A formal treaty was then arranged between the Romans and Sabines, whereby Romulus and Tatius were to be joint and equal rulers of the Roman people. Rome was to retain its name and each citizen was to be called a Roman, but as a community they were to be called Quirites (*q.v.*); the Sabines were to be incorporated in the state and admitted into the tribes and curies. After this arrangement had lasted for five years it came to an end by the death of Tatius, who was killed out of revenge by the inhabitants of Lavinium. According to Mommsen, the story of his death (for which *see* Plutarch) looks like an historical version of the abolition of blood-revenge. Tatius, who in some respects resembles Remus, is not an historical personage, but the eponymous hero of the religious college called *sodales Titii*. As to this body Tacitus expresses two different opinions, representing two different traditions: that it was introduced either by Tatius himself to preserve the Sabine cult in Rome; or by Romulus in honour of Tatius, at whose grave its members were bound to offer a yearly sacrifice. The *sodales* fell into abeyance at the end of the republic, but were revived by Augustus and existed to the end of the 2nd century A.D. Augustus himself and the emperor Claudius belonged to the college, and all its members were of senatorial rank.

See Livy i. 10–14; Tacitus, *Annals*, i. 54, *Hist.* ii. 95; Dion. Halic. ii. 36–52, Plutarch, *Romulus*, 19–24, Marquardt, *Romische Staatsverwaltung* (1885) iii. 446; Schwegler, *Romische Geschichte*, bk. ix. 3, 14; x 5.

TITUSVILLE, a city of Crawford county, Pennsylvania, U.S A., on Oil creek, 1,180 ft. above sea-level, 42 m S E. of Erie; served by the New York Central and the Pennsylvania railways Pop. (1920) 8,432 (86% native white); 1928 local estimate 10,000 (including immediate suburbs). It is in the oil and gas region of north-western Pennsylvania Development of the field dates from Aug. 27, 1859, when the first artesian oil well in America was drilled just outside Titusville by Col. Edwin L Drake (1819–80), in whose memory a monument was erected in Woodlawn cemetery by Henry H. Rogers in 1902. Under the leadership of John D. Archbold, Titusville was (until 1875) the principal centre in Pennsylvania of opposition to the Standard Oil Company. It was in the Titusville district that the natural gas resources of Pennsylvania were first developed (about 1872). On June 5, 1892, a cloudburst so flooded Oil creek that it wrecked many oil tanks along its banks. The oil caught fire (probably from lightning) and a mass of flames was carried down the creek, causing the loss of 60 lives and great damage to property. Titusville was founded in 1796 by Samuel Kerr and Jonathan Titus. It was incorporated as a borough in 1847 and chartered as a city in 1866.

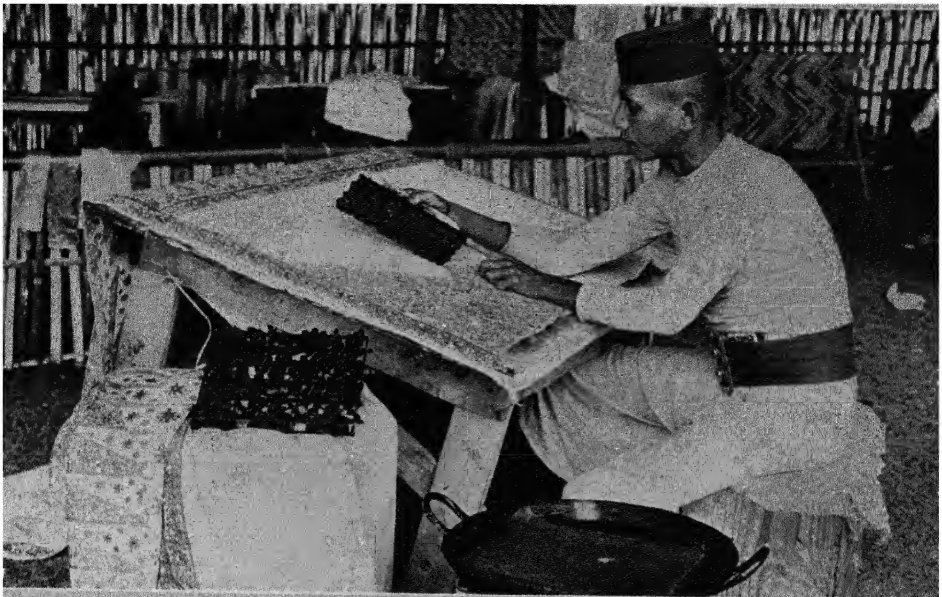


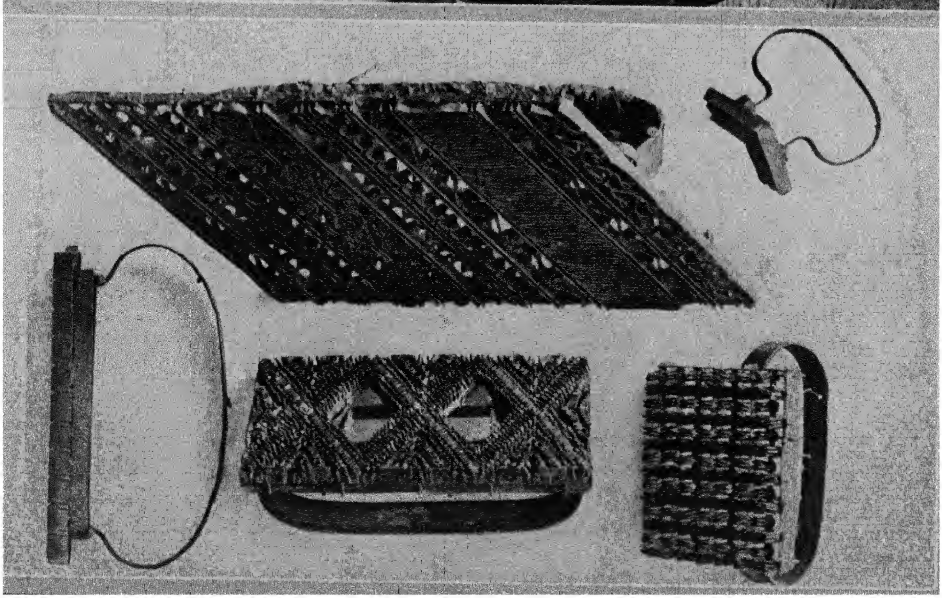
BY COURTESY OF THE OIL WELL SUPPLY COMPANY

FIRST OIL WELL IN AMERICA, SUNK NEAR TITUSVILLE IN 1859

TIVERTON, a town of Devon, England, at the confluence of the Loman and Exe, 164 m. W. by S. of London by the G.W. railway. Pop. (1921) 9,712. St. Peter's church, originally consecrated as a chapel by Leofric, bishop of Exeter, in 1073, is Perpendicular. Of the original Norman fabric only a doorway remains. Of the castle, founded about 1105 by Richard de Redvers, the banqueting-hall, a tower, the chapel and a 14th-century gateway remain. Blundell's grammar school, founded in 1604, has modern buildings outside the town in Tudor style.

After the decline of its woollen trade Tiverton became noted for the lace manufacture introduced by John Heathcoat (1783–





BY COURTESY OF (2) ROUFFAER AND JUYNBOLL FROM "DE BATIK-KUNST IN NEDERLANDSCH-INDIE" (N. V. A. OOSTHOEK UITGAVE MIT); PHOTOGRAPH, (1) EWING GALLOWAY

TJAPS AND THE METHOD OF APPLYING THEM IN TJAP PRINTING

Tjap printing differs from wood-block printing in that the colours are not applied directly upon the material. The printing surface of the tjaps is first dipped into hot wax and immediately stamped in the desired position on the fabric. When the material is immersed in the dye, its entire surface becomes coloured except those parts covered by the applied wax design. After dying, the wax is removed. In fig. 1 the native craftsman is engaged in stamping the fabric with a tjap block. Fig. 2 shows several tjaps, each of a different design. (*See* Batik)

1861), inventor of the bobbin net frame.

Tiverton is mentioned under the name of Tuyford in the will of King Alfred. In the Domesday survey it appears as a royal manor containing two mills, but it was bestowed by Henry I. on Richard de Redvers, and in 1245 appears as a mesne borough under Baldwin de Redvers. In 1618 the borough received its first charter of incorporation from James I. Fresh charters of incorporation were granted by James II. in 1689 and by George I. in 1724.

See *Victoria County History: Devonshire;* M. Dunsfold, *Historical Memoirs of the Town and Parish of Tiverton* (Exeter, 1790); W. Harding, *History of Tiverton* (1845–47).

TIVOLI (tĭv′ō-lē), (anc. *Tibur*, *q.v.*), a town and episcopal see, province of Rome, 18 m. E.N.E. of Rome by road and tramway, 24½ m. by rail, 760 ft. above sea-level. Pop. (1921), 4,801 (town), 16,389 (commune). Tivoli lies on the west of the Sabine mts., where the river Anio issues from them, upon a limestone rock above the river. The town on one side overlooks the Campagna di Roma and Rome itself, on the other the deep gorge of the Anio, with its lofty falls, and the environs are very beautiful. The Villa d'Este, begun in 1549 by Pirro Ligorio for Cardinal Ippolito d'Este the younger, has the finest example of a Renaissance garden in Italy; it was erected on a steep slope, with many terraces, and embellished with numerous fountains. The castle was built (1460) by Pius II. on the site of the amphitheatre; it is now a prison. The town contains numerous old churches and houses: the cathedral has a fine 12th century campanile, and contains an old copy of the painting of Christ in the Sancta Sanctorum in Rome, S. Silvestro, 11th century paintings; S. Giovanni Evangelista, paintings by an unknown follower of Melozzo da Forlì, etc. In November 1826 a flood of the Anio led to a change in its course, and threatened to carry away the town. A new channel, consisting of two parallel tunnels 290 and 330 yd. long, was therefore made to the north-east in 1826–35, and on emerging from these the river has a fall of 354 ft. Farther north-west are smaller falls (the *cascatelle*) of that portion of the river which is carried through the town and serves for industrial purposes. Five miles W. are the sulphur baths of Acque Albule, which were known to the ancients, and are still frequented. The temperature of the water is 75·2° F. The falls in the river afford electric power for lighting Rome and driving its trams, as well as for driving several factories, etc., in Tivoli itself.

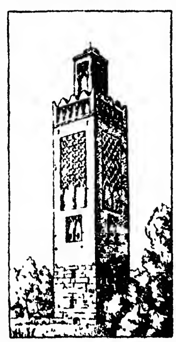
TJAP PRINTING, a kind of block-printing executed by means of dipping blocks into heated wax and then impressing them upon the material—usually a cotton or silk fabric—after which it is dyed and the wax removed, leaving a permanent design. These blocks are made by the natives of Java and the other islands of the East Indies by bending small strips of copper into the desired curves for sections of the pattern and inserting them into the end grain of the blocks of wood allowing them to project a little less than one-eighth of an inch from the surface. The small copper ridges formed in this way are similar to the cloisons which are applied to keep the enamels separated in the decoration of the well-known ware *Cloisonné*. Owing to the fact that it is a very difficult and painstaking task to make these blocks or tjaps the results of this art often bring as high prices as direct hand-work. (*See* BATIK.)

TLAXCALA (tläsh-kah′lah), a State of Mexico, smallest, but most densely populated in the republic, bounded N., E. and S. by Puebla, and W. by the State of Mexico. Area 1,554 square miles. Pop. (1921) 178,570. Tlaxcala lies on the great central plateau of Mexico and has a mean altitude of about 7,000 feet. The State has three railway lines crossing its territory. The capital is Tlaxcala with a population of only 2,069 and no town in the State reaches 10,000. The State nearly coincides with the ancient Indian republic founded in the 13th century by a branch of the Nahuatlan race, who probably migrated from the western shores of Lake Texcoco. Though surrounded on all sides by the great Aztec empire, the tiny republic maintained its independence until the arrival of the Spaniards. The Tlaxcaltecs, or Tlascalans, after a fierce resistance to Cortés in 1519, became efficient allies of the Spaniards and contributed largely to their final success.

TLAXCALA, a town of Mexico, capital of a State of the same name, on the Atoyac river, 7,500 ft. above the sea, 85 m. E. of Mexico City by rail. Pop. (1921), 2,069. Historic interest attaches to the church of San Francisco, the first erected on the American continent, which still contains the vestments, pulpit, font and cedar ceiling brought from Spain in 1521.

TLEMÇEN, a town of Algeria, the capital of an arrondissement in the department of Oran, near the frontier of Morocco, 68 m. by road and 102 by rail S.W. of Oran. It stands 2,500 ft. above the sea, on the north slope of the Lella Setta hills, which rise to a height of 4,000 ft. The railway from Oran runs from Tlemçen to Ujda and is being continued as far as Fez. Another line links Tlemçen to the port of Beni-saf. But, although colonization prospers in the neighbourhood, Tlemçen has lost its former importance; the old capital has become a subprefecture.

The various quarters are grouped around the principal mosque—the Jewish to the south-west, the Moorish to the south-east, that of the merchants to the north-east, while the new town with the civic buildings lies to the north-west. Of the sixty-four mosques which existed at the period of the French conquest, several have disappeared. The great mosque (Jamaa-el-Kebir) has a brick minaret 112 ft. high, adorned with marble columns, and cased with mosaic of the most varied designs; a fountain of alabaster—of the kind known as Algerian onyx—stands in the alabaster-paved inner court; and 72 columns support the arches of the interior. This mosque was built A.D. 1136 to replace a much older building. The *mihrab* is finely ornamented with arabesques. The mosque of Sidi Ahmed bel Hassan, usually called Abul Hassan, built A.D. 1298, now transformed into a museum of antiquities, has two series of arches, which rest on alabaster pillars. The courts are ornamented by sculptures of great beauty and richness; the delicately-carved cedar ceiling bears traces of polychromatic painting. The mosque of El-Halawi (the Sweetmeat Maker), dating from 1353, has eight magnificent columns of Algerian onyx. The ceiling of cedar is richly carved, and there is a fine colonnade on each side of the court. The minaret is decorated with mosaics. The military authorities occupy the Meshuar or citadel, built in 1145, which separates the Jewish and Moorish quarters and was formerly the palace of the rulers of Tlemçen. Only the minaret of the mosque, dating from the 14th century, and the battlemented wall, flanked by two towers, remain of its former magnificence. The vast basin (*sahrij*) under the old walls, now dry (720 ft. in length, 490 in width and 10 in depth), was apparently made for naval exhibitions. A covered market occupied the site of the *Kissaria*, the place of residence of European merchants from Pisa, Genoa, Catalonia and Provence. Besides the large trade carried on there are native manufactories of cloth, carpets and leathern articles. A special manufacture is that of red shawls, used by Jewish women when in mourning.



FROM BENOIT, "ARCHITECTURE ORIENT"

13TH CENTURY MINARET OF THE MOSQUE OF AGADIR NEAR TLEMÇEN

In the immediate neighbourhood of the modern Tlemçen are numerous remains of the fortifications of Agadir (*vide infra*), and the minaret of the mosque, a beautiful tower dating from the 13th century, the lower part of which is built of large hewn stones from the Roman Pomaria. More noteworthy, however, are the ruins of Sidi Bu Medin and of Mansura. Sidi Bu Medin (more properly El Eubbad) is a little over a mile south-east of Tlemçen. It was founded A.D. 1337 by Ali V., the first of the Beni-Marīn (Marinide) sultans who ruled Tlemçen. The *kubba* or tomb of Sidi Bu Medin, near the palace, is held in great veneration by the Arabs. The saint himself was born at Seville A.D. 1126, and died near Tlemçen in his 75th year. The adjacent mosque is a beautiful specimen of Moorish art.

Mansura, which is about 1½ m. west of Tlemçen, owes its foundation to the attempts of the Beni-Marīn rulers of Morocco

to extend their sovereignty The Amir Abu Yakub Yusef besieged Tlemçen in the early years of the 14th century. The siege lasted eight years, and Yusef turned his camp into a walled city. The siege being raised, El Mansura (the victorious), as the new city was called, was abandoned. It was reoccupied when (1335) Ali V. renewed the siege, which this time proved successful. On the expulsion of the Marinides in 1359 Mansura was finally deserted Besides the walls and towers, and the minaret of the mosque, little remains of Mansura, of which Ibn Khaldûn has left a contemporary and graphic sketch. The minaret, notwithstanding that one side and parts of two other sides have perished, is ohe of the finest mosque towers in existence. It is 125 ft high, and is built of hewn stone

See W and G Marçais, *Les monuments Arabes de Tlemçen*, Paris, 1903; A Bel, *Tlemçen et ses environs* (with bibliography), Oron, 1908 (X., A Be)

HISTORY

The Sultanate of Tlemçen.—In 1248 Tlemçen was captured by Abu Yahia Yarmorasen (Ghamarasan) who was chief of the Zenata tribe of Berbers and claimed descent from the Caliph Ali. Yarmorasen, who died in 1282, founded the dynasty of the Abd-el-Wahid, who ruled the greater part of what now constitutes Algeria Under their sway Tlemçen flourished exceedingly The presence of Jews and Christians was encouraged and the Christians possessed a church The bazaar of the Franks (*kissaria*) was a large walled enclosure, the gates of which were closed at sunset. As many as 5.000 Christians lived peaceably in Tlemçen, and the sultan included in his army a Christian bodyguard. In 1337 the power of the Abd-el-Wahid was temporarily extinguished by the Marinide sultans of Morocco They left fine monuments of the period of their ascendancy, which lasted 22 years Once more, under the Abd-el-Wahid, now known as the Beni-Zeiyan, from 1359 to 1553, Tlemçen enjoyed prosperity. It had a population reputed to number 125,000, an extensive trade, a brilliant court and a powerful army The Spanish occupation of Oran (1509) struck a fatal blow at the European commerce of the town. The Beni-Zeiyan, after the capture of Algiers in 1516 by the corsair Barbarossa (*q v*) gradually lost their territory to the Turks, while Tlemçen itself for 40 years became tributary to the Spanish governor of Oran In 1518 the town was held for a short time by Arouj Barbarossa, but Arouj was killed in a fight with the Spaniards

In 1553 the Turks under Salah Rais, pasha of Algiers, captured Tlemçen and the Sultanate of Tagrart, as it was still frequently called, came to an end Under the Turks the town ceased to be of any importance When the French entered Algeria the sultans of Morocco were disputing the possession of Tlemçen with the Kuluglis, who fought first for themselves and afterwards for France. In 1835 Abd-el-Kader, on whose appearance the Moors retired, sought to re-establish the ancient empire of Tlemçen, but he retreated before Gen Clausel in 1836 The Treaty of the Tafna (1837) gave Tlemçen to Abd-el-Kader, but, war being renewed in 1842, Tlemçen was definitely occupied by the French

See W and G Marçais, *Les Monuments arabes de Tlemçen* (1903) This accurate and finely-illustrated work, one of the publications of the *Service des monuments historiques de l'Algérie*, cites the principal works dealing with Tlemçen, and gives a critical estimate of their value *See* also A Bel and P. Ricard, *Le travail de la laine à Tlemçen* (Algiers, 1913). (F. R. C.)

TLINGIT, one of the tribes, or rather assemblages of tribes, of the North Pacific Coast Indians, inhabiting the coastal strip of south-eastern Alaska as far north-west as Controller bay. Their culture is that of the area, with dependence on fishing, canoe navigation, woodworking, totemic art, potlatch wealth distribution and slavery They are divided into Raven and Eagle (or Wolf) moieties, and subdivided into matrilineal clans. The language is superficially distinct, but may prove ultimately to relate with Haida and Athabascan (Na-Dene family) Population, at discovery, estimated 10,000; 1861, 8,600, 1910, 4,400. (A L. K)

T. N. T.: *see* EXPLOSIVES; NITROGLYCERINE; BLASTING; CHEMICAL WARFARE; MEDICINE, ARTICLES ON

TOAD, a name commonly applied, in contradistinction to "frog," to tailless amphibians of stout build, with warty skin. The true toads are the *Bufonidae*, with dilated processes to the sacral vertebra and without any teeth in the jaws. The genus *Bufo* comprises about 100 species; smaller genera are *Eupemphix, Pseudophryne, Nectophryne, Nectes, Notaden, Myobatrachus, Rhinophrynus* and *Cophophryne*. *Bufo jerboa*, in its slender form and long limbs surpasses the typical frogs, whilst on the other hand some true frogs (*Rana*), adapted to burrowing habits, are superficially quite toad-like. The *Bufonidae* include terrestrial, burrowing, aquatic and arboreal types; *Rhinophrynus*, of Mexico, is an ant-eater

The genus *Bufo* is represented in every part of the world except the Australian region and Madagascar Two species are found in the British Isles the common toad, *B vulgaris*, and the more local natterjack, *B calamita*, which has a pale yellow line down its back, and legs so short that it cannot hop, but runs The common American species is *B lentiginosus*, very similar to *B vulgaris* Toads lay their eggs in long strings, forming double files in straight, jelly-like tubes. They feed on worms and insects A small toad, *Pseudophryne vivipara*, discovered in German East Africa, is viviparous (*See* AMPHIBIA)

BY COURTESY OF IOWA GEOLOGICAL SURVEY
TOADFLAX OR BUTTER AND EGGS

TOADFLAX (*Linaria*), a genus of small plants of the family Scrophulariaceae (*q v*), allied to the snapdragon (*q v*), but distinguished by the possession of a long spur at the base of the corolla. The common toadflax (*L vulgaris*), called also butter-and-eggs, has yellow flowers and is widespread as a wayside weed The ivy-leaved toadflax (*L Cymbalaria*) grows on walls.

TOALA, a tribe of the south-west of the Celebes, probably of mixed pre-Dravidian stock *See* Sarasin, *Versuch einer Anthropologie der Insel Celebes* (1905).

BY COURTESY OF THE MUSEUM OF THE UNIVERSITY OF PENN
TLINGIT INDIAN CHIEF IN CEREMONIAL COSTUME

TOBACCO, the name given to the leaves of several species of *Nicotiana* prepared in various ways mainly for smoking or chewing purposes, and in the powdered form, for inhalation as snuff The use of tobacco is more widely spread than is that of any other narcotic or stimulant

Historical.—The tobacco plant was brought to Europe in 1558 by Francisco Fernandes, who had been sent by Philip II of Spain to investigate the products of Mexico Jean Nicot, the French ambassador to Portugal, sent seeds of the plant to the queen, Catherine de' Medici The services rendered by Nicot in spreading a knowledge of the herb have been commemorated in the scientific name of the genus *Nicotiana* At first almost miraculous healing powers were attributed to the plant, and it was designated "*herba panacea*," "*herba santa*," "*sana sancta Indorum* " "Divine tobacco" it is called by Spenser, and "our holy herb nicotian" by William Lilly.

While the plant came to Europe through Spain, its use for smoking purposes spread to the Continent from England. Ralph Lane, the first governor of Virginia, and Sir Francis Drake, brought to the notice of Sir Walter Raleigh the habit of smoking tobacco Lane is credited with having been the first English smoker, and through the influence and example of the illustrious Raleigh "who tooke a pipe of tobacco a little before he went to

the scaffolde" the habit became rooted among Elizabethan courtiers. During the 17th century the indulgence in tobacco spread with marvellous rapidity through all nations.

Botany.—Few of the numerous species of *Nicotiana* possess any economic importance. The great bulk of the world's tobacco supply is derived from *N. tabacum*, the Virginian tobacco, a plant indigenous to America It is a coarse rank-growing annual, with a simple, unbranched, cylindrical stem, which often exceeds 6 ft. in height. The stem terminates in a panicle of pink or rose-coloured flowers, possessing an elongated corolla tube (fig 1). The plant has alternate, simple, oblong-lanceolate leaves, those at the lower part of the stem being slightly stalked, and of large size, reaching to 2 ft in length, while the upper leaves are semi-amplexicaul and of variable outline. The seeds are brown in colour, with a rough surface, and are so small and numerous that 1,000,000 may be produced by a single plant The stem and leaves of the plant are covered with long soft hairs which exude a viscid juice, giving the surface a moist glutinous feeling

BY COURTESY OF THE IMPERIAL TOBACCO CO
FIG 1—TOBACCO PLANT IN BLOOM

From this species, *N tabacum*, the tobaccos of Cuba, the United States, the Philippines, Canada, Nyasaland, Rhodesia and the Latakia of Turkey are derived, and it is also largely grown in India. the variety *macrophylla* is the source of Maryland tobaccos *N Persica*, regarded as another American variety of this genus, yields the famous Shiraz tobacco of Persia *N rustica* is a smaller branching plant with greenish-yellow flowers, and although a native of Mexico it is much cultivated in the East Indies.

Cultivation.—Tobacco is cultivated in localities scattered over almost the whole world, ranging from as far north as Quebec, Stockholm and the southern shores of Lake Baikal in one hemisphere, to as far south as Chile, South Africa and Victoria in the other While the plant can adapt itself to very varying conditions of climate and soil, the quality and flavour may be seriously deteriorated by unfavourable conditions Very slight differences in climate appear to cause great variation in quality

Given suitable climatic conditions, the type of tobacco produced is determined mainly by the character of the soil, which should be well drained, and contain a large percentage of humus Clay soils, retentive of moisture, as a rule yield heavy-cropping tobaccos which cure to a dark brown or red colour, while sandy soils produce tobaccos with a thin leaf, curing to a yellow or bright reddish colour Cultural details necessarily differ according to the locality, and the type of labour employed, but those prevailing in the United States, the chief source of tobacco may be taken as fairly representative, and are hereafter described

The seed is sown in nursery beds and the plants set out in the field later Great care is taken in the preparation of the seed-bed, which should lie in a sunny situation, protected from winds, and be composed of good, rich soil in fine tilth When necessary hot-beds are used Insect pests are destroyed by burning fires, raised by intervening logs above the surface of the ground, or by steaming the bed Fertilizers, usually guano or chemical manures, are incorporated with the surface soil, which is pulverized to 3 in in depth The seed, owing to its minute size, is usually mixed before sowing with a relatively large quantity of fine ashes, sand or meal, to ensure even distribution. Deep burying of the seed must be avoided, and the young and delicate seedlings carefully watered and if necessary shaded, during the early stages of growth. With seed of good quality a half-ounce of seed is sufficient for a bed of about 60 sq yd., and will yield about 40,000 plants for transplanting

The well hardened seedlings are transplanted into rows from 3 to 4 ft apart, with a distance of from 1½ ft. to 3 ft. between the plants, cigar types being the closer-spaced varieties When the flowering buds appear, these are removed by "topping," and also the suckers which are subsequently produced A limited number of leaves only is allowed to develop, ranging from 8 to 12 in the heavy types and from 15 to 20 or more in cigar wrapper and binder varieties, Burley and Maryland Cultivation under artificial shade has been found beneficial in some districts and this method is used with great success in the Connecticut valley and Florida for cigar wrapper leaf

Ripening is indicated by a change in colour of the leaf from a dark to a lighter shade of green, and by the appearance sometimes also of yellow spots A ripe leaf easily cracks or shows a crease when folded between the fingers The leaves on a plant decrease in age from below upwards, hence all are not ripe at one time. In high quality tobacco the leaves are "primed," or picked singly, as they ripen. The usual course is to cut the whole plants off close to the ground when the middle leaves are about ripe, and allow them to wilt before removal to the drying sheds. Here the plants are supported on laths and the primed leaves on strings or wires until ready for curing

Improvement by Selection.—Plants of the same variety grown under similar conditions reveal differences in such important characters as the number, size and shape of the leaves, tendency to form suckers, time of maturing, and resistance to disease. Variation in burning properties, elasticity of leaf, texture, taste, etc, are also observed The differences are attributed to two factors: (1) variation in type due to crossing, change of soil and climate; (2) variations in type due to inherent tendency, local conditions and maturity of seed

Careful selection is necessary in the choice of plants grown from imported seeds for seed purposes, and only small crops should be grown until the required type has been perpetuated. The tobacco flower is fortunately self-fertile, and hybridization can be avoided by enclosing the selected flowers in paper bags. The pollen also will retain its vitality for several weeks, if kept perfectly dry, and thus can be sent long distances without injury

Further treatment of the tobacco is usually conducted in three stages, known as "curing," "fermentation" and "ageing": on the success of these operations depend the production and fixing of the right colour, and the development of an agreeable aroma in the leaf

Curing.—Sun-curing is employed largely in Eastern countries, but is no longer practised in the so-called sun-cured district of Virginia.

Air-curing is performed in barns provided with a free circulation of air Cigar leaf and White Burley are usually cured thus, the process lasting about six weeks. In both sun- and air-curing the occurrence of damp weather may necessitate the use of fires

In fire-curing, when the tobacco has acquired a rich yellow colour, slow fires are lighted on the floor of the barn to raise the temperature slowly to 150° F and there maintain it for four or five days: re-firing is required at intervals as the leaves again become soft

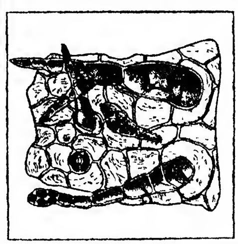


FIG 2—MICROSCOPIC STRUCTURE OF TOBACCO LEAF

The bright yellow leaf used for cut tobacco is cured by flue-heat in order quickly to secure and fix the required shade of colour The heat is steadily raised from 90° F to 160° and even to 180° in the final stages The whole operation lasts from three to five days In the modified process known as the "Kentucky cure," a temperature of not more than 100° F is used, and the process requires from four to six weeks Exposure to a moist atmosphere is in either case necessary to render the leaf sufficiently pliable for stripping and sorting. The tobacco is then made up into bunches or "hands" of from six to twelve leaves by twisting another leaf round the lower end.

Fermentation.—Under favourable conditions, the enzymes naturally occurring in tobacco leaf act on the organic matters present, and the considerable alteration in their chemical constitution, thus caused, exercises a mellowing effect on the tobacco

Changes occur in the nicotine and other nitrogenous constituents, and the starch and sugar bodies disappear, while the colour and aroma of the leaf also benefit by the operation when successfully conducted. Fermentation readily occurs when the tobacco is stacked into heaps, but precautions require to be taken to prevent the temperature rising beyond about 130° F, and the heaps are therefore frequently re-made and re-arranged during the operation which lasts about a month. Flue-cured tobacco is not fermented.

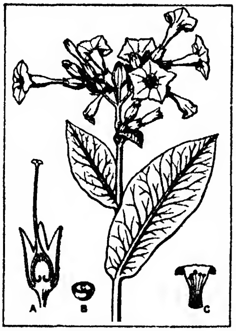


FIG. 3.—TOBACCO PLANT (NICOTIANA TABACUM), FLOWERING BRANCH
A. Longitudinal section through fruit, B. Branch cut across, C. Corolla

After grading, the tobacco is pressed tightly into bales or hogsheads, and stored in warehouses, kept at a moderate and fairly uniform temperature, where it may remain often for several years to mature and complete the "ageing" process, before being manufactured. Further fermentation often spontaneously occurs during this stage. In addition to bales and hogsheads packers make extensive use of boxes or cases, especially for cigar leaf.

Manufacture.—Tobacco is manufactured in various forms for smoking and chewing purposes, including cut smoking mixtures, cake or plug, and roll or spun tobacco. In the preparation of various smoking mixtures, the choice of leaf sufficiently mellowed by age, and the selection of suitable brands of leaf to secure the best results are all important considerations. The tobacco needs damping to render it workable, and this operation is usually conducted on the large scale by passing the leaf through rotating cylinders into which steam is injected.

In Great Britain the legal provisions exist that finished tobacco must contain not more than 32% of moisture, and that no other substance shall be found therein except essential oils for flavouring, and olive oil to the extent of 4%, which may be used only in spinning and making up roll tobacco.

The thick portion of the stalk is as a rule removed before the leaf is cut, except in the case of "bird's eye," to which the sections of cut stalk give its characteristic appearance. The stripped leaves are then pressed into cakes, more or less lightly when intended for shag and similar types, and by means of hydraulic presses when flakes are required. The tobacco is then cut into shreds by machine knives operating with a rapid vertical movement, the speed determining the thickness of the flakes produced. Shags and similar tobaccos are "panned" or roasted, partly to reduce the moisture, and partly to bring out their flavour.

Roll tobacco consists of a filler of broken tobacco which is twisted into a rope and enclosed in a leaf wrapper by means of a spinning wheel. The "brown twist" so produced may be used for chewing purposes, but is usually converted into black or "Irish" roll by coiling the twist into rolls of cylindrical shape, which, after being enclosed in canvas and tightly bound round with rope, are stoved in steam-heated hydraulic presses, and when sufficiently darkened in colour, removed to cold presses to mature.

In cake tobacco the leaves are moulded into shape by pressure, steam presses being used when dark coloured varieties are required. Sweetening materials such as glycerin, licorice and sugar are often added to this class of tobacco, although in Great Britain this practice is restricted to bonded factories.

Snuff.—For light coloured varieties stalks are employed. The distinctive aroma is developed by long periods of fermentation, sometimes after, as well as before, milling. Various salts and essential oils are employed for flavouring purposes, but in Great Britain there are certain legal restrictions regarding their use.

Chemistry of Tobacco.—The nature and proportion of the chemical constituents of tobacco are greatly modified by the compulsory diversion of the life processes of the plant to the sole object of producing leaves suitable for smoking purposes, and also by the changes caused by the curing and fermentation. In addition to containing the volatile alkaloid, nicotine, the characteristic constituent of tobacco, sugar and starch are present in considerable quantities in the bright varieties of leaf, and also salts of such organic acids as acetic, citric, malic and oxalic. In consequence a much higher proportion (about 50%) of the constituents of the leaf is soluble in water than is the case with other plants. The insoluble constituents are made up chiefly of cellulose and pectic acid, which in combination with lime, impart rigidity to the vegetable structure, and of albuminous matter and tannin derivatives.

Leaf tobacco is not usually dried below a moisture content of from 12 to 16%, as too dry a condition causes friability. The amount of nicotine ranges from 2% in bright leaf to 5% or more in dark varieties. The proportion of ash obtained from dry tobacco varies from about 10% in light leaf to 25% in cigar and other dark varieties.

Production.—Production in the various countries is described below in separate paragraphs.

United States.—Tobacco was first cultivated on a commercial scale in Virginia early in the 17th century. It is now grown commercially in eighteen States, the estimated produce for the year 1926 amounting to 1,323,388,000 lb and valued at $248,752,000. The produce of the chief tobacco-producing States expressed in millions of pounds, was as follows, viz., North Carolina (393), Kentucky (374¼), Virginia (132¼), Tennessee (107), South Carolina (57½), Pennsylvania (43½), Georgia (40), Ohio (38), Wisconsin (33¼), Connecticut (29¼), and Maryland (29).

Brazil.—The climate and soil are very suitable for cigar leaf and production is steadily increasing. The crop in 1925 amounted to 139,000,000 lb.

Japan.—The Government monopoly controls the growth of tobacco, and the produce is mostly retained for home use. The crop in 1925 exceeded 132,000,000 pounds.

China.—Production of light cigarette types of leaf of American origin is steadily increasing. Very large quantities of lower grade leaf are also grown, and China is one of the world's foremost tobacco producers.

Dutch Indies.—Sumatran tobacco is especially valued for cigar wrappers. High equable temperatures and a heavy rainfall characterize the eastern coastal growing regions, and very careful attention is paid to the cultivation. The production in 1925 reached nearly 207,000,000 pounds.

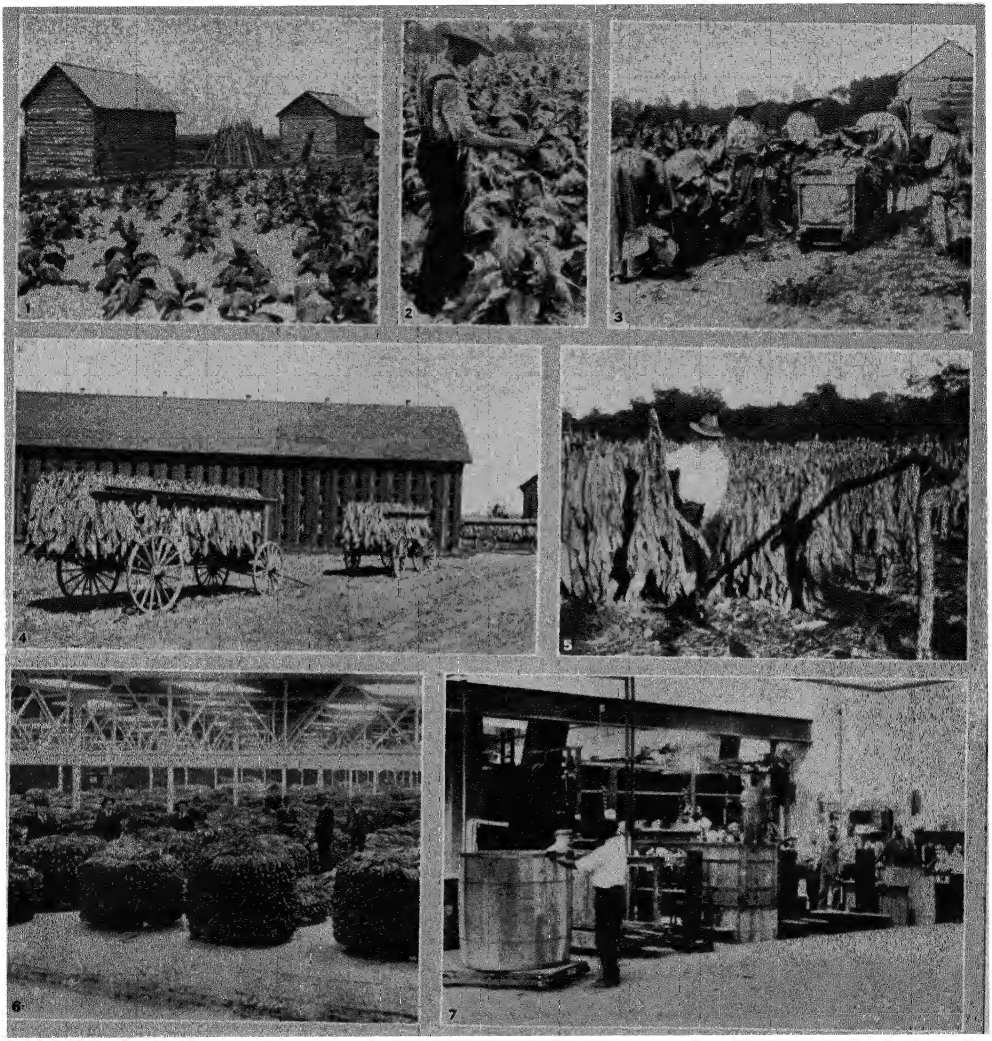
Other important tobacco-growing countries outside Europe are as follows. Dominican Republic (45), Mexico (18¾), Persia (23) and Algiers (65)—the figures in brackets indicate the crop in millions of pounds for the year 1925. In the Philippines, where leaf of the cigar type is grown, the production in 1924 was 101,000,000 lb. From Syria comes the characteristic smoke-cured Latakia variety of tobacco.

Europe.—Except in countries bordering on the Levant, where the Turkish type is grown, dark and heavy tobaccos are usually produced. The approximate production, expressed in millions of pounds, for the more important countries was as follows for the year 1925, viz.: Belgium (17), Hungary (38), Germany (42), France (69), Bulgaria (90), Italy (92), Turkey (104), Greece (129) and Russia (204).

British Empire.—A lower rate of duty is charged on tobacco grown in the empire, the amount of this deduction being increased from one-sixth to one-fourth in 1925. Production has been greatly stimulated thereby, the quantities imported into Great Britain at the imperial preference rate of duty having risen from 19,000,000 lb. in 1925 to close upon 41,000,000 lb. in 1927. The chief contributors to this total were as follows: Northern Rhodesia 1,697,214 lb., Southern Rhodesia 9,250,644 lb., Nyasaland, 14,033,665 lb., British India 8,555,111 lb., British North Borneo 1,348,501 lb., Canada 5,619,923 lb.

The increase in empire imports to Great Britain has been accompanied by a decline in imports of foreign origin. Empire imports, which represented only 1% of the total tobacco imports in 1919, amounted to 14·7% of the total in 1927.

Imperial preference at the outset found the British empire



PHOTOGRAPHS, EWING GALLOWAY

GROWING AND MARKETING OF TOBACCO

1. A North Carolina tobacco patch with curing barns and stack of wood (for firing tobacco after it has been cut and hung in the barns) in the background
2. Topping field of tobacco in Virginia. At this stage of growth top of plant is removed, causing it to spread out and grow larger leaves
3. Tobacco farmers in Virginia stripping the leaves from the stalks. These tobacco leaves are placed in the cart and hauled to the barn in the background of the picture
4. Wagon loads of tobacco destined for the curing barn in the background. Six weeks are necessary to cure this tobacco
5. First step in curing of tobacco crop in Nicaragua. Tobacco is hung on scaffolds in the field until it has wilted and turned yellow. It is then transferred to the barns
6. Typical auction floor with tobacco for sale stacked in little piles awaiting inspection of the buyers
7. Packing tobacco in large hogsheads at a warehouse in Virginia

unable to fill the demands of the British market for bright varieties of tobaccos of Virginia type and flavour. Empire production in the year 1920 exceeded 1,071,000,000 lb. and although thus equal to two-thirds of the output of the United States in quantity was not its equivalent in quality. Fully 90% of the Empire produce was grown in India by the aid of native labour, and was of a character suitable only for local consumption. In British Central Africa the possibility of producing acceptable types of tobacco was beginning to be realized. The more liberal tariff concessions granted under the imperial preference scheme in 1925 greatly increased the output of bright American types of leaf in Nyasaland, and brought large areas under cultivation for producing similar kinds of tobacco in Northern and Southern Rhodesia and also in Canada. For the most part the produce of these new sources of supply is either of the bright flue-cured variety suitable for cigarettes, or the darker fire-cured variety for use in smoking mixtures.

It is estimated that the empire production of tobacco in 1927 exceeded 1,100,000,000 lb, the output for the years 1925, 1926 and 1927 was in Canada 20,000,000 lb, 28,824,000 lb. and 43,-916,700 lb, respectively, and in Southern Rhodesia 1,987,382 lb, 5,313,000 lb and 17,000,000 lb respectively.

British consumption of empire-grown tobacco, especially so far as Rhodesian leaf is concerned, has not kept pace with the increased production While Rhodesian tobacco is eminently suitable for employment in cigarettes, it possesses an aroma of a distinctive character which differentiates it from American-grown tobacco The cigarette industry probably absorbs about 70% of the tobacco manufactured in Great Britain In the case of pipe tobaccos it is estimated that about 45% of empire tobacco is used, and 50% in British manufactured cigars.

The production of tobacco in Great Britain, which began early in the 16th century, soon encountered strong State opposition, as it was thought to interfere with the developing export trade from the New England States The growth of tobacco in England was legally forbidden in 1660, but only finally suppressed in 1782 by armed intervention and the imposition of severe penalties.

While the legal restrictions, which extended also to Scotland and Ireland were finally removed in 1910, adverse climatic conditions and other causes have militated against successful production on any considerable scale

World Statistics.—The following details extracted from the International Year Book of Agricultural Statistics (Rome 1927) show the world production of tobacco for the year 1925/6 expressed in thousand pounds Europe (excluding Soviet Russia) 556,600; Asia (excluding Soviet Russia) 287,540; Soviet Russia 389,180; Africa 115,280; North America 1,475,540, South America 193,380; Dutch Indies (culture of Europeans only) 216,000; Oceania 1,540—total 3,235,060 Countries not included would probably raise this figure to nearly 4,000,000,000 lb.

Taxation Methods.—Tobacco provides an important source of state revenue. A government monopoly exists in several European countries, including Austria, France, Hungary, Italy, Portugal, Rumania, Russia, Spain, Sweden, Czechoslovakia, Yugoslavia, and Japan. Taxation is applied to tobacco on importation in the form of a customs duty, usually levied at a lower rate on leaf than on manufactured descriptions, also by means of *ad valorem* duties levied on the retail prices charged. The latter method is usually adopted for raising internal revenue from the home manufactured article. In addition, licence duties for the manufacture and retail of tobacco are usually charged. The tobacco tariffs of the United States, Germany, Belgium and Holland are based on this plan, the lowest duties being placed upon imported leaf, and the luxury descriptions most heavily taxed.

In Great Britain tobacco pays duty in the manufactured state, only when imported or delivered from bonded factories for home consumption. The greater part of the tobacco for home consumption is received from abroad in the form of leaf, and on importation pays a customs duty at the rate of 8s. 10d. per lb., when the moisture present is not below 10%; in order to encourage growth in the empire a rebate of one-fourth of the duty is allowed on such produce. The revenue receipts from tobacco for Great Britain and Northern Ireland amounted to £53,857,530 for the fiscal year ended March 31, 1927.

Consumption of Tobacco.—The comparative consumption of tobacco in various countries is best appreciated by expressing it in pounds per head of the population. The following figures, which except in the case of the United States are approximate estimates, and not officially issued, give details for a few representative countries: viz, Great Britain and North Ireland 2·95 lb., United States 5 92 lb, Belgium 4 9 lb, France 2 9 lb., Italy 2·35 lb., and Egypt 4·76 lb. (*See* also CIGAR; CIGARETTE.)

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TOBACCO PIPE. The smoking of tobacco in pipes is a custom which has prevailed in America for a period of unknown duration. The most ancient pipes of which remains exist have been found in mounds or tumuli called pipe mounds, principally in Ohio, Indiana, Illinois and Iowa. These mound pipes, which are carved in porphyry and other hard stones, are very uniform in type, consisting of a slightly convex platform or base, generally from 3 to 4in in length, and about an inch broad, with the bowl on the centre A fine hole is pierced from one end of the platform to the bottom of the bowl, the opposite end being obviously for holding in the hand while the pipe is being smoked. In the commonest forms the bowl consists of a simple cylinder or urn, but in many cases remarkable artistic skill has been displayed in carving the bowls into miniature figures of birds, mammals, reptiles and human heads, often grotesque and fantastic, but always very vigorously expressed These mound or platform pipes with carved human and animal forms are objects of the highest ethnographic interest and importance, being among the most characteristic remains of the ancient inhabitants of the Mississippi valley The wide area over which these, as well as remains of baked clay pipes, are found throughout the American continent testifies to the universal prevalence of smoking in the pre-Columbian era. Many of the ancient clay pipes found in Mexico, etc, are elaborately moulded and ornamented, while others show considerable similarity to the early clay pipes of Europe. Among the North-American Indian tribes the tobacco pipe occupies a position of peculiar symbolic significance in connection with the superstitious rites and usages of the race. The calumet, peace pipe or medicine pipe, is an object of the most profound veneration, entrusted to the care of a highly honoured official, and produced and smoked with much ceremony only on occasions of great importance and solemnity. It is remarkable that, whilst the most ancient American pipes had no separate stem, it is the stem only of the medicine pipe which is the object of veneration among the Indians, the bowl used being a matter of indifference. The favourite material for Indian pipe bowls is the famous red pipe stone (catlinite), a fine-grained, easily-worked stone of a rich red colour from the Côteau des Prairies, west of the Big Stone lake in S. Dakota.

Throughout Great Britain and Ireland small clay pipes are frequently dug up, in some instances associated with Roman relics These are known amongst the people as elfin, fairy or Celtic pipes, and in some districts supernatural agencies have been called in to account for their existence. The elfin pipes have commonly flat broad heels in place of the sharp spur now found on clay pipes, and on that flat space the mark or initials of the maker is occasionally found. There is no reason to believe that these pipes are older than the 17th century. The introduction of the tobacco pipe into Europe is generally ascribed to Ralph Lane, first governor of Virginia, who in 1586 brought an Indian pipe to Sir Walter Raleigh, and taught that courtier how to use it. The pipe-makers of London became an incorporated body in 1619.

By degrees pipes of special form and material have come to be definitely associated with particular peoples, *e.g*, the elongated

painted porcelain bowls and pendulous stem of the German peasantry, the red clay bowl and long cherry wood stem of the Turk, and the very small metallic bowl and cane stem of the Japanese, etc. Among other kinds of pipe which have been popular at various times are the "corn-cob," where the bowl is made of the cob of maize or Indian corn, and the "calabash" with the bowl of a small gourd. The "churchwarden" is a clay pipe with a slender stem, some 16 or 20in long. The most luxurious and elaborate form of pipe is the Persian *kalyún,* hookah or water tobacco pipe. This consists of three pieces, the head or bowl, the water bottle or base, and the snake or long flexible tube ending in the mouthpiece The tobacco, which must be previously prepared by steeping in water, is placed in the head and lighted with live charcoal, a wooden stem passes from its bottom down into the water which fills the base, and the tube is fitted to a stem which ends in the bottle above the water Thus the smoke is cooled and washed before it reaches the smoker by passing through the water in the bottle, and by being drawn through the coil of tube frequently some yards in length The bottles are in many cases made of carved and otherwise ornamented coco-nut shells, whence the apparatus is called *nārgīla,* from *nārgīl,* a coco-nut

TOBAGO, an island in the British West Indies, 20 m. N E. of Trinidad, in 11° 15′ N and 60° 40′ W Pop (1921) 23,390 It is 26 m long and 7½ m broad Area 114 sq m or 73,313 acres, of which about 10,000 are under cultivation It consists of a single mountain mass (volcanic in origin), 18 m long, rising in the centre to a height of 1,800 ft A great part of the island is clothed with dense forest The higher lands are set apart as "Rain Preserve," where trees are not allowed to be felled The average temperature is 81° F and the yearly rainfall is 66 in The rainy season lasts from June to December, with a short interval in September The valleys are adapted to horse- and sheep-breeding The soil is fertile and produces rubber, cotton, sugar, coffee, cocoa, tobacco and nutmegs, all exported; *pimento* (allspice) grows wild The island is divided into seven parishes. Scarborough, the capital, on the S coast 8 m from its SW point, stands at the foot of a hill 425 ft high, on which was situated Fort King George There is a lighthouse at Baedlet Point Tobago, properly Tobaco, was discovered in 1498 by Columbus, who named it Assumption, and the British flag was first planted in 1580 It afterwards passed into the hands of the Dutch and then of the French, and was finally ceded to the British in 1814 It formed part of the colony of the Windward Islands until 1889 when it was joined to Trinidad, its legal and fiscal arrangements, however, being kept distinct Ten years later it was made one of the wards of Trinidad, under a warden and magistrate; its revenue, expenditure and debt were merged into those of the united colony, and Trinidad laws, with some few exceptions, were made binding in Tobago

See Aspinall, *Handbook of the West Indies; Colonial Office List.*

TOBIT, BOOK OF. This book of the Apocrypha is a religious novel which was for many centuries exceedingly popular both in Christian and Jewish circles in many lands. This is shown by the multiplicity of versions and editions which have survived Moreover, it was not without influence upon some of the writers whose work is contained in the Old Testament (*e.g.,* Daniel and some of the Psalms), Jewish pseudepigraphists (*e g,* the authors of the Book of Jubilees, the Testament of Job), some New Testament writers (*e g,* the Synoptists, especially in the description of the Resurrection and Ascension, St Paul, the author [s] of the Pastoral Epistles) and numerous post-apostolic Christian writers, many of whom, as did in particular Clement of Alexandria, regarded it as "Scripture." But in one respect it has achieved a distinction shared by no other Book of the Apocrypha, and by at most only one book (Jonah) of the Old Testament: it has made a remarkable appeal to the exponents of Christian Art, and its hero and his dog and certain dramatic incidents in his history became, in the Middle Ages, a favourite theme of the workers in ecclesiastic glass and mural decorations.

Date of the Work.—Hitzig's relegation of the date of writing to a time subsequent to the catastrophe of A D 70, Graetz's conviction that it belongs to the reign of Hadrian, Rosenthal's that it is a product of the School of Rabbi Akiba, and even W. R. Smith's attempt to connect it with the Maccabean revolt, are no longer favoured. Equally impossible is a date as early as 350 B.C., which was once favoured by writers influenced by Ewald. A date about 250 B C. seems to present least difficulties.

The author wrote to inculcate respect for the dead, consanguineous marriages, and practical virtues such as almsgiving. He found the ultimate sanction for these ideals in the Old Testament, but when he set out to inculcate them in his tale he drew on earlier, and even contemporary pagan models. The Egyptian *Tractate of Khons* supplied him with the idea of a maiden possessed by a demon whom the god expelled It is also clear that the widely diffused "Fable of the Grateful Dead"—a dead man rewarding the burier of his corpse—was much in his mind when he set out to write his book, but in this case it may have been less a matter of consulting a literary model than of reproducing the general ideas of a class of fables known to him from boyhood. Similarly there is no reason to posit any literary source, as J. H Moulton formerly did, to account for the alleged *Median* and more specifically Magian elements in the book—*e.g.,* the dog, the demon Asmodeus (Aēšma daēva), the *seven* angels, the saving heavenly visitor (Raphael). These are mostly not characteristics of the *later* Zoroastrian system, but belong equally to its earliest phases, and in great part even to pre-Zoroastrian Magianism, which, by 250 B C., would be known wherever Persian traders and soldiers were to be found

If, as is suggested, the author was an Egyptian Jew of 250 B C., he may have written in Aramaic or in Greek. Numerous attempts, based on the theory of mistranslations in the extant Greek texts from an Aramaic original have been put forward, but on the whole the hypothesis that he was a Jew who "thought in" Hebrew or Aramaic, while writing in the Greek of his period, suffices to explain the "Semitisms" which are observable in his Book Apart from the poem in ch. 13 there seems to be no reason for not regarding the book as a literary unity.

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TOBOGGANING, the sport of sliding down snow-covered hills and artificial ice-shutes on the toboggan, a sled from 3ft to 8ft. long and 2ft. to 3ft. wide, formed of strips of wood from ¼in to ½in in width, fitted together and curved up at the front (Micmac Indian, *tobaakan,* sledge) The toboggan is not so well fitted for use on roads that are not steep or very smooth as is the sled provided with runners, but is generally used on open hills, or upon artificial courses (chutes), which are very popular in Canada. In Switzerland tobogganing on this type of sled is called lugeing, and the sleds are known as luges; it is a popular sport with visitors to the Engadine, where both the sitting and *ventre-à-terre* position are practised The run from the top of the Schatzalp at Davos is one of the best luge-runs in Switzerland.

On the big runs, of which the Cresta is the most famous, the steel skeleton type of toboggan is invariably used, and the runner is equipped with knee and arm pads and a felt-lined steel crash helmet to protect him in the event of accidents; specially constructed boots with steel spikes render steering and braking with the feet easy The Cresta is built with several turns banked up with solid ice (*See* also COASTING.)

The United States.—With slight variations, toboggans are constructed, in the United States, in the same manner and of the same materials as in other parts of the world. Toboggans are best fitted for the soft fluffy snow of dry-cold climates, their flat bottoms and curled up fronts riding the surfaces with ease. They are often used for transportation purposes where other conveyances are of no use Dogs, sometimes called huskies, haul toboggans on hunting and camping trips through the north woods In Alaska, teams of dogs of from 2 to 12 animals are frequently used to pull toboggans loaded with supplies and provisions. Toboggan racing between Alaskan cities is a popular sporting

event and very often the winner of a toboggan Derby will receive a cash prize of several thousand dollars.

TOBOLSK, a town in the Uralsk Area of the Russian S.F.S.R., in 59° 22′ N, 68° 5′ E., on the Irtysh river, below the confluence of the Tobol. Part of the town is low-lying and subject to floods, but the upper part is 200 ft above the river and is crowned by an old fortress built in the reign of Peter the Great by Swedish prisoners, in imitation of the Kremlin at Moscow. The river is usually frozen from Nov. 20 to May 14, and vessels from the Ob can reach the town in flood time; the S S Louise reached it from Hull in 1877. Twelve miles south-east are the ruins of the "fort of Kuchum" (Isker, Sibir) captured by Yermak in 1581. Tobolsk was founded by the Cossacks in 1587, and formerly had an active trade in fish and furs, but Omsk rapidly superseded it. The only industrial enterprise is a preserve factory using cranberries, rockcherry and honey. If the railway constructed in 1917 from Sverdlovsk to Saitkovo on the Tavda, is prolonged to Tobolsk, its trade may revive, and with it the former sawmilling and match industry. The district around is noted for koustar (peasant) industries, especially carpentering, the making of fishing nets, carving on mammoth ivory and the preparation of wool and skins. The Tobolsk province was the earliest to be colonized, and also received the largest number of political exiles.

TOBRUK (anc *Antipyrgos*), a fine natural harbour situated in Cyrenaica, Italian North Africa, on the N. coast of Africa at the intersection of 32° N Lat, with 24° E Long (Pop. 1,500) The harbour, which is small but deep, and sheltered by high ground, opens to the east. It is about 2½ m. long by ½ m. wide; the depth in the centre is over 40 ft and soundings of over 30 ft extend to within a very short distance of the shores. It is the only safe port easily accessible to large vessels for over 1,000 m, between Sfax in Tunisia and Alexandria. Tobruk has long been the outlet for the trade of the oases which extend from Jarabule to Siwah.

TOCCATA, in music, a composition of indefinite form but of brilliant, fantasia-like character, with a preponderance of running passages, calculated especially to display the execution of the performer. (It *toccare*, to touch) Among the earlier masters, Bach left some magnificent examples, developing the highest possibilities of the form (*see* article on that composer), while well-known modern examples are those of Schumann and Debussy.

TOC H, an interdenominational organization for Christian social service, founded as a memorial to British youth who perished in the World War At Hooge, in the first German liquid fire attack in July 1915, there fell a lad named Gilbert Talbot, lieutenant in the Rifle Brigade and son of the bishop of Winchester In the following December in the Flemish town of Poperinghe a soldiers' club named "Talbot House" was opened in his memory.

In charge of this house was a Church of England chaplain, the Rev. P. B. Clayton, M C, who created there a centre of rest and recreation unique in its kind In 1920 Clayton established in London a new Talbot house, using, as this name was already appropriated, the signallers method of pronouncing its initials, namely "Toc H" The plan was to establish in the salient of London a house where men of all kinds would congregate and many of them live, dedicating a reasonable proportion of their leisure time to the service of their fellow men and, by including in its membership all men of goodwill

In 1922 the movement had so extended, not only through houses or "Marks" as they are called but also in branches throughout the country that it became incorporated by royal charter, with H R H. the Prince of Wales as its patron. In 1928 it had extended through the English speaking world and beyond the confines of the British empire. Capturing the imagination of youth by its call to service and sacrifice, developed on a wide yet deep interdenominational Christian basis, drawing together men of all classes and types often mutually antagonistic, it has become one of the greatest powers for good, by service to man, fellowship of the most genuine kind and spiritual development and expression. Regular membership involves a probationary test and the work of its members and branches is reviewed annually. Each branch is entrusted with a Lamp of Maintenance, first lighted by the patron and relighted with simple ceremony at every meeting in remembrance of "the Elder Brethren" and in re-dedication to the task they left unfinished—building "a new Jerusalem." (R. C G)

TOCHI VALLEY or DAWAR, one of the chief routes into Afghanistan in the North-West Frontier Province of India. It leads from the Bannu through tribal country, and is inhabited by the Dawari (*q.v.*). The valley is divided into two parts, known as Upper and Lower Dawar, by a narrow pass called the Taghrai Tangi, some three m long Between Dawar and British territory is the low range of uninhabited hills, which skirt the Bannu district. It was by this route that Mahmud of Ghazni effected several of his raids into India and the remains of a road flanking the valley and of defensive positions are still to be traced. After the Waziristan Expedition of 1894 the Tochi was garrisoned by British troops; but when Lord Curzon reorganized the frontier in 1901, the British troops were withdrawn, and their place supplied by tribal militia The chief posts are Saidgi, Idak, Miranshah, Datta Khel and Sheranni. The valley was the scene of action for the Tochi or Dawari Expedition under Brigadier-General Keyes in 1872, and the Tochi Expedition under General Corrie Bird in 1897. Since the disturbances following the World War a motor road has been made up the valley.

TOCQUEVILLE, ALEXIS HENRI CHARLES MAURICE CLEREL, COMTE DE (1805–1859), was born at Verneuil on July 29, 1805 Alexis de Tocqueville became an assistant magistrate in 1830 A year later he obtained from the French Government a mission to examine prisons and penitentiaries in America On his return he wrote *De la Démocratie en Amérique* (1835, 3rd ed., 1868). It was at once caught up by influential members of the Liberal party in England, which country Tocqueville soon after visited, and where he married an Englishwoman Returning to France, he was elected a member of the *Académie des sciences morales et politiques* (Jan 6, 1838) He sat in the chamber of deputies for several years both before and after the revolution of February, becoming in 1849 vice-president of the assembly, and for a few months minister of foreign affairs. He was a warm supporter of the Roman expedition, but an equally warm opponent of Louis Napoleon; he was arrested at the *coup d'état,* and retired from public life. Twenty years after his first, he produced another book, *De l'ancien régime,* which almost, if not quite, equalled its success. His health was never very strong, and in 1858 he broke a blood-vessel. He was ordered to the south, and died at Cannes on April 16, 1859. His complete works, including much unpublished correspondence, were produced after his death in uniform shape by H G de Beaumont (*Oeuvres complètes de Tocqueville*, 9 vols, 1860–1865)

During the last twenty years of his life, and for perhaps half that time after his death, Tocqueville had an increasing European fame He was the first and has remained the chief writer to put the orthodox liberal ideas which governed European politics during the first half or two-thirds of the 19th century into an orderly and attractive shape He wrote the first reasoned political account of democratic government in America. If not an entirely impartial writer, he was neither a devotee nor an opponent of democracy.

See Heinrich Jacques, *Alexis de Tocqueville; ein Lebens- und Geistesbild* (Vienna, 1876), James Bryce, *The Predictions of Tocqueville* (Baltimore, 1887), Count de Puymaigre, *Les Souvenirs d'Alexis de Tocqueville* (1893, Eng trans 1896) and *Correspondance entre Alexis de Tocqueville et Arthur de Gobineau* (1908).

TODA, a small pastoral tribe found on the Nilgiri hills in south India. Like the Nairs (*q v*), they form an islet of tall, well-bearded, straight-nosed men with rich brown complexions in the midst of the darker Dravidian peoples. The women are lighter in colour, and wear a single garment arranged as a mantle The men wear a similar one as a plaid. They practise adelphogamy, and have only three women to five men, but female infanticide probably only survives among the priesthood

See W. H. R. Rivers, *The Todas* (1906).

TODHUNTER, ISAAC (1820–1884), English mathematician, son of George Todhunter, a Nonconformist minister, was born at Rye on Nov. 23, 1820, and died at Cambridge on March 1,

1884. He was educated at University college, London, and at St. John's college, Cambridge. He became a fellow of his college and college lecturer and private tutor. Todhunter held many academic honours, and was a member of council of the Royal society. He became an assistant master at a school at Peckham, attending at the same time evening classes at the University college, London. In 1842 he obtained a mathematical scholarship and graduated as B A. at London university. In 1844 he entered St. John's college, Cambridge, where he was senior wrangler in 1848, and gained the first Smith's prize and the Burney prize; and in 1849 he was elected to a fellowship, and began his life of college lecturer and private tutor. In 1862 he was made a fellow of the Royal Society, and in 1865 a member of the Mathematical Society of London. In 1871 he gained the Adams prize and was elected to the council of the Royal Society. He died at Cambridge on the 1st of March 1884

WORKS—*Treatise on the Differential Calculus and the Elements of the Integral Calculus* (1852, 6th ed, 1873); *Treatise on Analytical Statics* (1853, 4th ed, 1874); *Treatise on the Integral Calculus* (1857, 4th ed, 1874); *Treatise on Algebra* (1858, 6th ed, 1871), *Treatise on Plane Coordinate Geometry* (1858, 3rd ed, 1861), *Plane Trigonometry* (1859, 4th ed, 1869); *Spherical Trigonometry* (1859), *History of the Calculus of Variations* (1861), *Theory of Equations* (1861, 2nd ed 1875); *Examples of Analytical Geometry of Three Dimensions* (1858, 3rd ed, 1873), *Mechanics* (1867), *History of the Mathematical Theory of Probability from the Time of Pascal to that of Lagrange* (1865); *Researches in the Calculus of Variations* (1871); *History of the Mathematical Theories of Attraction and Figure of the Earth from Newton to Laplace* (1873); *Elementary Treatise on Laplace's, Lamé's and Bessel's Functions* (1875), *Natural Philosophy for Beginners* (1877) An unfinished work, *The History of the Theory of Elasticity*, was edited and published posthumously in 1886 by Karl Pearson

TODI (anc *Tuder*), a town and episcopal see of the province of Perugia, Italy, 26 m S of Perugia by rail, on a steep hill above the east bank of the Tiber, 1,348 ft above sea-level, and 866 ft. above the river Pop (1921), 5,776 (town), 18,245 (commune) Some portions of the ancient town walls—of two enceintes, an inner and an outer, the former attributed to the original Umbrian inhabitants, the latter to the Romans—are preserved, while the mediaeval walls are still more extensive, and also remains of baths, amphitheatre, theatre, and a substruction wall of massive masonry, with four niches Here was found the bronze statue of Mars, now in the Vatican; some fine bronze objects of the 5th cent B C have been found in tombs. Beneath the cathedral square, at the highest point of the town, is a large Roman reservoir. The Romanesque cathedral has a simple façade (partly of the 11th, partly of the 14th century), with a fine portal and rose window In the same square are the massive Romanesque Gothic structures, Palazzo dei Priori (1213), the Palazzo del Capitano del Popolo (*c.* 1290) and the Palazzo del Podesta (1293–1337). The Gothic church of S Fortunato, with its nave and aisles of the same height, has a splendid portal

Just outside the town on the west is the church of S Maria della Consolazione, one of the finest buildings of the Renaissance, and often wrongly attributed to Bramante Contemporary documents prove that the interior was begun in 1508 by Cola di Matteuccio da Caprarola, and the exterior completed in 1516–1524 by Ambrogio da Milano and Francesco di Vito Lombardo; the slender dome was not added till 1607

See Pirro Priore Alvi, *Todi* (1910); G Bellucci, *La regione di Todi prima della storia*, Perugia, 1915; Bendinelli in *Monumenti dei Lincei*, xxiii, 609–684; xxiv, 841–914.

TODLEBEN (or **TOTLEBEN**), **FRANZ EDUARD IVANOVICH,** COUNT (1818–1884), Russian engineer general, was born at Mittau in Courland, on May 20, 1818 He entered the school of engineers at St Petersburg, and passed into the army in 1836. In 1848 and the two following years he was employed, as captain of engineers, in the campaigns against Schamyl in the Caucasus. On the outbreak of war between Russia and Turkey in 1853, he served in the siege of Silistria, and after the siege was raised was transferred to the Crimea (*see* CRIMEAN WAR) Sevastopol, while strongly fortified toward the sea, was almost unprotected on the land side. Todleben, though still a junior field officer, became the animating genius of the defence By his advice the fleet was sunk, in order to blockade the mouth of the harbour, and the deficiency of fortifications on the land side was made good before the allies could take advantage of it. The construction of earthworks and redoubts was carried on with extreme rapidity, and to these was transferred, in great part, the artillery that had belonged to the fleet.

It was in the ceaseless improvisation of defensive works and offensive counterworks to meet every changing phase of the enemy's attack that Todleben's peculiar power and originality showed itself He never commanded a large army in the open field, nor was he the creator of a great permanent system of defence like Vauban. But he may justly be called the originator of the idea that a fortress is to be considered, not as a walled town but as an entrenched position, intimately connected with the offensive and defensive capacities of an army and as susceptible of alteration as the formation of troops in battle or manoeuvre Until June 20, 1855 he conducted the operations of defence at Sevastopol in person; he was then incapacitated by a wound

In 1860 Todleben was appointed assistant to the grand-duke Nicholas, and he became subsequently chief of the department of engineers with the full rank of general He was given no command when war with Turkey began in 1877 It was not until after the early reverses before Plevna (*q v.*) that the soldier of Sevastopol was called to the front Todleben saw that it would be necessary to draw works round Osman Pasha, and cut him off from communication with the other Turkish commanders In due time Plevna fell Todleben then undertook the siege of the Bulgarian fortresses After the conclusion of preliminaries of peace, he was placed in command of the whole Russian army When the war was over he became governor of Odessa and hereditary count But his health was broken For some time after 1880 he held the post of governor of Vilna He died at Bad Soden near Frankfort-on-Main, on July 1, 1884

His great work on the defence of Sevastopol appeared in Russian, French and German (5 vols, 1864–72) Besides this, he wrote a letter to General Brialmont on the operations around Plevna, this was printed in the Russian engineer journal, and in German in the *Archiv fur preussische Artillerie-offiziere* (1878)

See Brialmont, *Le Général comte Todleben* (Brussels, 1884), *Life* by Schild r (in Russian, St Petersburg, 1885–87), Krahmer, *General-Adjutant Graf Todleben* (Berlin, 1888)

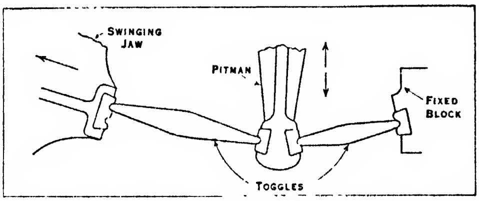
TODMORDEN, a municipal borough and market town in the West Riding of Yorkshire, England, 19 m N.N E of Manchester, on the L M S railway It lies in both the Sowerby parliamentary division of the West Riding and in the Middleton division of Lancashire Pop (1921) 23,892 It is situated on both sides of the river Calder, at an altitude of about 500 ft. and is surrounded by high moorland It is a railway junction for trans-Pennine routes from Manchester, Preston and Burnley to the industrial West Riding, and the Calder and Rochdale canal connects it by water with Rochdale and with towns lower down the Calder valley. The staple industry is the spinning and weaving of cotton and there are also foundries and machine-works. The municipal borough was incorporated in 1896.

TODY, a bird (*Todus viridis*) inhabiting Jamaica, with allied species in Cuba, Haiti and Porto Rico. A stolid bird, the tody is brightly coloured in grass-green, with a crimson gorget. It feeds on insects and, like its allies the king-fishers, constructs burrows in which to lay its white eggs.

TOGGENBURG, THE, an ancient county in the upper valley of the river Thur (Switzerland). On the death of the last count of Toggenburg (1436) Zürich and Schwyz, in the first intercantonal war, disputed its possession Purchased by the abbot of St. Gall in 1468, it was an area of constant strife between the abbots and the inhabitants, many among whom embraced Protestantism The Toggenburg war between the Roman Catholic cantons and Protestant supporters of the Toggenburgers resulted in a Catholic defeat (1712) and in the restoration of the ancient liberties. To-day it is a pleasant, highly prosperous part of the canton of St. Gall, inhabited by approximately equal numbers of Protestants and Catholics. Its exact limits are differently interpreted, but the entire upper valley of the Thur above the right-angled bend, near Wil, to the source near Wildhaus, is about 30 m long, and runs mainly south-east to north-west, be-

tween steep fir-clad slopes. Near the valley head are the Churfirsten range (Hinterruck, 7,575 ft.) southwards and the bold peaks of the Säntes (8,215 ft) northwards. The valley is well populated and has good through communications; a 20 m. railway runs from Wil, on the Winterthur-St Gall main line, to Nesslau, and public omnibuses make use of the excellent roads beyond, crossing the watershed near Wildhaus for Gams in the Rhine valley. The Toggenburg as a holiday area is still mainly confined to the Swiss themselves. The pastures throughout are unusually rich, but the predominant pastoral occupation of the upper half is replaced by manufactures, chiefly muslins, in the lower half. The old market centre of the valley was Lichtensteig, now surpassed in point of size and importance by several well built towns and villages, of which Wattwil (pop 6,100), near the entrance of the Ricken tunnel, is the largest.

TOGGLE-LEVER, a combination of three levers, one being at right-angles to the other two, and arranged so as to



A KNUCKLE FORM OF LEVER ACTION, TWO BEING STRAIGHTENED OUT BY A LATERALLY MOVING ONE

push against their closely-set ends One of the latter is pivoted at a fixed position, while its companion has endlong freedom Great power is obtained by the action of the lateral lever forcing the other two into a straight line One practical application is seen in the diagram, where the lateral lever is a rod, or pitman, given a short up and down motion from an eccentric on a shaft fitted with a heavy flywheel As the pitman rises, it forces the toggles (which are wide pieces in this case) into line, and exerts great pressure against the pivoted jaw The latter crushes rock or stone against a fixed jaw face Another valued application of toggles is in power presses for drawing hollow sheet-metal articles, such as bowls, pans, etc, from the flat sheet This operation necessitates holding the sheet firmly around the die during the drawing The toggle mechanism does this and transfers the great stress direct to the frame of the machine, instead of throwing it on the crankshaft

TOGO, HEIHACHIRO, Count (1847-), Japanese admiral, was born in Kagoshima, the son of a petty retainer. He joined the navy in 1863 and his first engagement was the "Kwaiten" five years later He studied naval science and navigation in England from 1871 to 1878, and first became a prominent figure when, in 1894, as captain of the cruiser "Naniwa," he sunk the Chinese troopship "Kowshing" *en route* for Korea, thus precipitating war with China When the Russo-Japanese conflict broke out in 1904, he was appointed to the command-in-chief of the Japanese fleet, and under his direction various brilliant operations took place, culminating in the battle of the Sea of Japan when the Russian fleet was annihilated. For these services he received (1907) the title of count. In 1906 he was made a member of the British Order of Merit (*See* Russo-Japanese War)

TOGOLAND, a country of West Africa (the French and German form is Togo). The maritime zone forms part of what was distinguished as the Slave Coast; it lies between the Gold Coast and Dahomey and extends from 1° 14′ E. to 1° 38′ E. Annexed to Germany in 1884, it was given a hinterland of nearly 35,000 sq. miles. Since 1919 it has been divided into British and French spheres (see *infra*).

Physical Features.—The coast is low and sandy and is formed by the detritus deposited by the sea current called Calema It is perfectly straight, without harbours, and approached only through a dangerous bar This coast strip, but 32 m. long, is nowhere more than 2 m broad It masks a series of lagoons, of which the largest, occupying a central position, is called the Togo, Avon or Haho lagoon Behind the lagoons an undulating plain stretches some 50 miles The Sio and Haho, the two largest rivers of the coast region, both flow into the Togo lagoon These rivers rise on the eastern versant of a chain of mountains which traverse the country in a south-westerly to a north-easterly direction. It has no general name but in the south is called Agome It is most elevated in its southern portion, Mt Dabo having a height of 3,133 ft. and Mt Atilakuse 3,248 feet Its general elevation is between 2,000 and 2,500 ft ; on the north-west side of the range the country is table-land, some 600 to 1,000 ft high Baumann Spitze (3,215 ft) is an isolated peak in 6° 50′ N , 0° 46′ E , east of the main range South and east of the range the country, apart from that watered by the coast streams, drains to the Mono river, which, in its lower course, forms the Togoland-Dahomey frontier. The greater part of the country lies west and north of the chain and belongs to the basin of the Volta The chief river traversing it (north to south) is the Oti, a tributary of the Volta

The climate on the coast is hot, humid and unhealthy. There are two wet seasons, the first lasting from March till June, the second from September to November A marked feature of the climate is the prolonged period, December to April, in which the dry wind called *harmattan* prevails. The rainfall is thought to average 55 in a year in the southern districts On the tableland seasons of drought are not uncommon.

Coconut palms, introduced by the Portuguese, grow along the coast and for 80 m or so inland The lagoons are surrounded by dense belts of reeds, and the coast-land is covered with low, dense bush There are forests of oil palms, rubber trees and vines, and timber and dyewood trees. There are rain-forests on the mountains and along the river valleys On the hills the baobab and hyphaene palm are characteristic; on the plateau are stretches of open savanna and park-like country with clumps of silk cotton and shea-butter trees The fauna resembles that of other parts of West Africa; it is poor on the coast

Inhabitants.—In the south-west the inhabitants are negroes of the Twi-speaking clans, while on the coast and in the south-east they are members of the Ewe (Dahomey) tribes Among the coast people there is a distinct infusion of Portuguese blood, and in all the ports are descendants of Brazilian negroes who returned to Africa during the 19th century The northern tribes are distinct from the coast tribes, are of finer physique, and until recently went almost naked Among these tribes the Mamprusi and Dagomba, the Kotokoli and Bassari may be noted Though the Togoland natives number fewer than one million over 40 different languages are spoken As is common in West Africa the people are divided into a large number of independent tribes, each under its own head chief, who is, however, subject to the authority of a council of sub-chiefs and leading officials The use of poisoned arrows by the northern tribes still prevailed in 1928. In the coast lands the inhabitants are traders and agriculturists, in the interior they are largely pastoralists. The people are mostly pagans, but some thousands have embraced Christianity or Islam

There are a number of ancient towns on the coast and lagoons Togo is on the south-eastern shores of the Togo lagoon On the narrow spit of land between the lagoons and the sea are Bagida and Porto Seguro—the last named one of the oldest towns on the Slave Coast and the port of Togo town—and, close to the eastern frontier, Little Popo, called by the Germans Anecho On the Volta, a short distance above the Oti confluence, are the adjacent towns of Kete-Krachi; on an affluent of the Mono in 7° N is Sagada In the north are Yendi and Sansane Mangu, both on trade routes between Ashanti and the Niger countries Lome, the chief port, is at the eastern end of the coast

Economic Development Under the Germans.—In the 30 years the country was under German rule attention was paid chiefly to agriculture, trade and communications. A jetty was built at Lome and from it two railways started; one—opened in 1907—went north-north-west to Palime (72 m), the other—opened in 1911—due north to Atakpame (105 miles). Along the coast a railway connected Lome with Anecho and several good

roads had been built. Germans started plantations of coffee, cocoa, kola-nuts, rubber and cotton, but the most valuable trade was in palm oil and kernels There was also a trade in maize, ground nuts and shea-butter. Several inland tribes reared cattle and sheep, and on the tableland horses and donkeys. Strict labour regulations were enforced on the natives Direct steamship communication was maintained with Hamburg and Bremen, and most of the trade was with Germany The value of exports rose from £153,000 in 1900 to £498,000 in 1912. In the same period imports increased from £176,000 to £571,000 In 1912 the chief exports were palm oil and kernels (£240,000), rubber (£48,000), live cattle (£30,000), cotton (£26,000) and maize (£12,000) In 1913, the last complete year of German rule, the total exports were valued at £457,000, the imports at £531,000 The European population (1912) was 368, of whom 327 were Germans.

The British Sphere.—The British sphere adjoins the Gold Coast It has an area of 13,040 sq m. and a pop. (1921 census) of 187,959; of these 9,652 were Christians and 5,678 Mohammedans. European residents (1927) numbered under 50. The sphere is divided into two sections, the northern being administered as if it formed part of the Northern Territories of the Gold Coast, the southern as if it formed part of the Gold Coast Colony. The southern section is known as the Ho district and has some 80,000 inhabitants, who are more advanced in civilization than their northern neighbours. The chief towns are Ho and Kpando. In this district large areas are given over to cocoa, and smaller areas to cotton. There is also an oil palm belt The northern section is divided into districts, of which Kete-Krachi—in which there are cotton plantations—adjoins the Ho district. This northern district contains the towns of Kete-Krachi (pop about 9,000) and Yendi (4,500). Trade in the north is chiefly in cattle and foodstuffs. The exports of the British sphere as a whole are mainly cocoa, cotton and palm kernels and palm oil; the chief imports are cotton piece goods, clothing, salt, tobacco and kerosene The division of Togoland left the whole railway system in the French sphere and the railway from Palime to Lome, which runs close to the border of the British sphere and is near to the chief cocoa farms, takes a large share of the trade The administration has, however, built good roads in the British sphere and a motor ferry over the Volta at Senchi connects the southern British section with the road system of the Gold Coast colony Separate statistics of the trade between the British sphere and the Gold Coast are not kept; the following figures relate to the trade crossing the frontier of the French sphere:—Year ending March 31, 1924: Exports £115,230 (cocoa £99,585); imports £24,400. Year 1926: exports £148,000 (cocoa £135,200); imports £26,000. In taking over the administration the Gold Coast authorities determined that the British sphere should have the same high standard in regard to public health, public works and education as the Gold Coast had. Consequently, expenditure for several years greatly exceeded revenue.

French Sphere.—The French sphere, which adjoins Dahomey on the east, has an area of 21,893 sq. miles In 1927 the pop was 742,808 natives, 331 Europeans and 49 Syrians. The sphere is administered as a separate entity, the chief official being styled commissioner. He is aided by an Economic and Financial Council (created in 1924), consisting of officials, merchants and nine native representatives. The native members are chosen by popularly elected councils and notables established in each district into which the sphere is divided.

The products and trade are similar to those in the British sphere, cocoa and cotton being of growing importance. There is also a trade in copra, an industry in the hands of the coast natives. Lome (pop. about 6,000) is the capital and centre of the external trade The chief imports, cotton piece goods, come almost entirely from Great Britain Exports were valued at 17,000,000 frs in 1922, and at 79,000,000 in 1926; in the same period imports rose from 10,000,000 frs. to 99,000,000 frs. France supplies about 25% of the imports and takes half of the exports In fiscal matters the French authorities sought to build up a reserve from which to undertake public works, and revenue for several years exceeding expenditure, a sum equal to £250,000 had been accumulated by 1927, in which year the budget was balanced at 33,380,000 frs. (£2,670,000) A programme of public works was then put in hand.

HISTORY

Foundation of a German Colony.—When Dr. Gustav Nachtigal was sent by the German Government to west Africa in 1884 as imperial commissioner on an annexation errand, he had the fortune to find between the Gold Coast (British) and Dahomey (French) a small stretch of the Guinea coast, sovereignty over which was not claimed by any European Power. The king of Togo—the ruler of this little patch—was induced to sign a treaty (July 5, 1884) placing his country under German suzerainty. Thus Togoland was founded, and by arrangement made with Great Britain and France a coast line of 32m was obtained Before the coming of the Germans as rulers, Portuguese, British, French and German firms had trading agencies along the lagoons behind the coast. In earlier days trade was chiefly in slaves (exported) and gin (imported); in later days the products of the oil palm had taken the place of slaves. The natives were in general dependent upon the rulers of Dahomey or Porto Novo; but the towns of Little Popo and Togo were capitals of small States which claimed freedom With the development of French interests in Dahomey there was the prospect of these minute kingdoms being absorbed by France In Togo town, however, Bremen merchants were influential and this fact helped Nachtigal to conclude his treaty Germany at once advanced claims to a large hinterland, and this caused a great deal of negotiation with Great Britain and France. It was not until 1899 that the inland frontiers of Togoland were fixed, Germany securing an area somewhat larger than Ireland Many of the tribes expressed preference for French or British rule respectively but the Germans had no great difficulty in making good their authority. The people were fairly good agriculturists and the Germans steadily developed the resources of the country; they created a port—Lome—and built railways After 20 years' work Togoland was self-supporting; it was the only German colony in Africa to attain that position

The World War.—In the first month of the World War (Aug 1914) Togoland was conquered by a British force from the Gold Coast under Capt. (temp. Lt -col) F. C Bryant, aided by detachments sent by the French from Dahomey Before surrendering, the Germans blew up the powerful wireless station at Atakpame, which had been completed a little earlier in the year and which communicated directly with Berlin Thereafter the western part, including Lome, was administered by the British and the eastern part by the French. Germany renounced her sovereignty by the Treaty of Versailles and the Supreme Council gave the mandate for its government to Great Britain and France The first division, made in an Anglo-French agreement of July 10, 1919, gave dissatisfaction to French colonial circles, as it left Lome to Great Britain, and by a convention of Sept 30, 1920, in exchange for an enlarged British area in the interior, Lome and the whole seaboard went to France. Both spheres are governed under mandates approved by the Council of the League of Nations on July 20, 1922, and, in each, citizens of the United States have obtained the right to equal treatment with the nationals of the members of the League. In both spheres the administration was carried on with the co-operation of the natives and without friction, there being a great development in trade.

See H. Klose, *Togo unter deutscher Flagge* (1899), a comprehensive survey, with bibliography; *Togoland,* a British Foreign Office handbook (1920); and the annual reports published by the British and French Governments on their respective spheres. (F. R. C.)

TOKAJ, a town in Hungary, at the confluence of the Bodrog and the Tisza and at the foot of the Hegyalja mountains which slope from a height of 2,700 ft. to a hilly plateau of 1,500 ft. near Tokaj. Here is the vineyard region of nearly 150 sq m. on a volcanic soil. The vines are believed to have been introduced by Italian colonists in the 13th century. From their grapes is produced the famous wine Tokay, the trade in which is the principal occupation. Pop. (1920), 5,073.

TOKAT, the chief town of a vilayet in Asia Minor. It is situated in the Sivas-Samsun *chaussée,* altitude 2,280 ft, at the mouth of a rocky glen which opens out to the broad valley of the

Tozanli Su, a tributary of the Yeshil Irmak. It rose to importance under the Seljuks. Pop. (1927), 77,579. The industries are the manufacture of copper utensils and yellow leather, and the stamping of colours on white Manchester cotton.

TOKELAU ISLANDS: *see* PACIFIC ISLANDS.

TOKUGAWA, YOSHINOBU, PRINCE (1837–1913), Japanese statesman, was born on Sept. 29, 1837 at Tokyo. He was the last of the Tokugawa Government, succeeding as shogun the 14th shogun, Iemochi, in 1866. Realizing after a year's time that the proper government of the country was impossible on the lines of feudalism, which was a bar to all progress and a source of continual internal strife, the shogun handed his resignation to the emperor on Oct. 14, 1867. This act of sacrifice was the prelude to the enlightened Meiji era, which dates from the beginning of 1868. Tokugawa, having renounced his shogunate rights, went into a strict retirement from which he never emerged. He even renounced the succession to his title for his direct heir in favour of a collateral branch of the family, the first to inherit the title being Prince Iyesato Tokugawa, for many years president of the house of peers The Emperor Meiji accepted the renunciation, but he conferred on him another title of prince to be bequeathed to his son He died on Nov 21, 1913 at Tokyo.

TOKUTOMI, IICHIRO (1863–), Japanese journalist and author, was born at Kumamoto in Jan. 1863 and educated at the Doshisha, Kyoto. In 1887 he issued a monthly magazine, *The Friend of the Nation*, and in 1890 started in Tokyo the daily *Kokumin Shimbun* (Nation), of which he was proprietor and editor. He also began to issue in the same year *The Far East,* an English monthly. Tokutomi, who was appointed a crown member of the House of Peers in 1911, published many important political and historical works including *The Future Japan* (1886) and *History of Modern Japan,* not yet complete. In 1924 the Imperial Japanese Academy awarded him the emperor's medal in recognition of the merit of his works on Japanese history.

TŌKYŌ, the capital of the empire of Japan, situated in 35° 41′ N. and 139° 45′ E, at the head of the bay of the same name on the south-east coast of the main island. In old times the city was called Yedo The city stands on the banks of the river Sumida, which, although wide, is unnavigable by vessels of large tonnage owing to its shallowness Yokohama, with which Tōkyō is connected by 18 m of railway, is practically the port of the capital The trains of the Tokai-do line, starting from the Shimbashi station, run westwards to Kobe, thence to Shimonoseki, at the western end of the main island, a distance of 700 m. The Uyeno station is the starting-point for trains to Aomori, a town 460 m. away, at the northern extremity of the island. The area of Tōkyō is about 100 sq m Topographically it may be divided into two parts, upland and lowland (Yamanote and Shitamachi) There are hills varying in height from 50 to 130 ft. in the upland district; that is to say, the outskirts of the city from north to west. Lowland Tōkyō, that part of the city covering the flats on both sides of the river Sumida, is intersected by a system of canals. The Nihon-bashi (Bridge of Japan), in the district of the same name, is famous, from this point all distances in Japan are measured. The largest bridges are those named Azuma, Umaya, Ryogoku, Shin-o and Eitai over the Sumida.

The streets are still, in some places, narrow and irregular; electric tramcars run throughout the city carrying passengers at a uniform rate of 5 sen, which means that it is possible to travel some 10 m. for about one penny. The jinrikisha, drawn by one man or sometimes two men, which were formerly the chief means of passenger conveyance, have notably decreased in number since the introduction of the trams Tōkyō suffers frequently from earthquakes. The numerous residences of the daimyos were the chief characteristics of the old town, especially in the Kojimachi-ku. Many of these have been demolished and government offices erected on their sites; others have given place to new streets and houses. Nearly in the centre of Kojimachi-ku, on an eminence, surrounded by moats, stood the castle of Yedo, formerly the residence of the shōguns, which was burnt down in 1873. The imperial palace was subsequently erected on this site. The palace is half European and half Japanese in its style of architecture. The Nijū-bashi is the main entrance. Hibiya Park is modelled on the European style, while retaining the special features of the Japanese gardeners' art. The largest and most beautiful are those in Shiba and Ueno, formerly the mausolea of the shōguns In Ueno, too, are the Imperial Museum, the Imperial Library and the Zoological Gardens. The famous temple of Kwannon, the goddess of mercy, is in Asakusa Park, in which a permanent fair is held.

Administration.—For administrative purposes Tōkyō is divided into fifteen districts or *Ku,* of which Kojmachi, Hongo, Koishikawa, Ushigome, Yotsuya, Akasaka, Azabu and Shiba are situated in the upland portion, while Kanda, Kyobashi, Nihonbashi, Shitaya, Asakusa, Honjo and Fukagawa are in the lowland. Suburban Tōkyō is divided into eight districts or *Gun,* which, with the city proper, collectively form the Tōkyō-Fu (prefecture), under the general control of one governor called Fu-Chiji. Questions affecting the interests of the whole Fu come before the *Fukwai,* or prefectural assembly, made up of representatives from both *Ku* and *Gun,* and a prefectural council, of which the governor is president; while matters concerning the city alone are discussed by a *Shi-kwai,* or municipal assembly, and administered by a municipal council, of which the Shicho or mayor is president. There is a regular water supply worked by the municipality Both police and fire brigade are under the command of a single *Keishisokan* (inspector-general). The telephone system is extensive, including long-distance wires to Yokohama, Osaka and other large towns There are many schools for advanced students devoted to the various branches of science, mechanics and art. The imperial university of Tōkyō, which consists of the colleges of law, medicine, literature, science, engineering and agriculture, is the principal institution of learning in the empire There are several daily newspapers as well as weekly and monthly publications of all kinds. In the lowland part of the city and in the suburbs there are many factories, their number having so much increased recently that Tōkyō may now be described as an industrial city

Population.—There are no reliable data as to the population of Yedo during the shōgunate Owing to the influx caused by the periodical visits of the daimyōs (feudal lords) with their numerous attendants, it probably exceeded $1\frac{1}{2}$ million during the period 1800–50 In 1925 the population was 1,995,567.

History.—No mention is made of Yedo or Tōkyō in Japanese history before the end of the 12th century It appears to have assumed no importance till about 1457, when Ota Dokwan, a general in the service of Uyesugi Sadamasa, governor of Kamakura, built a castle here About thirty years later the town fell into the hands of Hōjō of Odawara, and on his overthrow by Hideyoshi and Iyeyasu, the castle was granted to the latter, who was the founder of the shōgun house of Tokugawa In 1590 Iyeyasu made his formal entry into the castle of Yedo, the extent of which he greatly enlarged. From this date the real importance of Yedo began. The family of the Tokugawas furnished the shōguns of Japan for nearly three hundred years, and these resided during that period at Yedo At the restoration in 1868 the shōgunate was abolished, and the population of Yedo speedily decreased. A fresh vitality was imparted by the transfer of the court from Kyoto, and the town then received its present name Tōkyō (eastern capital). In Sept. 1923 a disastrous earthquake followed by extensive fires razed several districts of Tōkyō to the ground An area of 25 sq m was burnt and numerous bridges were destroyed Reconstruction of a purely temporary nature was rapid Shimbashi bridge was re-opened in 1925 but in the same year the new Parliament buildings were destroyed by fire.

University. (*See* UNIVERSITIES.)—By recent imperial ordinances and various other developments this has become the centre of progressive university education in Japan It has now faculties of law, medicine, engineering, agriculture and economics, in addition to those of science and letters, with no less than 255 members of the academic staffs. The Tōkyō astronomical observatory is directly attached to the university, which also takes a definite part in the compilation of national and geographical records. By Law 8 of March 27, 1922, the Government appropriation for the university was sanctioned as 2,984,805 yen

TOLAND, JOHN (christened JANUS JUNIUS) (1670–1722), English deist, was born on Nov. 30, 1670, near Londonderry, Ireland Brought up a Roman Catholic, in his sixteenth year he became a zealous Protestant. He studied at Glasgow, and then at Leiden under the famous scholar Friedrich Spanheim. He went in 1694 to Oxford where he began the book which made him famous—his *Christianity not Mysterious* (1696, anonymous; 2nd ed in the same year, with his name; 3rd ed, 1702, including an *Apology for Mr Toland*) It gave great offence, and several replies were immediately published. The author was prosecuted by the grand jury of Middlesex, and, when he attempted to settle in Dublin at the beginning of 1697, he was denounced from the pulpit and elsewhere His book having been condemned by the Irish parliament (Sept 9, 1697) and an order issued for his arrest, Toland fled to England The resemblance, both in title and in principles, of his book to Locke's *Reasonableness of Christianity,* led to a prompt disavowal by Locke of the supposed identity of opinions, and subsequently to the famous controversy between Stillingfleet and Locke Toland's next work of importance was his *Life of Milton* (1698), in which a reference to "the numerous supposititious pieces under the name of Christ and His apostles and other great persons," provoked the charge that he had called in question the genuineness of the New Testament writings. Toland replied in his *Amyntor, or a Defence of Milton's Life* (1699), he opened up the question of the history of the scriptural canon In 1701 Toland spent a few weeks at Hanover as secretary to the embassy of the earl of Macclesfield, and was received with favour by the electress Sophia in acknowledgment of his book *Anglia Libera,* a defence of the Hanoverian succession. On his return from the Continent he published *Vindicius Liberius* (1702), in which he described *Christianity not Mysterious* as a youthful indiscretion. The next year he visited Hanover and Berlin, and was again graciously received by the electress and her daughter Sophia Charlotte, queen of Prussia, the "Serena" of the *Letters* published on his return to England (1704) In two of these (*A Letter to a Gentleman in Holland,* and *Motion essential to Matter*), ostensibly an attack on Spinoza, he anticipated some of the speculations of modern materialism The *Account of the Courts of Prussia and Hanover* (1705) was used by Carlyle in his *Life of Frederick the Great* From 1707 to 1710 Toland lived in varying circumstances on the Continent In 1709 he published (at The Hague) *Adeisidaemon* and *Origines Judaicae.* The last of his theological works were *Nazarenus, or Jewish, Gentile and Mahometan Christianity* (1718) in which he maintained that the early Christians were Jewish Christians observing the Mosaic law and that their successors were the Nazarenes or Ebionites afterwards regarded as heretics by the Church

His last book, *Pantheisticon* (1720), gave great offence He died on March 11, 1722, in London, as he had lived, in great poverty, with his pen in his hand The term "free-thinker" was first applied to Toland, who indeed uses it himself

See Mosheim's *Vindiciae antiquae christianorum disciplinae* (1722), containing the most exhaustive account of Toland's life and writings; a *Life of Toland* (1722), by "one of his most intimate friends"; "Memoirs of the Life and Writings of Mr John Toland," by Des Maizeaux, prefixed to *The Miscellaneous Works of Mr John Toland* (London, 1747), and also G. Berthold, *John Toland und der Monismus der Gegenwart* (1876).

TOLEDO, a province of Spain, formed in 1833 from part of New Castile; bounded on the north by Ávila and Madrid, east by Cuenca, south by Ciudad Real and west by Cáceres. Pop. (1920), 442,933; area 5,919 sq. miles. The surface is mountainous. Towards the centre there are extensive tablelands, but the whole of the south and east is occupied by the Montes de Toledo, and the hills which separate the waters of the Tagus on the north from those of the Guadiana on the south. Toledo is well watered by the Tagus (*q v*) and its numerous affluents. Gold, silver, lead, iron, quicksilver, copper, tin and other minerals have been discovered, but the mining industry does not prosper and there is little export trade in agricultural products. The principal manufactures are silk and woollen cloth, earthenware, soap, oil, chocolates, wine, rough spirit (*aguardiente*), guitar strings and arms. There is also a small trade in charcoal and timber. The province is traversed by three lines of railway—that of Madrid–Seville–Cadiz in the east, Madrid–Toledo–Ciudad Real through the centre, and Madrid-Cáceres-Lisbon in the north.

TOLEDO, the capital of the Spanish province of Toledo and formerly of the whole kingdom, 47 m. by rail S.S.W. of Madrid, on the river Tagus, 2,400 ft above sea-level. Pop (1920) 25,251. Toledo is of immemorial antiquity; it was a stronghold of the Carpetani and may have been a Carthaginian trading-station. Livy (xxv. 7) mentions *Toletum* as *urbs parva, sed loco munita,* which was captured by the Romans in 193 B C. Under Roman rule it became a *colonia* and the capital of Carpetania. Its ecclesiastical importance is coeval with the introduction of Christianity into Spain; there were numerous church councils held here, notably in 396, 400 and 589, and here also was the chief battle ground in the long political and religious struggle which ended (589) in the triumph of Spanish Catholicism over Arianism. From the reign of Athanagild (534–547) until the Moorish conquest in 712, Toletum was generally regarded as the capital of Visigothic Spain. The Moorish chroniclers grow eloquent over the treasures captured by Musa and his army in 712 *Tolaitola,* as the city was then called, prospered under the Moors, first as a provincial capital in the caliphate of Cordova, governed by an emir (712–1035), afterwards as an independent state (1035–85) Its rulers protected the large Jewish colony, founded extensive silk and woollen industries, and made their city an important centre of Arab and Hebrew culture, one of the great names associated with it being that of Rabbi ben Ezra (1119–74) The Spanish and Jewish inhabitants adopted the language and many customs of their conquerors, becoming "Mozarabs," but retaining their own creeds In 1085 Alphonso VI of Leon and Castile captured Toledo, aided by the Cid, and in 1087 made it his capital, its commercial and political decline dates from 1560, when Philip II chose Madrid as his capital.

Toledo occupies a rugged promontory of granite, washed on all sides except the north by the Tagus, which here flows swiftly through a deep and precipitous gorge From a distance it has the aspect of a vast fortress, built of granite, defended by the river and by a double wall on the north, and dominated by the towers of its cathedral and alcázar The absence of traffic in its maze of dark and winding alleys creates a silence uncommon in so large a city The principal *plaza* is the arcaded Zocodover, described by Cervantes in the *Novelas ejemplares* The houses, tall,

THE PUENTE DA ALCANTARA ACROSS THE TAGUS RIVER, A MOORISH BRIDGE REBUILT IN THE 13TH AND 17TH CENTURIES

massive and sombre, are entered by huge iron-studded doors, and most of their windows open on a sheltered inner court (*patio*), the walls facing the street being often blank, though their monotony is sometimes relieved by carved stone-work

The Tagus is spanned by two fortified Moorish bridges, the Puente da Alcántara, on the north-east, which was rebuilt in the 13th and 17th centuries, and the Puente de San Martin, on the north-west, founded in 1212 and rebuilt in 1390. The Mudéjar Puerta del Sol is the finest of several ancient gateways, among which the Puerta Visagra (1550, restored 1575), and the Puerta

del Cambron (1102, restored 1576) are also interesting. The Puerta Visagra Antigua, a Moorish gateway of the 9th century, has been walled up, but its original form is preserved. The Alcázar, a huge square building with a tower at each corner and a fine arcaded *patio*, stands on the highest ground in Toledo, originally the site of a Roman fort, and now a military academy. Its fine façade designed by Juan de Herrera, a gateway by Alonso de Covarrubias and a staircase by Herrera and Francisco de Villalpando have been preserved. The Ayuntamiento, or City hall, is a 15th century building with 17th century alterations by Domenico Theotocopuli (el Greco).

The cathedral occupies the site of a Visigothic church St. Ferdinand founded the present cathedral in August 1227 The completion of the main fabric was delayed until 1493, while many of the chapels and other subordinate buildings were added even later; thus Renaissance and baroque features have been introduced into a design which was originally Gothic of the 13th century. The interior is 395 ft. long by 178 ft. broad, and is divided by 84 pillars into five naves, with central lantern and choir, and a complete series of side chapels. Most of the chapels date from the 15th and 16th centuries, and are very magnificent in detail The superb stained-glass windows, chiefly of Flemish work, belong to the same period and number 750 The choir-stalls, placed in alabaster recesses divided by columns of red jasper and white marble, are among the finest extant examples of late mediaeval and Renaissance wood-carving, though rivalled by the *retablo*, which rises behind the high altar to the roof The treasury, reliquaries and library still contain many priceless mss and works of art, including the silver monstrance executed by Enrique de Arfe in 1524, and paintings by Goya, El Greco, Titian and Rubens In the Mozarabic chapel mass is still performed daily according to the Mozarabic liturgy, which was also used in six of the parish churches until about 1850 (*See* MOZARAB)

Apart from the cathedral, many of the other churches are of great interest and beauty Several of them, notably Santo Tomé and San Vicente, contain masterpieces of El Greco (d 1614), many of whose pictures are collected in the Casa del Greco, founded by the Marqués de Vega-Inclán The Franciscan convent and church of San Juan de los Reyes (florid Gothic) were founded in 1476 by Ferdinand and Isabella. El Cristo de la Luz was originally a mosque, built in 922 and incorporating some pillars from an older Visigothic church. Santo Tomé, also a mosque, was reconstructed in the Gothic style during the 14th century. El Cristo de la Vega, formerly known as the Basilica de Santa Leocadia, occupies the site of a Visigothic church built in the 4th century to mark the burial-place of the saint. The Mudéjar Santa Maria la Blanca became successively a synagogue, in the 13th and 14th centuries, a church (1405), an asylum for women (1550), barracks (1791–98) and again a church.

Toledo's characteristic industry is the manufacture of swords, carried on by private firms and especially in the royal factory (1788), which, like the railway station, is about 1 m. from the city. Toledan blades have been famous for 2,000 years, the *culter toletanus* being mentioned in the *Cynegetica* of Grattius (Faliscus), during the 1st century B.C. The industry throve under the Moors and especially during the 16th century; it is now practised on a smaller scale, but the blades produced are still remarkable for flexibility and strength.

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TOLEDO, a city of north-western Ohio, U.S.A, a port of entry and the county seat of Lucas county, on Maumee bay (the south-western tip of Lake Erie) at the mouth of the Maumee river. It is on Federal highways 20, 23, 24, 25 and 127, has a municipal airport of 225 ac.; and is served by the Ann Arbor, the Baltimore and Ohio, the Big Four, the Hocking Valley, the New York Central, the Nickel Plate, the Pennsylvania, the Pere Marquette, the Wabash, and the Wheeling and Lake Erie railways, several other steam lines for freight, nine electric railways and lake steamers. Pop. (1920) 243,164 (107 males to 100 females, and 82% native white); 1928 local estimate 313,200. The city has an area of 37 sq m., lying on both sides of the curving river, but chiefly on the west, with seven bridges connecting the east and west sides. It has tall hotels and business buildings; shaded residential streets; beautiful schools and public buildings, notably the well endowed Art museum, which houses a fine collection of Egyptian antiquities and glass and many canvasses of famous painters. There are 742 m of streets (360 m. paved), 482 m. of sewers, parks covering 2,004 ac., 21 m. of boulevards, 181 churches, 10 hospitals, 60 public and 35 parochial schools and a public library with 14 branches, containing 260,000 volumes The University of the City of Toledo (founded in 1872 as a private institution, and organized as a municipal university in 1884) has a campus of 160 ac and an annual enrolment of over 2,000. Toledo is the seat also of St John's university (Roman Catholic; 1898), several private secondary schools and a State hospital for the insane Private charitable organizations and welfare agencies are jointly financed through a community chest. The city operates under a mayor-council form of government, provided by the charter of 1914 There is an official city plan commission, and a comprehensive plan has been adopted.

The harbour has 35 m of shore line and a depth of 21 ft., accommodating the largest lake vessels. Its traffic in 1925 amounted to 16,304,042 tons, valued at $85,108,760, giving it third rank (after Duluth-Superior and Buffalo) among the ports of the Great Lakes. In 1927 it handled 16,340,070 tons of coal. Foreign commerce was represented in 1927 by imports valued at $2,456,795 (nearly all wheat) and exports of coal, corn, wheat and crude oil valued at $9,305,602 Domestic receipts amounted to $14,540,576 (largely iron ore, wheat, flax and oats), domestic shipments to $64,341,580, of which $7,868,450 represented automobiles and most of the remainder ($55,203,015) coal received by rail from the Ohio, Kentucky and West Virginia fields Toledo has a large wholesale trade, and is one of the leading markets of the country for clover seed, hay and grain, coffee and spices and winter vegetables Its manufacturing industries are important and highly diversified, with an aggregate output in 1927 valued at $437,499,441. The assessed valuation for 1925 was $584,523,250.

The site of Toledo lies within an immense tract acquired by the United States from several Indian tribes in 1795. A stockade fort (Ft. Industry) was built here about 1800. In 1817 two companies bought from the government most of the land now occupied by the city, and laid out two towns, Port Lawrence in 1817 and Vistula in 1832. They were united in 1833 under the name of Toledo, and in 1837 the town was chartered as a city The "Toledo War" was a dispute over the boundary line between Ohio and Michigan, both claiming a strip of rich agricultural land within which lay the site of Toledo, even then recognized as of great commercial importance. In 1818 the Ohio legislature accepted the "Harris line" (surveyed in 1817 in accordance with the State Constitution) and in 1835 the legislature, on the recommendation of Governor Lucas, passed an act providing for the organization of new townships in the territory thus added, and for the appointment of three commissioners to re-mark the northern State line On the appointment of the commissioners Governor Mason of Michigan ordered out a division of the territorial militia, which late in March 1835, took possession of Toledo. A division of Ohio militia marched to Perrysburg, 10 m south of Toledo Meanwhile President Jackson had sent Richard Rush of Philadelphia and Benjamin C Howard of Baltimore to Ohio as peace emissaries, and on their arrival at Toledo both forces disbanded. In June the Ohio legislature created Lucas county, mostly from the disputed territory, and made Toledo its judicial seat In June 1836, Congress decided the dispute in favour of Ohio, and in 1837 Michigan was admitted to the Union on condition of relinquishing all claim to the strip in question, receiving the upper peninsula by way of compensation. In 1840, three years after its incorporation, Toledo had a population of 1,222. Toledo's city administration became famous under the mayoralty of Samuel Milton ("Golden Rule") Jones (1846–1904), a manufacturer who was first elected by the Republican Party in 1897, and then re-elected on a non-partisan ticket in 1899, 1901 and 1903. He introduced business methods into the city's affairs,

and won his nickname through his honesty and sincerity in both business and politics. The independent movement started by him was carried on by Brand Whitlock (*q.v.*), mayor in 1906–13.

TOLEDO, COUNCILS OF. From the 5th to the 16th century about thirty synods, variously counted, were held at Toledo in Spain. As nearly one hundred early canons of Toledo found a place in the *Decretum Gratiani*, they exerted an important influence on the development of ecclesiastical law. The last council of Toledo was that of 1582 and 1583

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TOLENTINO (anc *Tolentinum Picenum*), a town of the Marches, Italy, in the province of Macerata, 11 m by rail W by S. of that town Pop (1921) 5,184 (town); 13,065 (commune). It is situated on the Chienti, 735 ft above sea-level, and was once a fortified town of great strength The church of S Nicholas of Tolentino has a fine portal by the Florentine Giovanni Rosso (1435) At Tolentino in 1815 a battle was fought in which the French under Murat were defeated by the Austrians

TOLERANCE. Manufacturing on the interchangeable system, which originated in the production of fire-arms, requires that pieces to fit together shall not exceed a certain maximum dimension or fall below a certain minimum dimension The margin of error between the maximum and minimum dimensions is termed the tolerance Exact sizes being a mechanical impossibility, the machines and tools which make the parts of an engine or machine are set and maintained to cut or grind such parts within certain limits The finer the limits the more costly the manufacturing becomes, hence the tolerances or margins must be calculated according to the class of work produced, *e g*, it is not necessary to work so closely on the parts of a large engine or machine as it is on a small mechanism or tool Grades of tolerance are therefore tabulated for various needs Tolerances usually range from the maximum amount of variation that the grade of work will permit to $\frac{1}{10,000}''$; thus the diameter of a shaft might have a tolerance of $\pm\frac{1}{1,000}''$ indicating that the shaft is permitted to be larger than standard by this amount or smaller by the same amount In the uni-lateral system the tolerance is expressed in only one direction. For example, $-\frac{1}{10,000}''$, and the diameter of the shaft might be basic size or $\frac{1}{10,000}''$ under basic size *Allowance*, a term distinct from tolerance, denotes the difference in the size of two mating pieces to make a particular quality of fit, either a tight force fit, an easy push fit or a running fit

TOLFA, a town of the province of Rome, Italy, 10 m E N E of Civitavecchia by road, 1,558 ft above sea-level Pop. (1921), 4,554. It is the chief place in the Tolfa Mountains, an extinct volcanic group between Civitavecchia and the Lake of Bracciano Vapours are emitted which deposit sulphur and alum, and alum mining is carried on The alum is treated both here and at Civitavecchia. Near Tolfa and Allumiere tombs of the early (pre-Benacci) Villanovan period, belonging to the 12th century B C. have been found.

See R. MacIver, *Villanovans and Early Etruscans* (Oxford, 1924).

TOLL, JOHAN KRISTOFFER, COUNT (1743–1817), Swedish statesman and soldier, was born at Mollerod in Scania, the son of one of Charles XII.'s warriors. He served in the Seven Years' War In the *coup d'état* of 1772 he ranged himself on the side of Sprengtporten (*q.v*), and was told to capture the southern fortress of Kristianstad By sheer bluff he won over the whole garrison on Aug 21, seven days later. Gustavus III.'s *coup d'état* at Stockholm completed the revolution. Toll was liberally rewarded. In 1783 he was placed at the head of the secret "commission of National Defence," which ruled Sweden during the king's absence broad In 1786 he had risen to the rank of major-general and was Gustavus's principal adjutant

After the death of Gustavus III., Toll was for a short time war minister and commander-in-chief in Scania, and was sent later as ambassador to Warsaw. Unjustly involved in the "Armfelt conspiracy," he was condemned to two years' imprisonment, but was reinstated in 1796 when Gustavus IV. attained his majority. At the riksdag of Norrköping, 1800, he was elected marshal of the diet and was an able leader of the royalist party. He carried on the negotiations with the Powers concerning Sweden's participation in the war against Napoleon. In the Pomeranian campaign of 1807 he helped to defend Stralsund, and on its surrender to Marshal Brune on Aug. 20, he persuaded the latter (Sept 7) to make a convention by which the Swedish army was allowed to return unmolested to Sweden, and was rewarded by his marshal's bâton In 1814 Bernadotte created Toll a count.

See R Nisbet Bain, *Gustavus III. and his Contemporaries* (1895), K N Liliekrona, *Faltmarskalken Grefve J. K. Toll* (Stockholm, 1849–50). (R. N. B)

TOLLER, ERNST (1893–), German poet, was born in Samotschin on Dec. 1, 1893. On the outbreak of the World War he joined the army as a volunteer, but was invalided out. A Socialist and friend of Kurt Eisner, Toller took a very prominent part in the Munich revolution of 1919, for which he was sentenced in July 1919 to five years' imprisonment in a fortress. He achieved celebrity with his revolutionary dramas *Die Wandlung* (1920); *Masse-Mensch* (1921; Eng trans. 1923), *Die Maschinenstürmer* (1922; Eng. trans 1923) and *Hinkemann* (1924); and with two volumes of lyrics, written in prison, *Gedichte der Gefangenen* and *Das Schwalbenbuch* (1924, also Eng trans). His *Masse-Mensch* ("Masses and Man") was greeted in many circles as exemplifying a new theatrical technique and had much influence on the Russian theatre

See S. Grossmann, *Ernst Toller, Hochverrater und Dichter* (1919)

TOLSTOY, Count Leo (Lyov) Nikolayevich (1828–1910), Russian novelist and moral philosopher, was born on Aug 28, (Sept 9,) 1828, at his parents' country-place of Yasnaya Polyana, in the province of Tula. The Tolstoys are a family of Russian gentry dating back to the 16th century (*not* of German origin as is often affirmed, and as Tolstoy himself believed). Peter Andreyevich Tolstoy (*q v*) was created a count by Peter the Great. His descendant, count Nicholas Ilyich, the novelist's father, after serving as an officer in the army, married Princess Marie Volkonsky, who brought him a substantial fortune. They had five sons of whom Leo was the youngest but one The surroundings in which he grew up were those of a family of the upper middle gentry of the last of the period of serfdom This environment produced in him the "peer-and-peasant" view of life.

Early Years.—Tolstoy's mother and father died in 1831 and 1837, and he was brought up by elderly female relatives. His education was in the hands of French tutors, a state of things that was already an anachronism So his intellectual and cultural groundwork was mainly 18th century French, and his contact with contemporary Russian culture was late and unsympathetic In 1844 Tolstoy matriculated as a student of Kazan university, which was then probably the greatest seat of learning east of Berlin. But he worked little, and early developed an attitude of contempt for academic learning. He spent most of his time in society, Kazan being a social centre for the Russian gentry second only to St. Petersburg and Moscow In his old age he remembered with gratitude these years of unreflecting happiness. But his questioning mind was already asserting itself, and it is to his Kazan years that he assigns the "tremendous" influence on him of the works of Rousseau In 1847 he gave up the university and settled at Yasnaya Polyana with the intention of farming and looking after his serfs But he found himself unprepared for the work he had undertaken, and the attempt ended in failure.

The next years were mainly passed in Moscow, where he gave himself over to the dissipated and irregular life so frequently led by the young men of his class and time. But the work of self-study and self-criticism, of which his diary, started in 1847, is such a remarkable record, went on, and the idle life could not satisfy him. In 1851 he turned a new page: he went to the Caucasus and there enlisted as a *junker* (gentleman-volunteer) in an artillery unit. His time was spent in quiet garrison life in Cossack villages, diversified by hunting and occasional expeditions against the mountaineers. In 1852 he completed his first story, *Childhood*, and sent it to Nekrasov, the editor of the leading liter-

ary review, who accepted it enthusiastically and had it published at once In 1854 Tolstoy received his commission, and was transferred (on his application) to the army that was operating against the Turks on the Danube, and a few months later to Sevastopol, where he remained till the end of the siege. After the fall of the fortress he was sent with dispatches to St Petersburg, where he remained, frequenting society and literary circles, and much preferring the former to the latter. With the *littérateurs* he failed to get on Their plebeian arrogance shocked him, and he had no respect for their ideal of European progress. His resounding quarrel with Turgeniev may be taken as typical of these relations In 1857 he retired from the army.

In the same year (and again in 1860) he travelled abroad, and (like Dostoyevsky a few years later) brought back nothing but disgust with the materialistic and plutocratic civilization of the west After his second journey abroad he settled at Yasnaya Polyana, and accepted an appointment to a magistracy introduced by the Emancipation act of 1861 for the settling of land disputes between the squires and their former serfs He also started a school for peasant children on new and original lines, based on his belief in the superior value of their natural lights to the artificial standards of civilization, and published a journal (*Yasnaya Polyana*) devoted to the advancement of his pedagogical ideas But before long he gave up both magistracy and school. He was on the brink of an inner crisis.

The crisis, however, did not mature till 15 years later. it was postponed by his marriage He had been contemplating marrying for some time His romance with Valeria Arseniev had ended in nothing He was obsessed by grave misgivings and doubts before he proposed to Sophie Behrs, a young girl 16 years his junior, with whom he fell in love in 1861 He overcame them, however, and they were married in the following year

Literary Works (1852–76). Tolstoy's literary work grew out of his diary. It was primarily an attempt to lay bare the *mechanism* of the inner life, and to give clear and verbal definition to the semi-articulate processes of the consciousness His first literary attempt, *The Story of Yesterday* (1851, first published 1926) sets out to give an exhaustive account of his feelings and reactions during a given space of twenty-four hours. His first completed and published work, *Childhood* (1852), less exuberantly analytical and more conventional in form, reveals a greater command over the more intimate and elusive movements of the consciousness than had ever before been displayed in literature In the stories that followed he further perfected his instruments of analysis, often to the detriment of the imaginative unity of the work At the same time a conflict which was to remain dominant throughout his life comes to the forefront—the conflict between spontaneous, unreflecting, natural Life and the claims of reason and moral law In *The Cossacks* (written 1854, published in what the author regarded as an unsatisfactory form in 1862) the victory rests with life. natural man, unconscious of good and evil, and consequently beyond the reach of ethical reason is glorified in the Cossacks who put to shame the reflecting and impotent hero, Olenin The futility, meanness and vulgarity of civilized man is exposed again and again in *Two Hussars* (1856), *Lucerne* (1857), *Three Deaths* (1859) and in *Kholstomer* (1861), a very characteristic satire on the life of the upper classes, in which the rôle of the intelligent savage of 18th-century literature is played by a racehorse All his early work is subjective, and the reflecting and introspective character, whether his name is Olenin or Nekhlyudov (as in *Boyhood*, 1854, and *Youth*, 1857) is always Tolstoy himself The other men whose feelings are analyzed, are merely types of "man in general" —psychological mechanisms of cause and effect, devoid of personality. Such for instance are the officers of the *Sevastopol* stories (1855) in whom Tolstoy dissects the components of fear and courage.

After his marriage Tolstoy lived at Yasnaya Polyana, passing some part of the year at Moscow and on his estate beyond the Volga. His married life was happy and prosperous His income was increased by successful farming and the sale of his books. His wife was entirely devoted to him and to her children of which she bore him nine. His inner conflict was lulled for many years by the triumph of spontaneous life over questioning reason His philosophy in those years was "that one should live so as to have the best for oneself and one's family," and not try to be wiser than Life and Nature.

This philosophy found its full expression in the first of his few great novels, *War and Peace* It was commenced in 1864 and completed in 1866 After that he turned again for a time to pedagogical writings, and made several attempts at other historical novels, including one on Peter the Great, that remained unfinished, because of the invincible repulsion aroused in him by the proposed hero In 1873 he began *Anna Karenina*, which appeared in instalments from 1875 to 1877 Towards the end of his work on this second of his great novels he entered on the prolonged and fateful crisis that resulted in his conversion. Indications of its approach are clearly visible in the latter part of the novel

War and Peace and *Anna Karenina* are Tolstoy's masterpieces They mark, in a certain sense, the highest point reached in its development by the modern realistic novel Literary realism attains in them its goal. an adequacy of the verbal pattern to the living reality which ultimately produces the feeling, familiar to readers of Tolstoy, that his characters are to be classified with people in flesh and blood not with other characters in fiction This supreme achievement was largely prepared for by his previous apprenticeship, but *War and Peace* marks an enormous advance over all that had preceded it The countless characters that fill the stage are seen not from outside only, but from the inside The women in this respect are particularly remarkable, and among them most of all Natasha who is the centre of the novel, the embodiment of its philosophy, the quintessence of spontaneous nature-wise mankind Nor does the author introduce himself so crudely as he does in his earlier work, but is transformed into the two distinct and objective characters of Prince André and of Pierre With its world of characters, and against its vast background of Russian and European history the novel is a real piece of life, transformed by art The novel is markedly optimistic, and has not without propriety been described as an idyll of the Russian landed gentry Not that the horrors of life are entirely absent but they are overcome by the beneficent influence of a benevolent Life-god presiding over the action The idyllic atmosphere is preserved in the greater part of *Anna Karenina*, which as a whole marks no advance on *War and Peace*, though each of the individual characters (and again especially the women) come up to the same level, and even, perhaps, present a greater variety of persons entirely different from the author and seen from inside

His Conversion.—About 1876 Tolstoy began to feel uneasy about the unreflecting and prosperous life he was leading, the thought of approaching death grew into an invincible obsession, and the passionate craving for a religious justification of his life became the dominating force in him At first he turned to the orthodox faith of the people, hoping that a religion that made so many millions happy in the midst of their misery would save him, but the proud rationalism of his mind could not accept its rites and fasts, he renounced the Church, and out of his own reading of the Gospels gradually evolved a new Christianity, from which all the metaphysical and non-ethical elements were eliminated The decisive stage in this conversion, he tells us, was the moment when he realized that the whole message of Christ was contained in the words (Matt 5, 39) "that ye resist not evil." This doctrine of non-resistance became the foundation of the creed which soon became known as Tolstoyism (tolstovstvo)

It is necessary to distinguish two stages in this conversion: the initial pang of despair. and disgust with unjust and fleshly life, and the subsequent efforts to reduce this essentially mystical and incommunicable experience to a logical and consecutive doctrine Tolstoy gave a complete account of his conversion in *A Confession* (written 1879, revised 1882, published 1884). It is a work of great imaginative sincerity and tremendous rhetorical power worthy to rank by the side of the *Confessions* of St Augustine But the initial and more essential stage of despair is recorded with even greater power in a fragment, posthumously published, *The Memoirs of a Madman* (1884). The same experience is at the base of the two greatest imaginative works of his old age—*The Death*

of Ivan Ilyich (1884) and *Master and Man* (1895).

At first Tolstoy took no steps to propagate his new faith. It was not till after the revelation of social misery he had in a visit to the Moscow slums that his religion assumed a definitely social coloring, and not till his intimacy with V. G. Chertkov that "Tolstoyism" became an organized sect, and began to acquire proselytes This happened in 1884

Tolstoy's Teaching.—Tolstoy's religion expounded in *What I believe in,* and in *A Short Exposition of the Gospels,* is based on the natural light immanent in the human conscience which reveals to us the God that is the supreme Good and Reason God is not personal, and there is no personal immortality Jesus was a great man, whose teaching is true not because he was the Son of God, but because it coincides with the light of the human conscience. The Buddha and other men were as great, and Jesus holds no monopoly of the truth Tolstoy advanced no metaphysics and no image of the world order His religion is purely anthropocentric. God and the Kingdom of God are "inside us." The aim of man is to achieve happiness, which can be done only by doing right, by loving all men, and by freeing oneself from the appetites of greed, lust and anger All forms of violence are equally wicked. Not only war but all forms of compulsion inherent in the State are criminal. The true Christian must abstain from participating in them; he must refuse conscription; he must not accept any work under the State; he must not sit on a jury. Opposing the State with violence is also wicked and cannot lead to any better forms of life Revolutionary activity, though it may be based on the good feeling of love for the oppressed, is evil because it breeds hatred and violence. The social order can become better only when all men have learned to love each other. Still there is a great difference in Tolstoy's attitude to the State and to the Revolutionaries, he disapproves of the latter, but all the force and bitterness of his invective is kept for the former Property, as the gratification of greed and lust and the assertion of a single man's monopoly over things that belong to all, is wicked. It is the chief source of violence and so on. The rich have built up a corrupt and artificial civilization, and created for themselves fictitious values, which must be got rid of The poor, however demoralized by servitude, have preserved their good nature in greater purity because they have not been corrupted by the artificial culture of the rich. Love and compassion must be extended to all living things, and abstention from the flesh of slaughtered animals is a characteristic tenet of Tolstoyism So are abstinence from intoxicants and drugs (particularly tobacco), the artificial demand for which was created by a corrupt civilization, and which dim the natural conscience of man.

Tolstoy can hardly be called a social reformer for he advanced no practical proposal for the improvement of social conditions. He did not believe in the possibility of reform in the accepted sense of the word. The first duty of the true Christian being is to abstain from living by the work of others, and from taking part in the organized violence of the State. The only practical measure he advocated was the solution of the land question by means of the land tax of Henry George. His disapproval extended to the organized violence of Western capitalistic democracy as well as of Russian autocracy.

On the whole, the direct influence of Tolstoy's teaching in Russia was not great His disciples were never numerous (and seldom of a very high quality) He established relations with many dissenting Russian sects, but most of these (*e.g*, the ***Doukhobors,*** *q v*) were essentially alien to him in spirit. His larger influence, however, was immense, and very soon crossed the frontier. In the last 15 or 20 years of his life he was probably the most venerated man in the world His fame reached into China and India as well as Europe and America Visitors from all ends of the world made Yasnaya Polyana a new Mecca

From the first, the Russian Government viewed Tolstoy's new activity with hostility. But it never attempted to do anything against him. Some of his more anti-Orthodox writings, as well as some of his bitterest attacks on the Romanoff dynasty had to appear abroad. But what appeared in Russia was quite sufficient for a complete acquaintance with his teaching. In 1901 the Synod of the Russian Church excommunicated him,—an act which has been much misinterpreted and which merely registered a fact he had himself proclaimed many years earlier, viz., that he had ceased to belong to the Church. On the other hand many of Tolstoy's followers suffered imprisonment and banishment to Siberia chiefly for refusal of military service.

Tolstoy's conversion changed his attitude to his literary creation He did not abandon it, nor did it deteriorate in quality, but it became different, so did his views of its social and moral function. They are contained in *What is Art* (1896), one of the most remarkable books ever written on the subject. Art, according to Tolstoy, is a means of emotional communion, a means by which the artist "infects" other people with feelings he has himself experienced. If this "infection" does not take place there is no art. If it is limited to a small number of persons of the same class, time or nationality as the author, it is negligible and inferior art; if the appeal extends to mankind in general, but the feelings thus communicated are evil feelings it is genuine but evil art; if the feelings are good, it is good art and if they are the highest feelings possible, the religious feelings of love and compassion, it is the highest form of all, religious art. The application of these standards led Tolstoy to reject or to minimize by far the greater part of modern art and literature, including his own early work, which had exalted the life of the rich and idle. This change of attitude went hand in hand with a change in his literary taste He rejected the "superfluous detail" of realism not only because it limited the appeal of literature to those familiar with the society described, but because it ceased to satisfy him aesthetically Already in 1873 he had written some stories for the people, in which everything that was not essential for the narrative development had been rigorously eliminated. From 1884 onwards he wrote a number of new stories of the same kind, masterpieces of chaste and classical narrative technique at the service of one unifying and crystallizing idea, the idea of ethical Christianity

The same method, on a larger scale, is applied in *Father Sergius,* in *The False Coupon,* and in *Hadji-Murād* (1896–1904) which was the favourite work of his old age and which he intended as an example of good art appealing to the sense of human brotherhood, though not to the highest religious feelings

Apart from these works stands *Resurrection* (published in 1899–1900) in which he returned to his old "superfluous-detail" and which consequently failed to satisfy him. It contains beautiful passages in the idyllic style of *War and Peace,* and pages of powerful satire on the evil social order, but it falls short of being a masterpiece

The most important imaginative work of his last period are the stories based on his inner experience—those connected with his conversion (*The Death of Ivan Ilyich, Master and Man, The Memoirs of a Madman*), and those in which he embodied his experience of sex, the *Kreutzer Sonata* (1889) and *The Devil* (1889, pub. 1911). The former group in particular stands in importance by the side of *War and Peace* The atmosphere pervading them is totally different: they are as grimly tragical as the earlier novel is idyllic. They are on a level with the greatest religious writings of the world.

Tolstoy's plays (with the exception of a comedy written in 1863 and published in 1926) all belong to the period after his conversion. They include *The Power of Darkness* (1889), a powerful drama of peasant life; *The Fruits of Enlightenment* (1st ed., 1891; 2nd ed., 1911), a light comedy satirizing the fads of "society," and *The Living Corpse* (pub. 1911), one of his last writings in which there is a mellowness of old age, and in which the character creator of *War and Peace* makes his last appearance.

Last Years.—Tolstoy's conversion led to his adopting a new mode of life—he dressed like a peasant, did much manual work learned bootmaking and adopted a vegetarian diet. His wife and children (except his youngest daughter, Alexandra) remained hostile to his teaching and the Countess Tolstoy would not hear of his renouncing his worldly belongings which, she maintained, be held in trust for his children. So he made over all his property (including the copyright of his works written before 1880) to her. The paradoxical situation arose of the preacher of poverty and

abstention continuing to live in affluence surrounded by a family who disapproved of his views, but adored him. The first tension between him and his wife was followed by a rapprochement, cemented by the birth in 1886 of a sixth son. But the death of the little boy at the age of seven was followed by an increasing estrangement between husband and wife. She grew increasingly hysterical, embittered and tactless, and life at Yasnaya became a hell, a constant state of war between the family and followers of Tolstoy, between Countess Tolstoy and Chertkov Tolstoy suffered deeply from the incongruity of his position at home At last on Oct. 28, 1910, he left home secretly at night with his daughter Alexandra He had no particular aim in view. His health broke down at Astapovo (gov. of Ryazan) He was laid up there in the station-master's room, and he died on Nov. 8 (21), 1910. He was interred at Yasnaya, without a Christian burial.

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TOLSTOY, ALEXEI KONSTANTINOVICH, COUNT (1817–1875), Russian novelist, dramatist and poet, was a distant relation of Leo Tolstoy Born at St. Petersburg on Sept 5, 1817, and brought up on his uncle's estate at Tchernigoff, which he inherited in 1836, he was a playmate of the Emperor Alexander II. He studied at the university of Moscow, and was afterwards attached to the Russian Legation at Frankfurt and served in the Crimean War He held various court appointments, and spent much time in western Europe He died at his Tchernigoff estate, Krasni Rog, on Oct 10, 1875 With his two cousins Zhemchuzhnikov, Tolstoy wrote between 1853 and 1863 much satirical nonsense-verse under the joint pseudonym of a fictitious civil servant, Kosma Prutkov. He also wrote some magnificent lyric poetry; one of his most famous pieces, a paraphrase of the lament for the dead in the Russian church service, is translated by Maurice Baring in the *Oxford Book of Russian Verse.* Outside Russia, however, Alexei Tolstoy is best known by his historical romance, *Prince Serebrany* (1863) (Eng trans. by C A Manning, 1927), and his dramatic trilogy *Death of Ivan the Terrible* (1866; Eng trans. by A. Hayes, 1926); *Tsar Feodor Ioannovich* (1868; verse trans A. Hayes, 1924), and *Tsar Boris* (1870) Some of his poems are translated in C T Wilson's *Russian Lyrics in English Verse* (1887); Anglo-Russian Literary Society, Nos. 21, 23, 25, and J Pollen's *Rhymes from the Russian* (1891)

See A. Lirondelle, *Le Poète Alexis Tolstoï* (1912).

TOLSTOY, PETR ANDREEVICH, COUNT (1645–1729), Russian statesman, was the son of the *okolmnichy* Andrei Vasilevich Tolstoy.

Even before Poltava, Tolstoy had the greatest difficulty in preventing the Turks from aiding the Swedes, and when Charles XII. took refuge on Turkish soil he instantly demanded his extradition. This was a diplomatic blunder, as it only irritated the already alarmed Turks; and on Oct. 10, 1710, Tolstoy was thrown into the Seven Towers, a proceeding tantamount to a declaration of war against Russia. On his release from "this Turkish hell," in 1714, he returned to Russia, was created a senator, and closely associated himself with the omnipotent favourite, Menshikov. In 1717 his position during Peter's reign was secured once for all by his successful mission to Naples to bring back the unfortunate tsarevich Alexius, whom he may be said to have literally hunted to death

Tolstoy materially assisted Menshikov to raise the empress consort to the throne on the decease of Peter (1725), and the new sovereign made him a count and one of the six members of the newly instituted supreme privy council When Menshikov, during the last days of Catherine I, declared in favour of Peter II, Tolstoy endeavoured to form a party to promote the accession of Catherine's second daughter, the tsarevna Elizabeth. But Menshikov was too strong and too quick for his ancient colleague On the very day of the empress's death (May 11, 1727), Tolstoy, now in his eighty-second year, was banished to the Solovetsk monastery in the White Sea, where he died two years later

See N. A. Popov, "Count P A. Tolstoy" (Russ) in *Old and New Russia* (St Petersburg, 1875), and "From the Life of P. A Tolstoy" (Russ) in *Russian Reporter* (St Petersburg, 1860); R N. Bain, *Pupils of Peter the Great* (London, 1897); and *The First Romanovs* (London, 1905). (R. N. B)

TOLTEC, a people frequently referred to in Aztec legend as formerly dominant in the region of the valley of Mexico, and associated with the ruins at Tollan (now Tula), that is, "Toltec place," but literally, place of tules or rushes Their greatest preserved monuments, however, are at San Juan de Teotihuacan 30m north-east of Mexico city; and the terms Toltec and Teotihuacan are used by different archaeological schools as names of the same period. Cholula, one of the large cities of Mexico in 1519, was associated with the Toltec traditionally; and in a measure Tezcoco In Yucatan, Toltec influence is visible in ball courts, art style, etc, in the late Maya cities, especially Chichen Itzá The legends or myths of the hero Quetzalcoatl (Kukulcan in Maya) associate him with the Toltec; and as he was the reputed institutor of higher culture, the Toltec were considered the first bearers of arts and knowledge, which is probably true for the region Tula-Mexico-Cholula Brinton looked upon the Toltec as a mythical invention by the Aztec, a view significant only as a valid reaction against a former too credulous acceptance of the details of native tradition The Toltec presumably were Nahua speaking; they may have been at their zenith about A D 900, and suffered decline about A D. 1100

TOLUCA, a city of Mexico and capital of the State of Mexico, on the south-west border of the Anahuac plateau, about 8,650 ft. above sea-level. Pop (1921) 34,265 Toluca is on the Mexican National railway, 45 m west-south-west of the national capital Its situation gives it a cool climate The Government has a meteorological station here and a national college. The Nevado de Toluca, an extinct volcano, rises to a height of 14,950 ft on the south-west side of the town

TOLUENE or Methylbenzene, a constituent of the light oils distilled from coal tar (*q v*), is a colourless mobile liquid boiling at 111° C/760 mm and having a density of 0 8812 at 4° C. It is insoluble in water but dissolves readily in alcohol or ether Toluene (*Ger* Toluol), an aromatic hydrocarbon (*see* CHEMISTRY, ORGANIC), is an important starting point in the manufacture of intermediates and synthetic colouring matters (*See* BENZALDEHYDE; BENZOIC ACID, DYES, SYNTHETIC) Its mononitro-compounds furnish ortho- and para-toluidines, two valuable bases employed in the production of magenta and other aniline dyes During the World War toluene was in such great demand for the manufacture of the high explosive trinitrotoluene (*see* T N T) that its output from coal tar had to be supplemented by supplies from other sources such as Borneo petroleum

On sulphonation toluene yields mainly two sulphonic acids, of which toluene-ortho-sulphonic acid is employed in the production of saccharin (*q v.*)

Originally discovered by Pelletier (1838) in an oil obtained from the resin of *Pinus maritima* it was subsequently prepared by Sainte-Claire Deville (1841) on distilling tolu balsam It is to the

latter circumstance that the hydrocarbon owes its name. Its relationship to benzene was established by acting with sodium on a mixture of methyl iodide and bromobenzene and also by condensing benzene and methyl chloride in the presence of dry aluminium chloride.

Oxidation of toluene leads successively to benzaldehyde and benzoic acid, whereas its hydrogenation furnishes hexahydrotoluene *p-tolualdehyde*, a pungent oil (b p 204° C), results from the interaction of toluene with carbon monoxide and hydrogen chloride in the presence of aluminium and cuprous chloride, or from hydrogen cyanide and hydrogen chloride with aluminium chloride.

See T E Thorpe, *Dictionary of Applied Chemistry*, Vol VII, 1927 (G T. M)

TOMA, a small, light-complexioned, muscular folk, in French Guinea, who speak a language related to the Mande-Fu group

See Gamory-Dubourdeau, "Notice sur les coutumes des Toma," *Bulletin, Comité Études—Hist. et Scient d'Afrique Occidentale* (1925).

TOMASZÓW, an industrial town of Poland, in the province of Lodz Pop (1921), 28,300 It has woollen mills, iron-works and steam flour-mills, and is the centre of the silk industry

TOMATO, the name applied to various species of plants known botanically as *Lycopersicum*, a genus of the family Solanaceae, to which the potato, tobacco and egg-plant also belong There is doubt as to the distinction of the cultivated species of tomato *L esculentum* includes the varieties of the common tomato, *L pimpinellifolium* is the currant tomato, *L cerasiforme* the cherry tomato and *L pyriforme* the pear tomato, though the last two are sometimes considered mere varieties of *L esculentum* The common tomato with large fruits containing a number of cells is *L esculentum* var *commune;* the red or yellow fruits are of the nature of berries The plant has been much altered by cultivation and now more than 150 so-called varieties are on the market The seeds of the tomato were brought by the Spaniards from South America and the fruit was for some time known as "love apple" Enormous quantities, both fresh and canned, are now consumed annually and it is very extensively grown in Great Britain and the United States Large quantities are grown under glass in the Lea Valley district and the Worthing district in England, and also in the Channel islands (*See* VEGETABLE)

See L. H Bailey, *Standard Cyclopedia of Horticulture* (1914–27) and *Manual of Cultivated Plants* (1924) and W W Robbins, *Botany of Crop Plants* (1924).

TOMB, a broad term for any grave or funerary structure, especially one of relatively large size or with considerable decorative richness Thus the tumuli or barrows used in many parts of northern and eastern Europe during the bronze and early iron age, the structures over a grave, common in Roman, mediaeval and modern times, structures containing a sarcophagus in which the body is placed, and those richly ornamented sarcophagi in niches or shrine-like constructions in the interiors of churches, all come under the general name, tomb. (*See* also BARROW, BURIAL AND FUNERAL RITES; CAIRN, MAUSOLEUM; SARCOPHAGUS, TUMULUS) Since knowledge of the past is so largely gleaned from ancient burials, tombs play a most important part in all archaeological study, particularly in that of very ancient times, prior to written records (*See* ARCHAEOLOGY)

Ancient.—Architecturally, tombs reach importance only with the development of Egyptian civilization, towards the end of the 4th millennium B C The early dynasty tombs are largely of the mastaba (*q v*) type, consisting of low, flat-roofed, masonry structures, with the tomb chamber itself sunk in the rock below, royal tombs of this period almost always took the form of pyramids (*q v*) During the middle kingdom, rock-cut tombs in cliff sides largely superseded the earlier types, they were usually fronted by a colonnaded porch In the later empire, even this exterior embellishment disappeared, and tombs were merely chambers cut deep in the rock, at the ends of long tunnels, with inconspicuous entrances. Many types of tomb are found in western Asia, both prior to and after the dominance of Hellenic Greek culture. Those of Lydia and Lycia are particularly remarkable. In Greece the most interesting type of pre-Hellenic tomb is the tholos or bee-hive type, roofed in corbelled masonry, and evidently imitating in shape a primitive house form The so-called tholos of Atreus at Mycenae (*c* 1200 B C.) is typical Other rectangular types are, however, found On the Greek mainland, during the Hellenic period, tombs were largely superseded by simple graves or funerary urns, the gravestones, or stele, were of great beauty though small in size In Asia Minor, on the other hand, tombs were often large and lavish The climax was reached in the mausoleum (*q v.*) erected to enshrine the body of King Maussolos (353 B C) In the Roman world tombs of every type are found The Italians early built elaborate tombs, especially famous are those at Cervetri and Volterra, and others at Vulci and near Perugia. These Etruscan tombs are sometimes of tholos type, sometimes tumuli, and sometimes represent the rectangular interiors of Italian houses, and are richly carved and painted A similar variety is found in Roman tombs There are pyramids (Gaius Cestius, Rome, probably prior to 12 B C), circular or tumulus types like that erected by Augustus for himself in Rome (28 B C) and the much larger and more monumental tomb of Hadrian, now the castle S Angelo, and rectangular, shrine-like structures, like the so-called tomb of Absalom at Jerusalem (? 2nd century A D), or the tomb of Annia Regilla at Rome (end of the 2nd century A D) The greater number of Roman burials were, however, in columbaria (*q v*)

Mediaeval.—In the mediaeval period, owing to the crowded conditions of churchyards, exterior tombs are rare, but tombs of privileged persons within churches common An exception is the group of arcaded tombs of the Scaliger family at Verona (14th century) The interior tombs, particularly common in England, took the form of sarcophagi, bearing a recumbent effigy, like the crusaders' tombs in the Temple church in London, or of little shrines enclosing a sarcophagus, like Prior Rahere's tomb in the church of S Bartholomew the Great, London (1400–05) Of the shrine tombs, the most interesting are the royal tombs in Westminster Abbey, London

Renaissance.—The early Renaissance period saw many tombs of great beauty constructed throughout Europe In Italy, the most common type was a decorated niche containing a sarcophagus An exquisite example is the Marsupini tomb in S Croce, Florence (*c* 1460), by da Settignano The sarcophagus type is also found One of the first monuments in England showing Renaissance inspiration is the tomb of Henry VII in Westminster Abbey, by Torrigiano, the same is true in France of the tomb of the children of Charles VIII in Tours cathedral (1506), by J Juste and M Colombe, and a similar rôle is played in Spain by the "Tomb of the Catholic Kings," in Granada, the tomb of Ferdinand and Isabella, by Fancelli (1517) and of Don Felipe and Donna Juana, by Ordóñez (1520) The most interesting groups of later Renaissance tombs are those of the Venetian churches, and the papal tombs in S Peter's, Rome, the royal tombs in S Denis, near Paris, and the later tombs in the aisles of the chapel of Henry VII, Westminster Abbey In the 18th century, throughout Europe, wall monuments in churches generally superseded tombs, there is, however, a new development of exterior tombs, usually taking the form of a richly decorated sarcophagus, sometimes known as table tombs, common both in England and her colonies.

Oriental.—In Mohammedan countries tombs were reserved for great personages or royal families The richest and most monumental are the domed turbehs of the Turkish sultans in Constantinople, and the tombs built by the Muslim rulers of India, especially the great tomb of Mahmoud at Bijapur (1626–60) and the Taj Mahal (*q v*) at Agra (1632–47)

Chinese tombs vary according to the locality Near Foochow there is a characteristic group in which a cylindrical stele is placed on a terrace in the middle of a crescent-shaped embankment Farther north, near Hangchow, the cylindrical stelae are lower and topped with domes, and a semi-circular wall frequently takes the place of the embankment. The great imperial tombs are entirely different and resemble each other, whether at Nanking, in the western hills near Peking, or in Mukden. They all consist of a series of colonnaded halls crossing a great main axis,

bordered with statues of beasts and men. The royal tombs at Tokyo, in Japan, resemble the Chinese tombs in having a series of great halls, and in being rather temples than simple tombs; the arrangement, however, is more informal, and a characteristic feature of the Japanese tombs is the hundreds of votive, stone lanterns which stand in the courts.

Modern.—The tomb of Napoleon in the church of the Invalides, Paris (1843–61) by Visconti, is a characteristic modern expression of a tomb which has become a national shrine More recent tombs show a continuous development towards an increasing simplicity and the attempt to gain emotional effect by perfection and sincerity rather than by grandeur. (T. F H)

TOMMASINI, VINCENZO (1880–), Italian composer, was born in Rome on Sept. 17, 1880. He studied at the Liceo in Rome and later became assistant director of the Accademia di S. Cecilia His first work of importance was the string quartet of 1910; this was followed by the "Erotic poem" for orchestra and the comic opera *Uguale fortuna* in 1911. The symphonic poem, *Chiari de luna* was produced in 1916, and in 1917 he achieved his great triumph with *The Good-humoured Ladies,* a ballet, founded on Goldoni's comedy. The original performance was in Rome and it has since been played in the principal music centres by Diaghilev's company with great success For the music Tommasini took a selection of the sonatas of Domenico Scarlatti, orchestrating them with much skill and charm Later works are *Il beata regno* (1921) and *Paesaggi Toscani* (1923).

TOMPKINS, DANIEL D. (1774–1825), American politician, was born at Scarsdale, Westchester county, N Y , on June 21, 1774 He graduated at Columbia college in 1795, and was admitted to the bar in 1797 In 1803 he was a member of the State assembly, and in 1804 he was elected to the national House of Representatives, but became a judge of the State supreme court, and served as such until 1807 He was governor of New York in 1807–17; and in 1817–25, during both terms of President James Monroe, was vice-president of the United States In March, 1812, under the authority of the New York constitution of 1777, he prorogued the legislature—the only instance of the exercise of this power During the War of 1812 he was active in equipping and arming the New York militia For this purpose he borrowed much money on his personal security, and sometimes neglected to secure proper vouchers Later the State comptroller announced a shortage of $120,000 in the military accounts, but Tompkins claimed that the State owed him $130,000 Later investigations disclosed that the State actually owed him more than $90,000 He died on Staten Island, N Y , on June 11, 1825

The *Military Papers of Daniel D Tompkins, 1807–1817* (1898–1902) were published by the State. *See* D S Alexander, *Political History of New York,* vol 1 (1906).

TOMPKINSVILLE, a former village of Richmond county, New York, U.S A , since 1898 a part of the borough of Richmond, New York city It is on the north-east shore of Staten Island in New York bay, about 5½ m S by W of the southern extremity of Manhattan Island.

TOMSK, a town of the Siberian Area of the Russian S F S R , in 56° 30′ N , 85° 12′ E , on the right bank of the Tom river and on both sides of its tributary the Ushaika, at an altitude of 485 feet. Pop. (1926) 92,485. The river is frozen from Nov 17 to May 13. A branch line links Tomsk with Taiga on the trans-Siberian railway The town was founded in 1604, but did not become important until 1824, when gold was found in the district and a gold smelting laboratory was later established in the town; the gold industry is now rapidly declining. The town is an educational centre, with a university, library and museum

TOMSKY, pseudonym of Michael Pavlovich Efremov (1880–), Russian politician, born on Oct. 19, 1880, in St Petersburg (Leningrad), was the son of a workman, and became a factory hand at the age of 12 In 1904 he joined the Bolshevik party and was a member of the Reval council of workers' deputies during the revolution of 1905 Between 1906 and 1917 Tomsky suffered various terms of imprisonment and deportation, and was finally sentenced to five years' hard labour in the Moscow Butyrka prison, followed by deportation for life to Siberia Released by the revolution of 1917, Tomsky took part in the Bolshevik July rising in St. Petersburg and the October revolution in Moscow. Afterwards he devoted himself particularly to trade union work, and edited *The Metal Workers' Review.* He was elected member of the Moscow trade union council, and in 1918 became president of the all-Russian central trade union council, with a short interval when he acted as representative of the Soviets in Turkestan On the reorganization of the R S F S R. into the U S S.R he became a member of the central executive committee of the U S S.R.

Tomsky was vice-president of the Soviet delegation to London in 1924, and a member of the delegation to Paris in 1926. He acted as general secretary of the provisional international council of the trade unions from its formation on Aug. 1, 1920, to May 1921, and addressed the British trade unions at the conferences at Hull (Sept. 1924) and Scarborough (Sept. 1925)

His most important writings and addresses are included in the following volumes. *Die Neuen Aufgaben der russischen Gewerkschaften* (1922) , *Der gegenwartige Stand der Gewerkschaftsbewegung in Russland* (1923) , *Getting Together: Speeches Delivered in Russia and England: 1924–25* (1925).

TONALITE, in petrology, a rock of the diorite class, first described from Monte Adamello near Tonale in the Eastern Alps. It may be described as a quartz-diorite containing biotite and hornblende in nearly equal proportions. The principal felspar is plagioclase, but orthoclase occurs also, usually in small amount. With increase in silica, the tonalites pass into the granodiorites (*see* GRANITE)

The hornblende of the diorites is green, sometimes with a tinge of brown; the biotite is always brown and strongly pleochroic Often these two minerals are clustered together irregularly or in parallel growths They have generally a fairly strong tendency to idiomorphism, but may sometimes enclose plagioclase felspar in ophitic manner. Both of them decompose to chlorite, epidote and carbonates The plagioclase felspar, which may form more than one-half of the rock, is andesine or oligoclase; simple crystals are rare, the majority being complex growths with centres of felspar rich in lime, while in the external zones the proportion of soda felspar increases greatly. The inner portions have often well-defined, but very irregular, boundaries, and are sometimes sponge-like, with the cavities filled up with a later, more acid, deposit This seems to indicate that growth has taken place in stages, alternating with periods when the crystallized felspar was corroded or partly dissolved The orthoclase sometimes forms irregular plates enclosing individuals of plagioclase Quartz occurs both in irregular simple grains and as micropegmatite. Occasionally pale green pyroxene is visible in the centre of crystals of dark green hornblende. The accessory minerals apatite, magnetite and zircon are always present, and very common also are orthite in coffee-coloured zonal prisms practically always encircled by yellow epidote, and reddish-brown crystals of sphene, simple or twinned

Externally tonalites are very like granites but are usually darker Towards their margins the larger alpine masses of tonalite often assume banded or gneissic facies, due apparently to movement during intrusion In the south of Scotland (Galloway district) they accompany hornblende- and biotite-granites, hornblende- and augite-diorites. The newer granites of the Highlands of Scotland in many places pass into tonalites, especially near their margins, and similar rocks occur in Ireland Grano-diorites have been described from California, and rocks of similar character occur in the Andes, Patagonia and Lesser Antilles Tonalites are also said to be frequent among the igneous rocks of Alaska (J S. F.)

TONAWANDA, a city of Erie county, New York, U S A , on the Niagara river, 11 m. N of Buffalo, at the western terminus of the State Barge canal. It is served by the Erie, the Lehigh Valley, the New York Central and electric railways. Pop (1920) 10,068 (20% foreign-born white); 1928 local estimate 11,300 Tonawanda and North Tonawanda (*q.v.*), on the opposite side of the canal, though separate municipalities, form practically one community. They have a fine harbour, electric power from Niagara Falls and many large manufacturing industries Tona-

wanda was incorporated as a village in 1854 and as a city in 1903. The name is an Indian word, said to mean "swift water."

TONBRIDGE, a town of Kent, England, 27 m. S.S.E. of London by the S. railway. Pop. (1921) 15,947. It stands above the River Medway, which is crossed by a stone bridge erected in 1775. There are remains of an ancient castle of the Early Decorated period. The castle was formerly defended by three moats, one of them formed by the Medway. Tonbridge school was founded by Sir Andrew Judd, lord mayor of London in the time of Edward VI, and was rebuilt in 1865.

TONE, THEOBALD WOLFE (1763–1798), Irish rebel, the son of Peter Tone, a Dublin coachmaker, was born in Dublin on June 20, 1763. He entered Trinity college, at twenty-two he married Matilda Witherington, a girl of sixteen, took his degree in 1786 and went to London He was entered at the Middle Temple, and afterwards read law in Dublin, being called to the Irish bar in 1789. Tone wrote two pamphlets in 1790, one of which, *A Review of the Conduct of Administration* attracted some notice from the Whigs

Tone made the acquaintance of Thomas Russell (1767–1803), Napper Tandy (*q v*) and others, and the society of the "United Irishmen" was formed (1791). The original purpose of this society was simply the formation of a political union between Roman Catholics and Protestants, to secure parliamentary reform; it was only when that object appeared to be unattainable by constitutional methods that the majority of the members adopted the more uncompromising opinions which Wolfe Tone held from the first, and conspired to establish an Irish republic by armed rebellion Tone desired to root out the popular respect for Charlemont and Grattan, and to transfer to more violent leaders the conduct of the national movement Grattan was a reformer and a patriot without a tincture of democratic ideas, Wolfe Tone was a revolutionary whose principles were drawn from the French Convention Grattan's political philosophy was allied to that of Edmund Burke, Tone was a disciple of Danton and Thomas Paine.

In 1794 the United Irishmen, persuaded that their scheme of universal suffrage and equal electoral districts was not likely to be accepted by any party in the Irish parliament, began to found their hopes on a French invasion An English clergyman named William Jackson, who had imbibed revolutionary opinions in France, came to Ireland to negotiate between the French committee of public safety and the United Irishmen For this emissary Tone drew up a memorandum on the state of Ireland, which he described as ripe for revolution; the paper was betrayed to the government, and in April 1794 Jackson was arrested on a charge of treason. Several of the leading United Irishmen, including Reynolds and Hamilton Rowan, immediately fled the country; the papers of the United Irishmen were seized; and for a time the organization was broken up. Tone, who had not attended meetings of the society since May 1793, remained in Ireland till after the trial and suicide of Jackson in April 1795 He was enabled to make terms with the government, stipulating only that he should not be called on to give evidence against Rowan and the others, and was permitted to emigrate to America, where he arrived in May 1795.

He went to Philadelphia where he met fellow exiles, and the French minister, Adet, who gave him letters of introduction to the Committee of Public Safety in Paris In February 1796 he arrived in Paris and had interviews with De La Croix and L. N. M. Carnot, who were greatly impressed by his energy, sincerity and ability. A commission was given him as adjutant-general in the French army, which he hoped might protect him from the penalty of treason in the event of capture by the English. He drew up two memorials representing that the landing of a considerable French force in Ireland would be followed by a general rising of the people, and giving a detailed account of the condition of the country. The French directory, which possessed information from Lord Edward Fitzgerald (*q.v*) and Arthur O'Connor confirming Tone, prepared to despatch an expedition under Hoche. On Dec. 15, 1796, the expedition, consisting of 43 sail and carrying about 15,000 men, sailed from Brest. Tone, who accompanied it as "Adjutant-general Smith," had the greatest contempt for the seamanship of the French sailors, which was amply justified by the disastrous result of the invasion. The ships were dispersed by a storm off the coast of Kerry.

But the Dutch fleet was delayed by bad weather, and before it put to sea in October, only to be crushed by Duncan in the battle of Camperdown, Tone had returned to Paris; and Hoche, the chief hope of the United Irishmen, was dead. Bonaparte, with whom Tone had several interviews about this time, was much less disposed than Hoche had been to undertake in earnest an Irish expedition; and when the rebellion broke out in Ireland in 1798 he had started for Egypt. When, therefore, Tone urged the directory to send effective assistance to the Irish rebels, all that could be promised was a number of small raids to descend simultaneously on different points of the Irish coast. One of these under Humbert succeeded in landing a force in Killala bay, and gained some success in Connaught before it was subdued by Lake and Cornwallis, Wolfe Tone's brother Matthew being captured, tried by court-martial, and hanged; a second, accompanied by Napper Tandy (*q v*), came to disaster on the coast of Donegal; while Wolfe Tone took part in a third, under Admiral Bompard, with General Hardy in command of a force of about 3,000 men, which encountered an English squadron near Lough Swilly on Oct. 12, 1798.

Tone, who was on board the "Hoche," refused Bompard's offer of escape in a frigate before the action, and was taken prisoner when the "Hoche" was forced to surrender At his trial by court-martial in Dublin, Tone made a manly straightforward speech, avowing his determined hostility to England and his design "by fair and open war to procure the separation of the two countries," and pleading in virtue of his status as a French officer to die by the musket instead of the rope He was, however, sentenced to be hanged on Nov 12; but on the 11th he cut his throat with a penknife, and on Nov. 19, 1798, he died of the wound He was buried in Bodenstown churchyard.

See *Autobiography of Theobald Wolfe Tone*, edited with introduction by R. Barry O'Brien (2 vols, 1893); R. R Madden, *Lives of the United Irishmen* (7 vols, 1842)

TONE POEM: *see* SYMPHONIC POEM

TONGA, the Tonga or Friendly Islands, an archipelago in the S. Pacific Ocean about midway between Fiji and Samoa For the geography, etc., *see* PACIFIC ISLANDS

History.—In 1616 the vessels of Jacob Lemaire and Willem Cornelis Schouten reached the island of Niuatobutabu and had a hostile encounter with the natives. In 1643 Abel Tasman arrived at Tongatabu and was more fortunate. The next visitor was Samuel Wallis in 1767, followed in 1773 by Captain Cook In 1777 Cook returned, and stayed seven weeks among the islands. In 1799 a revolution broke out, and war dragged on for many years, until finally checked by the strong rule of Taufaahau, who became king in 1845, under the name of George Tubou I In 1822 a Methodist missionary had arrived in the island, and others followed The attempt to introduce a new faith led to renewed strife, this time between converts and pagans, but King George supported the missionaries, and by 1852 the rebels were subdued. The missionaries persuaded the king to grant a constitution to the Tongans. A triennial parliament, a cabinet, a privy council, and an elaborate judicial system were established, and the cumbrous machinery was placed in the hands of a "prime minister," a retired Wesleyan missionary, Shirley Baker. Baker induced the king to break off his connection with the Wesleyan body in Sydney, and to set up a State church. Persecution of members of the old church followed, and in 1890 the missionary-premier was removed from the island by British influence.

King George Tubou died in 1893 at the age of 96, and was succeeded by his great-grandson, under the same title. In 1900 a treaty was concluded by which the king placed his kingdom under British protection. On the death of George II. (1918), Queen Salote ascended the throne. Since 1905 British coin has been legal tender in Tonga. Education has been rapidly developed: in 1924 there were 105 public primary schools.

See Captain Cook's *Voyages* and other early narratives; G. Vason,

Four years in Tongatabu (1815); J. Martin, *Mariner's account of the Tonga Islands* (Edinburgh, 1827); A Monfat, *Les Tonga, ou Archipel des Amis* (Lyons, 1893); B. H. Thomson, *The Diversions of a Prime Minister* (1894); for traditions and historical material *see* the *Journals* of the Polynesian Society (New Zealand); P. S. A. Stewart, *Handbook of the Pacific Islands* (1922).

TONGHAK or **CHUNTOKYO,** a religious system of Korea, founded in 1864. The prime object was to preserve all national customs and ideals and oppose Christianity. Its forms are those of Confucianism but its spirit and voice are those of Buddhism and Taoism. The founder, Choi Jaiwoo (崔濟愚, 1824–64), was a great classical scholar with originality in ethical thought. At 16, having lost his father and being very poor, he wandered round the country from his birthplace, Kungchu, South Korea. He was struck by the chaotic conditions, the corrupt officialdom, the poverty and superstition of farmers, the unrest and misery of the towns, and the intellectual degeneracy of the nation. All this made him feel keenly the lack of a religion which could give the people a fresh vision and courage. Buddhism had been banished to mountain solitudes in the 15th century, Confucianism was for the upper classes only, so that there was no religion that could direct the destiny of the masses.

Choi Jaiwoo's belief was that *Chun* or *Tien* (天 god), the creator of all things, made heaven, earth and man; that man is the most intelligent and noble of all creations. Everything exists because there is man, who is as great as God provided he holds fast to God-given qualities Man, in fact, is God (人乃天); they are one, not two *To* or *tao*, an infinite being, existent before the creation of the world, is the way to heavenly doctrine. Thus his teaching, *Tonghak* (東學, Eastern Learning) was called *Chun tokyo* (天道教, Heavenly Way Doctrine).

Since man is the highest of all God's creations, he must enjoy complete freedom and absolute equality. He must realize the self and develop it to be as noble as possible by emancipating body, mind and soul Man is thus the core of the universe The Kingdom of Heaven will exist on earth when all men develop intellectually, socially and spiritually, and for this goal man must pray and work. The founder was accused of heresy and executed on March 1, 1864, in Taiku, South Korea Choi Sihyung (崔時亨, 1827–99) became his successor. He preached the doctrine of his predecessor adding the precept of abstention from flesh, and organized churches throughout Korea. He was hanged for heresy on June 2, 1899 His successor, Son Pyunghi (孫秉熙, 1861–1922) led a Tonghak rebellion. He sent many students abroad and took an active part in the Revolution of 1919; he was put in jail, where he died on May 19, 1922.

The Chuntoists support a number of schools and a college and teach the ideas of western civilization as well as oriental cultural elements. They preach any sacrifice in the cause of humanity and justice. Chuntoist activity in politics and the lack of a doctrine regarding the future life have given rise among Christians to the impression that Chuntoism is not a religious sect; but Confucianism, if judged by the two latter criteria, would also be considered non-religious.

Chuntoism has grown into one of the most potent forces of Korea to-day. Its most prominent leaders are the educator, Choi Rin, and the philosopher, Paik Inho. (Y. K.)

TONGKING, a province of French Indo-China, and protectorate of France, situated between 20° and 23½° N. and 102° and 108½° E., and bounded by China, British Upper Burma, Laos, Annam, and the Gulf of Tongking. Area, 40,530 sq.m. The population is 7,401,912, including 9,143 Europeans. Tongking comprises two regions: (1) the delta of the Song-Koi (Red river), which, beginning at Son-Tay and coalescing with the delta of the Thai-Binh, widens out into the low-lying and fertile plain within which are situated the principal cities. The delta is joined to upper Tongking by undulating country becoming more and more elevated inland and called sometimes Middle Tongking; (2) upper Tongking, a mountainous forest clad country, deeply dissected by the slot-valleys of the Taibinh, the Red River and their tributaries. The main geographical feature in the country is the Song-Koi, which, taking its rise in Yun-nan at more than 2,000 metres above sea level, enters Tongking at Lao-Kay, and flows thence in a south-easterly direction to the Gulf of Tongking. It was this river which mainly, in the first instance, attracted the French to Tongking, as it was believed that, forming the shortest route by water to Yun-nan, it would prove to be the most convenient and expeditious means of transporting the tin, copper, silver and gold which are known to abound there. This belief has proved fallacious because the upper course of the stream is constantly impeded by rapids, the lowest being about thirty miles above Hung-Hoa Beyond Lao-Kay navigation is impracticable during the dry season, and at all other times of the year goods have to be there transferred into light junks. Near Son-Tay the Song-Koi receives the waters of the Song-Bo (Black river) and the Song-Ka (Clear river), and from that point divides into a network of waterways which empty themselves by countless outlets into the sea The Song-Cau rises in north-eastern Tongking and below the town of Sept Pagodes, where it is joined by the Song-Thuong to form the Thai-Binh, divides into numerous branches, communicating with the Song-Koi by the Canal des Rapides and the Canal des Bambous

The coast line of Tongking from Mon-Kay on the Chinese frontier to Thanh-Hoa, near that of Annam, has a length of 375 m From Mon-Kay as far as the estuary of the Song-Koi it is broken, rugged and fringed with islands and rocky islets The bay of Tien-Hien, to the south of which lies the island of Ke-Bao, and the picturesque bay of Along, are the chief indentations. Beyond the island of Cac-Ba, south of the Bay of Along, the coast is low, flat and marshy.

Although under the monsoon régime, the climate of Tongking is less trying to Europeans than that of the rest of French Indo-China. During the hot season the temperature ranges between 82° and 100° F, but from October to May the weather is cool. The country is subject to typhoons in August and September.

In the wooded regions of the mountains the tiger, elephant and panther are found, and wild buffalo, deer and monkeys are common. The delta is the home of many varieties of aquatic birds. Tea, cardamom and mulberry grow wild, and in general the flora approximate to that of southern China.

The Annamese (*see* ANNAM), who form the bulk of the population of Tongking, are of a somewhat better physique than that of the other Indochinese. Savage tribes inhabit the northern districts—the Muongs the mountains bordering the Black river, the Thôs the regions bordering the Clear river and the Thai-Binh The Muongs are bigger and stronger than the Annamese They have square foreheads, large faces and prominent cheek-bones, and their eyes are often almost straight.

Rice, which in some places furnishes two crops annually, is the most important product of the delta, and the exports of the latter were valued at 149,000,000 francs in 1926. Elsewhere there are plantations of coffee, tobacco, cotton, jute, sugar-cane, etc. The cultivation of silkworms is of growing importance. (Export of raw silk 79,400 kg in 1926.)

Gold, copper, tin, lead and other metals are found in the higher regions of Tongking. There is a large output of coal from Hon-Gay on the bay of Along (Output [1925] 1,363,000 metric tons) The production of phosphates reaches 15,294 tons.

Hanoi, Hai-Phong and Nam-Dinh carry on cotton-spinning, and Hanoi and Nam-Dinh are well known for the manufacture of carved and inlaid furniture The natives are skilful at enamelling and the chasing and ornamentation of gold and other metals The manufacture of paper from the fibrous bark of the paper-tree is a wide-spread industry and there are numerous distilleries of rice-spirit.

In 1926 the imports were valued at 1,700,758,000 francs, while the exports did not exceed 1,316,401,000 francs in value

The transit trade via Tongking between Hongkong and Yun-nan is entirely in the hands of Chinese houses, the tin of the Yun-nan mines and cotton yarns from Hongkong constituting its most important elements. The waterways of the delta are lined with embankments, the causeways along which form the chief means of land communication of the region. (For railways, *see* INDO-CHINA, FRENCH.)

The protectorate of Tongking approaches nearer to direct

administration than that of Annam, where the conditions of the protectorate are more closely observed. Till 1897 the emperor of Annam was represented in Tongking by a viceroy (*kinh-luoc*), but now the native officials are appointed by and are directly under the control of the resident-superior, who resides at Hanoi (pop. 103,235), the capital of Indo-China, presides over the protectorate council, and is the chief territorial representative of France. Tongking is divided into nineteen provinces, in each of which there is a resident or a vice-resident. In each province there is a council of native "notables," elected by natives and occupied with the discussion of the provincial budget and public works. There is also a deliberative council of natives for the whole of Tongking. The provincial administration, local government and educational system are analogous to those of Annam (*q.v.*). Two chambers of the court of appeal of Indo-China and a criminal court sit at Hanoi; there are tribunals of first instance and tribunals of commerce at Hanoi and Hai-Phong. When both parties to a suit are Annamese, it comes within the jurisdiction of the *An-Sat* or native judge of the province.

The local budget for 1927 balanced at 18,017,180 piastres. *See* also INDO-CHINA, FRENCH and ANNAM.

HISTORY

For the early history of Tongking, *see* ANNAM and INDO-CHINA, FRENCH. Tongking was loosely united to Annam until 1801, when Gia-long, king of Annam, brought it definitely under his sway. Having, by the treaty of 1862 and the annexation of Cochin China, firmly established themselves in Annamese territory, the French began to turn their attention to Tongking, attracted by the reported richness of its mineral wealth The invasion of northern Tongking by the disbanded followers of the Taiping rebels offered a pretext for action Hostilities were checked for a time by the Franco-Prussian War (1870–71), but in 1873 Garnier attacked Hanoi as a protest against the hindrances offered to Dupuis, a trader with military stores for Yunnan, and carried the citadel by assault He then sent to Saigon for reinforcements and meanwhile attacked the five other important fortresses in the delta (Hung-Yen, Phu-Ly, Hai-Duong, Ninh-Binh, and Nam-Dinh), and captured them all This provoked the Tongkingese to call in the help of Lu-Vinh-Phuoc, the leader of the "Black Flags" (bands of Chinese rebels infesting the mountainous region of Tongking), who at once marched with a large force to the scene of action. Within a few days he had recaptured several villages near Hanoi, and so threatening did his attitude appear that Garnier, who had hurried back after capturing Nam-Dinh, made a sortie from the citadel, a move resulting in his death and that of his second in command

Meanwhile the news of Garnier's hostilities had alarmed the governor of Saigon, who, wishing to avoid war, sent Philastre, an inspector of native affairs, to offer apologies to the king of Annam. When, however, Philastre heard of Garnier's death, he took command of the French forces, and at once ordered the evacuation of Nam-Dinh, Ninh-Binh and Hai-Duong—a measure which resulted in a general massacre of native converts in the area. In pursuance of the same policy Philastre made a convention with the authorities (March 1874) by which he bound his countrymen to withdraw from the occupation of the country, retaining only the right to trade on the Song-Koi and at Hanoi and Hai-Phong. For a time affairs remained in *statu quo,* but in 1882 Le Myre de Villers, the governor of Cochin-China, sent Henri Rivière with a small force to open up the route to Yünnan by the Song-Koi. With a curious similarity the events of Garnier's campaign were repeated. Finding the authorities intractable, Rivière stormed and carried the citadel of Hanoi, with very slight loss, recaptured Nam-Dinh, Hai-Duong, and other towns in the delta, and then, like Garnier, fell a victim to his own impetuosity (May 1883).

In the meantime the Annamese court had been seeking to enlist the help of the Chinese in their contest with the French. The tie which bound the tributary nation to the sovereign state had never been entirely broken, and the present seemed an admirable opportunity for acknowledging the fact.

The king, therefore, despatched in 1880 a special embassy to Peking, loaded with unusually costly offerings and bearing a letter as from an acknowledged tributary which the emperor afterwards ordered to be published in the *Peking Gazette.* Rivière's death and the defeat of his troops left France in extreme difficulty, and M. Ferry, who had become French premier in 1883, decided on a vigorous policy. Hanoi was still besieged by the "Black Flags" and the outlying garrisons had mostly to be withdrawn; reinforcements under Admiral Courbet and General Bouet could barely keep the native forces at bay, and only in the lower delta did the French make headway, seizing Hai-Duong and Phu-Binh almost without a casualty. Dr. Harmand, commissary-general, proceeded with Courbet and a naval force to the Hué river. After a feeble defence Hué city was taken and a treaty concluded with the king (Aug 1883), in which the French protectorate was fully recognized, the king further binding himself to recall the Annamese troops serving in Tongking.

Though this treaty was exacted from Annam under pressure, the French lost no time in carrying out that part of it which gave them the authority to protect Tongking, and Bouet again advanced in the direction of Son-Tay But again the resistance he met with compelled him to retreat, after capturing the fortified post of Palan. Meanwhile, on the determination to attack Son-Tay becoming known in Paris, the Chinese ambassador warned the ministry that, since Chinese troops formed part of the garrison, he should consider it as tantamount to a declaration of war But his protest met with no consideration On the arrival of reinforcements an advance was again made, and on Dec. 16, 1883, after some desperate fighting, Son-Tay fell

During 1884 the French made themselves masters of the lower delta Throughout the campaign Chinese regulars fought against the French, who thus found themselves involved in war with China. In May 1884 M Fournier, the French consul at Tientsin, signed, with Li Hung Chang, a memorandum by which the Chinese plenipotentiary agreed that the Chinese troops should immediately evacuate northern Tongking A second treaty was signed at Hué confirming the French protectorate over Annam and Tongking, but hostilities did not cease A misunderstanding over the date of the Chinese evacuation led to Col Dugenne being despatched to occupy Lang-Son. The expedition was badly managed and 25m. from their objective the French entered an irregular engagement with the Chinese forces and were routed. An expedition, led by Colonel Donnier, against the Chinese garrison at Chu, about 10m south-east from Lang-kep, was completely successful; and in a battle near Chu the Chinese were defeated

In Jan 1885 large reinforcements arrived and Brière de l'Isle, who had succeeded Millot as commander-in-chief, ordered an advance towards Lang-Son. The difficulties of transport greatly impeded his movements; still, the expedition was successful. On Feb. 6 three forts at Dong-Song, with large supplies of stores and ammunition, fell into the hands of the French. Three days' heavy fighting made them masters of a defile on the road, and on the 13th Lang-Son was taken, the garrison having evacuated the town just before the entrance of the conquerors General Négrier, who commanded a division under Brière de l'Isle, pressed on in pursuit to Ki-Hea, and even captured the frontier town of Cua-Ai. But Brière de l'Isle had to hurry back to the relief of Tuyen-Kwan, which was doggedly resisting the attacks of an overwhelming Chinese force, and Négrier was left in command at Lang-Son. The withdrawal of Brière de l'Isle's division gave the Chinese greater confidence, and, though for a time Négrier was able to hold his own, on March 22 and 23 he sustained a severe check between Lang-Son and That-Ke, which was finally converted into a complete rout. Brière de l'Isle reached Tuyen-Kwan, the garrison of which was commanded by Colonel Dominé, on March 3 and effected its relief. The disaster at Lang-Son caused the downfall of the Ferry ministry (March 30). Shortly afterwards Sir Robert Hart succeeded in negotiating peace with China. By the terms agreed on at Tientsin (June 1885), it was stipulated that France was to take Tongking and Annam under its protection and to evacuate Formosa and the Pescadores. (For further history, *see* INDO-CHINA.)

See J. Dupuis, *Le Tong-kin et l'intervention française* (1898); C B.

Norman, *Tonkin, or France in the Far East* (1884), Prince Henri d'Orléans, *Autour du Tonkin* (1896); J Ferry, *Le Tonkin et la mère-patrie* (1890); J. Chailley, *Paul Bert au Tonkin* (1887), E Lunet de Lajonquière, *Ethnographie du Tonkin Septentrional* (1906), A. Gaisman, *L'Oeuvre de la France au Tonkin* (1906); H. Lyantey, *Lettres du Tonkin et de Madagascar* (2 vols., 1920); also the bibliography under INDO-CHINA, FRENCH.

TONGUE. Anatomically the tongue is divided into a main part, a base toward the pharynx, a dorsum or upper surface, a root by which it is attached to the hyoid bone and floor of the mouth, a tip which is free and an inferior free surface in contact with the front part of the floor of the mouth and with the lower incisor teeth. The dorsum is covered by stratified squamous epithelium, and, when at rest, is convex both anteroposteriorly and transversely; it is thickly studded with papillae, of which four kinds are recognized

Filiform papillae are minute conical projections covering the whole of the dorsum as well as the tip and borders of the tongue They are very numerous and contain a short core of subepithelial mucous membrane covered by a thick coating of epithelial cells, which coating may divide at its tip into a number of thread-like processes

Fungiform papillae are less numerous than the last, and somewhat resemble "button mushrooms", they generally contain special taste buds

Circumvallate papillae are usually from seven to ten in number and are arranged in the form of a V, the apex of which points down the throat They lie quite at the back of the upper surface of the tongue and each consists of a little flat central mound surrounded by a deep moat, the outer wall of which is slightly raised above the surface, and it is to this that the papillae owe their name Both sides of the moat have taste buds embedded in them, while into the bottom small serous glands open

Foliate papillae are only vestigial in man and consist of a series of vertical ridges occupying a small oval area on each side of the tongue near its base and just in front of the attachment of the anterior pillars of the fauces (*See* PHARYNX)

The posterior surface or base of the tongue forms part of the anterior wall of the pharynx and has a different appearance from that of the dorsum On it are found numerous circular or oval elevations of the mucous membrane caused by lymphoid tissue (lymphoid follicles), on the summit of the most of which is a mucous crypt or depression The division between the superior or oral surface of the tongue and the posterior or pharyngeal is sharply marked by a V-shaped shallow groove called the *sulcus terminalis* which lies just behind and parallel to the V-shaped row of circumvallate papillae At the apex of this V is a small blind pit, the *foramen caecum*

At the lower part of the pharyngeal surface three folds of mucous membrane, called *glosso-epiglottic folds,* run backward, the middle one passes to the centre of the front of the epiglottis, while the two lateral ones pass backward and outward to the fossa of the tonsil

On the inferior free surface of the tongue there is a median fold of mucous membrane called the *fraenum linguae*, which is attached below to the floor of the mouth On each side of this the blue outlines of the ranine veins are seen, while close to these a little fold on each side, known as a *plica fimbriata,* is often found It must not, however, be confused with the plica sublingualis described in the article MOUTH AND SALIVARY GLANDS.

The substance of the tongue is composed almost entirely of striped muscle fibres which run in different directions. Some of these bundles, such as the *superficial, deep, transverse* and *oblique linguales* are confined to the tongue and are spoken of as intrinsic muscles. Other muscles, such as the hyo-glossus, stylo-glossus, etc come from elsewhere and are extrinsic, these are noticed under the head of MUSCULAR SYSTEM The arteries of the tongue are derived from the lingual, a branch of the external carotid (*see* ARTERIES), while the veins from the tongue return the blood, by one or more veins on each side, into the internal jugular vein (*see* VEINS).

The nerves to the tongue are the (1) *lingual* or gustatory, a branch of the fifth (*see* NERVES: *Cranial*) which supplies the anterior two-thirds with ordinary sensation and also, by means of the chorda tympani which is bound up with it, with taste sensation; (2) the glossopharyngeal which supplies the circumvallate papillae and posterior third of the tongue with taste and ordinary sensation; (3) a few twigs of the superior laryngeal branch of the vagus to the pharyngeal surface of the tongue; and (4) the hypoglossal which is the motor nerve to the muscles

Embryology.—The mucous membrane covering the second and third visceral arches fuses to form the furcula (*see* RESPIRATORY SYSTEM) Just in front of this a rounded eminence appears at an early date in the ventral wall of the pharynx to form the *tuberculum impar* which is separated from the furcula by the depression known as the *sinus arcuatus* This tuberculum impar gradually grows to form the central part of the tongue in front of the foramen caecum, while the anterior part of the organ is derived from two lateral swellings which appear in the floor of the mouth and surround the tuberculum impar antero-laterally The posterior third, or pharyngeal part, is developed from the anterior part of the furcula in the middle line, that is to say from the third visceral arch The sinus arcuatus becomes gradually shallower as these two parts of the tongue grow together and eventually is indicated by the *sulcus terminalis,* in the mid line, however, the isthmus of the thyroid grows down from it, forming the *thyroglossal duct* the remains of which are seen in the foramen caecum (*see* DUCTLESS GLANDS) It will be seen that the tongue is developed in connection with the first, second and third visceral arches, and it is therefore to be expected that the fifth, seventh and ninth nerves which supply those arches would help to supply it, but the vagus from the fourth arch reaches it in addition, while the fact that most of the muscular substance of the tongue is supplied by the hypoglossal nerve is explained on the theory that some of the cervical skeletal musculature has grown cephalad into the tongue and has carried its nerve with it

Comparative Anatomy.—The tongue is present in fishes but it is an immovable swelling in the floor of the mouth and is practically devoid of muscles In the hag (*Myxine*) among the Cyclostomata, and pike (*Esox*) among the Teleostei, teeth are developed on the tongue In the Amphibia the tailed forms (Urodela) usually have tongues like fishes, though in the genus Spelerpes the organ is very free and can be protruded for a great distance In the majority of the Anura the tongue is usually attached close to the front of the floor of the mouth so that it can be flapped forward with great rapidity There are, however, two closely allied families of frogs (Xenopodidae and Pipidae) which form the order of Aglossa, because the tongue is suppressed

In the reptiles the tongue is generally very movable, though this is not the case in the Crocodilia and many of the Chelonia The forked tongues of snakes and many lizards and the highly specialized telescopic tongue of the chameleon are familiar objects

In birds the tongue is usually covered with horny epithelium and is poorly supplied with muscles When it is very protrusible, as in the woodpecker, the movement is due to the hyoid, with the base of the tongue attached, moving forward

In the Mammalia the tongue is always movable by means of well-developed extrinsic and intrinsic muscles, while papillae and glands are numerous The filiform papillae reach their maximum in the feline family of the Carnivora where they convert the tongue into a rasp by which bones can be licked clean of all flesh attached to them.

Foliate papillae are best seen in the rodents, and when they are well developed the circumvallate papillae are few, often only one on each side

In the lemurs an under tongue or *sub lingua* is found, which is probably represented by the *plicae fimbriatae* under the human tongue, and by some morphologists is regarded as the homologue of the whole tongue of the lower vertebrates, the greater part of the mammalian tongue being then looked upon as a new formation

For further details and literature *see* R. Wiedersheim's *Comparative Anatomy of Vertebrates,* translated by W N Parker (London 1907); C. Gegenbaur, *Vergleich Anat der Wirbelthiere* (Leipzig, 1901); A. Oppel, *Lehrb vergleich mikroskop Anat der Wirbelthiere,* Teil 3 (Jena, 1900), Parker and Haswell, *Text Book of Zoology* (London, 1897) (F G P.)

TONGUE, DISEASES OF. The most important disease of the tongue is cancer which may affect any part but is liable to occur at the sides, when the organ is irritated by a carious tooth or an ill-fitting denture. It shows itself as a hard raised ulcer and microscopically is a squamous cell carcinoma (*see* TUMOURS). The lymphatic glands in the neck and beneath the jaw are early affected by extension of the disease. At first the disease causes little more than discomfort and some pain in feeding but soon the extension leads to fixation and the jaws often cannot be separated more than to admit passage of a lead pencil between the teeth The secondary growths in the neck and beneath the jaw increase in size rapidly and may break down leading to a foul ulcer or to haemorrhage from invasion of one of the great blood vessels in the neighbourhood. The great salivation that accompanies cancer of the tongue is one of its greatest trials The natural duration of the disease from first observation to death is on an average little over a year Until recently the sole possible form of treatment was surgery consisting in removal of the tongue and of cervical glands in a single or a divided operation When the growth affects the anterior portion of the organ this operation meets with a fair amount of success but when the side or back of the tongue is affected the operation is serious and the results are poor so far as concerns prolonged duration of life. At the present time treatment by radium in the form of radium needles or minute "seeds" containing radium emanation is practised Sufficient time has not passed for dogmatic statement but the results appear to compare favourably with those of surgery. Whenever a carious tooth irritates the tongue the dentist's services should be sought Other diseases of the tongue of importance are syphilitic In leukoplakia the epidermis becomes thick and white in patches over the dorsum; the condition is of great importance since cancer is liable to begin in such leukoplakic patches The other syphilitic condition is gumma (*see* VENEREAL DISEASES), a condition difficult to diagnose from cancer except by the course it takes. As procrastination is fatal if the condition be cancer in reality, and a person from whom the tongue has been removed is not greatly inconvenienced thereby, the treatment should be based upon the more serious assumption

Hardly coming under the definition of diseases are those morbid states of the tongue met with in various disorders involving other parts of the body The appearances noted when the physician "looks at the tongue" vary according to the degree to which epithelial cells cover the papillae and the degree to which saliva is formed. In the white or plastered tongue of acute febrile disease the papillae are covered by a thick layer of proliferated epithelium in which are many micro-organisms, and the mouth is dry. If the fever continues and intensifies the coat peels off and a red, dry, denuded tongue results. If, on the contrary, improvement in the patient's condition is taking place the tongue begins to "clean" at the tip and edges, *i e*, secretion of saliva recommences and the white coat is removed by rubbing against the teeth and palate. The flabby, tooth-indented tongue of dyspepsia, the red, cracked tongue of diabetes, the tremulous tongue of alcoholism, the laterally displaced tongue indicating paralysis as in cerebral apoplexy are other examples of the information which examination of the tongue affords to the instructed eye (*see* Howship Dickinson, *The Tongue in Disease*, London, 1888).

So-called "thrush" (aphtha) occurs over the tongue and mouth of babies in poor condition, usually from faulty feeding; it is caused by the growth of yeast moulds in the superficial layers of the epithelium and is favoured by an acid reaction of the saliva and mucus in the mouth The treatment is rectification of the feeding and local application of a mixture of myrrh, borax and honey. Other abnormal conditions of the tongue occur such as small ulcerations in some cases of advanced pulmonary tuberculosis and inflammatory masses in actinomycosis (*q.v.*).

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(W. S. L.-B.)

TONGUES, GIFT OF, a faculty of abnormal and inarticulate vocal utterance, under stress of religious excitement, which was widely developed in the early Christian circles, and has its parallels in other religions. It is also called Glossolalia (Gr γλῶσσα, tongue, λαλεῖν, speak). In the New Testament such experiences are recorded in Caesarea (Acts x 46), at Corinth (Acts xix. 6; 1 Cor. xii, xiv), Thessalonica (1 Thess. v. 19) Ephesus (Eph. v. 18), and universally (Mark xvi. 17), From the epistles of Paul, who thanked God that he spake with tongues more than all or any of his Corinthian converts, we can gather a just idea of how he regarded this gift and of what it really was.

Paul discriminates between the Spirit which during these paroxysms both talks and prays to God and the *nous* or understanding which informs a believer's psalm, teaching, revelation or prophesy, and renders them intelligible, edifying and profitable to the assembly. Accordingly Paul lays down rules which he regarded as embodying the Lord's commandment. A man "that speaketh in a tongue speaketh not unto men, but unto God; for no man understandeth"; and therefore it is expedient that he keep this gift for his private chamber and there pour out the mysteries. In church it is best that he should confine himself to prophesying, for that brings to others "edification and comfort and consolation" If, however, tongues must be heard in the public assembly, then let not more than three of the saints exhibit the gift, and they only in succession. Nor let them exhibit it at all, unless there is some one present who can interpret the tongues and tell the meeting what it all means. If the whole congregation be talking with tongues all at once, and an unbeliever or one with no experience of pneumatic gifts come in, what will he think, asks Paul Surely that "you are mad" So at Pentecost on the occasion of the first outpouring of the Spirit the saints were by the bystanders accused of being drunk (Acts ii. 15). In the church meeting, says Paul, "I had rather speak five words with my understanding, that I might instruct others also, than ten thousand words in a tongue."

Paul on the whole discouraged glossolaly. "Desire earnestly the greater gifts," he wrote to the Corinthians. The gift of tongues was suitable rather to children in the faith than to the mature. Tongues were, he felt, to cease whenever the perfect should come; and the believer who spoke with the tongues of men and of angels, if he had not love, was no better than the sounding brass and clanging cymbal of the noisy heathen mysteries It was clearly a gift productive of much disturbance in the Church (1 Cor xiv. 23). He would not, however, entirely forbid and quench it (1 Thess. v. 19), so long as decency was preserved.

It is not then surprising that we hear little of it after the apostolic age It faded away in the great Church, and probably Celsus was describing Montanist circles (though Origen assumed that they were ordinary believers) when he wrote (Origen, *Contra Celsum*, vii. 9) of the many Christians of no repute who at the least provocation, whether within or without their temples, threw themselves about like inspired persons; while others did the same in cities or among armies in order to collect alms.

Tertullian in the 3rd century testifies that glossolaly still went on in the Montanist Church which he had joined; for we must so interpret the following passage in his *De anima*, cap. ix. "There is among us at the present time a sister who is endowed with the charismatic gift of revelations, which she suffers through ecstasy in the spirit during the Sunday service in church. She converses with angels, sometimes even with the Lord, and both hears and sees mysteries." The magical papyri teem with strings of senseless and barbaric words which probably answer to what certain of the Fathers called the language of demons. It has been suggested that we here have recorded the utterances of glossolalists.

The attitude of Paul toward glossolaly among his converts strikingly resembles Plato's opinion as expressed in the *Timaeus*, p. 72, of the enthusiastic ecstasies of the ancient μάντις (soothsayer). The gift of tongues and of their interpretation was

not peculiar to the Christian Church, but was a repetition in it of a phase common in ancient religions. The very phrase γλώσσαις λαλεῖν, "to speak with tongues," was not invented by the New Testament writers, but borrowed from ordinary speech.

Virgil (*Aen.* vi. 46, 98) draws a life-like picture of the ancient prophetess "speaking with tongues" He depicts her quick changes of colour, her dishevelled hair, her panting breast, her apparent increase of stature as the god draws nigh and fills her with his divine afflatus. Then her voice loses its mortal's ring: "nec mortale sonans" The same morbid and abnormal trance utterances recur in Christian revivals in every age, *e g*, among the mendicant friars of the 13th century, among the Jansenists, the early Quakers, the converts of Wesley and Whitefield, the persecuted protestants of the Cevennes, the Irvingites, and the revivalists of Wales and America.

Oracular possession of the kind above described is also common among savages and people of lower culture; and Dr Tylor, in his *Primitive Culture*, ii. 14, gives examples of ecstatic utterance interpreted by the sane Thus in the Sandwich Islands the god Oro gave his oracles through a priest who "ceased to act or speak as a voluntary agent, but with his limbs convulsed, his features distorted and terrific, his eyes wild and strained, he would roll on the ground foaming at the mouth, and reveal the will of the god in shrill cries and sounds violent and indistinct, which the attending priests duly interpreted to the people"

See E B Tylor, *Primitive Culture;* H Weinel, *Die Wirkungen des Geistes und der Geister* (Freiburg, 1899); Shaftesbury's *Letter on Enthusiasm*, Mrs. Oliphant, *Life of Irving*, vol. ii, G. B Cutten, *Speaking with Tongues, Historically and Psychologically Considered* (1927) (the most complete existing survey of the subject). *See* also Thouless, *Introduction to the Psychology of Religion*, chap xi

TONIC SOL-FA. Tonic Sol-fa has as its leading principle the relationship of Sol-fa syllables to a key-note. The prefix "tonic" was used by John Curwen to distinguish his method from others. Curwen (1816–1880) developed his method from that of Miss Sarah Ann Glover (1785–1867) of Norwich, to whom he always acknowleged his indebtedness, but, seeing no probability of her system becoming popular (it was out of print), he announced a number of modifications (twenty-one are tabulated in his *Teacher's Manual*), which, with his remarkable pedagogical and organizing powers, established the "Tonic Sol-fa Method and Notation" as a national movement

What, then, is Tonic Sol-fa? It is a letter-notation, as distinguished from a staff-notation. The initials of seven old syllables are used They formed what was later called a "movable *do*" system, and Tonic Sol-fa follows this old practice. Guido d'Arezzo (995–1050) noticed that each line of a hymn to St. John began stepwise, forming his hexachord instead of the former Greek tetrachords, and he took the first syllable of each line of the hymn as a sound-name, thus ut, re, mi, fa, sol, la The last line of the hymn was Sancte Iohannes The initial letters, *si*, were added in the 16th century to represent the seventh of the modern major scale In the 17th century *do* (probably from Dominus) was substitued in most countries for *ut* In the 19th century in England *si* was changed to *te* to avoid confusion with the initial of *sol*, and the spelling of all the syllables was adapted to the English language, with the advantage of having an open vowel sound for every note. The higher octave was shown by a small figure on the right above the note (d^1), and the lower octave syllables had a figure below the note ($s_1 s_1$) at the right side as shown

Besides the signs for tune already given, a notation of time was adopted, and equal spacing represented duration pictorially. A vertical line (|) precedes the accent at the beginning of the bar (measure). A short perpendicular line (|) shows the middle or medium accent of common time (four-pulse measure). An accent mark if followed by an unfilled (un-syllabled) space indicates a rest. When a note follows the accent mark it occupies the time from that accent to the next. A long dash (—) after a note requires the sound to be continued through the next pulse or beat. A dot (full point) between two notes divides the pulse into equal parts (d.r). A dot before a continuation mark (short dash) indicates that the previous note is to be continued through half of that pulse. A comma is the sign for a quarter-pulse (d,r). A dot and comma placed together show that the preceding note is of ¾-pulse length, and the following note ¼-pulse length (d ,r). An inverted comma is placed after a note of one-third pulse length (d,r) A line placed below two or more notes signifies that the notes are to be sung to the single syllable or word underneath the notes (d r). A brace binds each line of the score, and a double bar shows the end of the music. A tune may be quoted which gives within one bar five signs for rhythm

Key A	m	m	, r	|d ,l_1	.— : l_1	d ‖
	Oft	in	the	stilly	night,	Ere ‖

The question of key arises At the beginning of the tune the pitch of it is indicated by the standard pitch-names (Key A, etc) Here comes the "enlightening fact" to a beginner A tune in Tonic Sol-fa notation has the same appearance (apart from octave marks) whether pitched high or low, it is recognized as the same tune In the song of Moore above, for example, the same syllables would be used whether sung at a pitch suitable to tenor or bass The Tonic Sol-faist, having a movable doh method, has not to use a fresh set of syllables with every change of pitch, in the "fixed doh" way.

In modulation (called transition) to a new key in the course of a tune, the Tonic Sol-faist finds a new signature at the point of change, and is thus prepared If a sharp key (passing from key F to key C is a remove sharp-wards) is imminent, the new tone (the sharp) is printed over the music (for example, A t) on the right of the key-name. If the tune passes flat-wards, the "distinguishing tone" is placed on the left of the key-name (fah in key F, for example, f F) If the transition involved four removes to the right (sharp-ward progressions) the distinguishing tones would be t m l r Four flat-ward removes would have as distinguishing tones at each remove, r s d f , read backwards The latest practice is to name the number of new tones above three by a figure, as B 4, for example In the minor key (mode) the key-note is *lah*, thus in A minor "Lah is A"

Besides having changes of key defined by fresh signature (a practice which is growing in staff notation printing), the Tonic Sol-faist is given a new syllable, forming a bridge-tone or double-name, of which, with practice, he thinks the first and sings the second, or as a beginner he will glide from one to the other, as m'lah, or as a barrister addresses m'lor In print, this is shown thus ^{m}l. Explanation of the treatment of minor keys cannot be pursued here, but the "minor mode" gives the Tonic Sol-faist no trouble.

A further detail is with regard to the inflected names adopted for "accidentals" (chromatics). Doh becomes, a semitone higher, de, and the long *e* sound also represents *re, fe, se, le* Depress *te* and it is named *taw*, printed *ta* Similarly down "the modulator" may be found *la, ma, ra* Characteristic of the minor mode are *ba* (pronounced bay) and *se*

First lessons in Tonic Sol-fa are begun with the aid of a chart of tune the modulator just named Its ladder-like appearance is a great aid to the beginner; it is the counterpart of the up-and-down picture of the staff notation The mental image of the modulator remains, it is the answer to the objection that Tonic Sol-fa is a dead-level picture Even before it is used, the learner hears "the sound before the sign." He learns the scale by "steps of the method," first *d*, *s* and *m*, second *r* and *t*, third *f* and *l*, fourth the whole scale and transition Such simple tools enable the ordinary teacher of an elementary school to get from small children amazing results in sight-singing Each scale tone when sung slowly is also found to have its own character or mental effect, and this is noticed in illustrating by familiar phrases of music, which, however, must not be pressed too far; *d* is firm, *s* martial, *m* mild, *r* prayerful (at high pitch, rousing), *t* leading upward, *f* leaning downward, *l* the mournful tone The method applies other devices for teaching effect: French time-names for rhythm; hand-signs which, dispensing with printed notes, enable the teacher to give exercises rapidly. The ear is trained from the first lesson.

The value of it all is greatest in the higher stages: harmony is clarified by the tonic principle; transposition of music

is easy; rhythm is analyzed and simplified by the time-names; and, in addition, Tonic Sol-fa is the best introduction to the staff notation. More and more, publishers find it worth while to print the Tonic Sol-fa notation along with the Staff. The facility and certainty of the Tonic Sol-faists have been admitted and praised by every conductor who has had experience of them. The story of the successful struggle to give this method a footing need not be told here The danger now is when people in authority, or capable musicians who learnt music easily, say that the notation is unnecessary, while passing compliments upon the method of teaching, and at the same time ignoring the need of giving children a good foundation in reading this notation. (J Gra)

TÖNISSON, JAAN (1868–), Estonian statesman, was the son of a farmer in the Viljandi district of Livonia After graduating in law at the University of Dorpat (Tartu) he was for some years in the judicial service of the Russian Imperial Government, but quitted it in 1896 to become editor of *Postimees* (*The Postilion*), the oldest Estonian daily newspaper in Dorpat Thenceforward he took an active part in the Estonian national movement. Tönisson took a line independent of both German and Russian political influences and concentrated upon work in the economic and cultural spheres. In the revolution of 1905 he was at the head of the Estonian moderate constitutional movement, which he likewise represented in the Russian Duma, where he attached himself to the Russian Cadet Party, and to the non-Russian element. With the other signatories to the Viborg Appeal, he was sentenced to three years' imprisonment and loss of political rights From 1917 onwards Tönisson, as leader of the Estonian People's Party, was a member of all the representative bodies of the Estonian people In the winter of the same year, after he had been expelled by the Bolsheviks, he carried through at Stockholm with the representatives of the Allied Powers the preliminaries of a *de facto* recognition of Estonia From 1919 to 1920 he was prime minister, and during his period of office peace was concluded with Russia In the second Riigikogo (parliament) he formed a democratic bloc of his own party, the Christian People's Party and the National Liberals and became president of the Chamber

TONK, an Indian state in the Rajputana agency It consists of six isolated tracts, some of which are under the Central India agency. Total area, 2,553 sq m ; total population (1921), 287,898. The chief, whose title is nawab, with a salute of 17 guns, is a Mohammedan of Afghan descent The founder of the family was Amir Khan, the notorious Pindari leader at the beginning of the 19th century, who received the present territory on submitting to the British in 1817 The town of Tonk is 60 m south from Jaipur, near the right bank of the river Banas Pop (1921), 30,374. It is surrounded by a wall, with a mud fort

There is another town in India called Tonk, or Tank, in Dera Ismail Khan district, North-West Frontier Province. It is the residence of a nawab, who was formerly semi-independent

TONKAWA, a tribe of south central Texas, usually considered as constituting a distinct linguistic stock, belonged to the Plains group of nomadic buffalo hunting Indians The natives lived in skin tepees, planted little or not at all and bore a reputation, probably deserved, for cannibalism They fought, at one time or another, most of their neighbours, from the Apache to the Caddo The original population of perhaps 1,500 has shrunk to a few dozen

TONNAGE, SHIPPING: *see* Shipping, Tonnage Terms

TONNAGE AND POUNDAGE. In England, customs duties anciently imposed upon exports and imports, the former being a duty upon all wines imported in addition to prisage and butlerage, the latter a duty imposed *ad valorem* at the rate of 1s. in the £ on all merchandise imported or exported. The duties were levied at first by agreement with merchants (poundage in 1302, tonnage in 1347), then granted by parliament in 1373, at first for a limited period only They were considered to be imposed for the defence of the realm. From the reign of Henry VI until that of James I. they were usually granted for life. They were not granted to Charles I., and in 1628 that king took the unconstitutional course of levying them on his own authority, a course denounced a few years later by 16 Car. I. c. 18 (1640), when the long parliament granted them for two months After the Restoration they were granted to Charles II. and his two successors for life. By acts of Anne and George I., the duties were made perpetual and mortgaged for the public debt. In 1787 they were finally abolished, and other modes of obtaining revenue substituted, by 27 Geo. III c. 13 (1787)

Poundage also signified a fee paid to an officer of a court for his services, *e.g* , to a sheriff's officer, who is entitled by 29 Eliz c 4 (1586–87) to a poundage of 1s. in the £ on an execution up to £100, and sixpence in the £ above that sum

TONNERRE, a town of north-central France, in the department of Yonne, 52 m S E. of Sens on the P.L.M. railway. Pop (1926) 3,867 Its ancient name of *Tornodorum* points to a Gallic or Gallo-Roman origin for Tonnerre In the 6th century it became the capital of the region of Tonnerrois and in the 10th century of a countship

It stands on a slope of the vine-clad hills on the left bank of the Armançon At the foot of the hill rises the spring of Fosse-Dionne, enclosed in a circular basin 49 ft in diameter The church of St. Pierre has a fine lateral portal of the Renaissance period to which the church, except the choir (1351), belongs The church of Notre-Dame is mainly Gothic, but the fine façade is Renaissance. The hospital itself was rebuilt in the 19th century The Renaissance Hôtel d'Uzès was built in the 16th century

TONOPAH, an unincorporated city of Nevada, U S A , 170 m S E of Reno, in the San Antonio mountains, at an altitude of 6,072 ft.; the county seat of Nye county It is served by the Tonopah and Goldfield railroad The population was 4,144 in 1920 Tonopah is a vast mining camp, which has produced over $100,000,000 worth of silver since the first strike was made in 1899 In 1928 development of a new bonanza field was under way

TONQUA BEAN. The Tonqua, Tonka or Tonquin bean, also called the coumara nut, is the seed of *Dipterix odorata*, a leguminous tree growing to a height of 80 ft , native of tropical South America The drupe-like pod contains a single seed possessed of a fine sweet "new-mown hay" odour, due to the presence of coumarin (*q v*) Tonqua beans are used in perfumery

TÖNSBERG, a seaport of Norway, in Jarlsberg-Laurvik *amt* (county), situated on a bay on the south coast, near the entrance to Oslo Fjord, 72 m S by W of Oslo on the Skien railway Pop. (1927), 11,969 It is one of the most ancient towns in Norway, declined in importance after the middle ages, but is now a rapidly growing industrial town and the headquarters of a sealing and whaling fleet It has refineries for preparing whale and seal oil and saw-mills, and exports whale oil, pitch and butter. The harbour is frozen in winter but a channel is kept open

TONSILLITIS, acute inflammation of the tonsils (*see* Lymphatic System) due to their invasion by infective micro-organisms. Sometimes an attack follows on exposure to sewer gas, and it is common in house surgeons, nurses and others who have to spend most of their time in a hospital.

Tonsillitis is frequently associated with acute rheumatism (*q.v.*) and it is thought that the tonsils are often the portal whereby the streptococci causing rheumatism gain access to the body A similar view obtains with regard to the sore throat in scarlet fever. Acute tonsillitis may run on to the formation of abscess (quinsy) Tonsillitis may begin with a feeling of chilliness or an attack of shivering Then come on swelling in the throat, pain, tenderness and difficulty in swallowing, pain about the ear and jaw, and swelling of the glands in the neck. The temperature is raised, breath offensive and the tongue thickly coated. There may be yellow spots of inspissated mucus in the tonsillar crypts but these differ from the "false membrane" of diphtheria in that they can be easily brushed off by a swab, though often a true diagnosis can only be made bacteriologically The most trustworthy drugs are salicylic acid, iron and quinine. If abscess threatens, a slender-bladed knife should be thrust from before backward deeply into the swollen mass. And if, as most likely happens, matter then escapes, the patient's distress speedily ends.

Chronic tonsillitis is often associated with adenoids (*q.v.*) in children. It leads to enlargement of the tonsils which may meet

across the middle line of the throat. The lymphoid tissue of which the tonsil is composed is one of the body's lines of defence against invasion by infective micro-organisms, but these enlarged tonsils are abnormal in structure and not only fail as defensive mechanisms but also interfere seriously with the general health. Often, therefore, it becomes necessary to remove them surgically. Formerly the projecting mass was simply cut off but now the general procedure is enucleation of the entire tonsil.

TONSURE, a religious observance in the Roman Catholic and Orthodox Eastern Churches, consisting of the shaving or cutting of part of the hair of the head as a sign of dedication to special service The reception of the tonsure in these churches is the initial ceremony which marks admission to orders and to clerical rights and privileges. It is administered by the bishop with an appropriate ritual Candidates for the rite must have been confirmed, be adequately instructed in the elements of the Christian faith, and be able to read and write. Those who have received it are bound (unless in exceptional circumstances) to renew the mark, consisting of a bare circle on the crown of the head, at least once a month, otherwise they forfeit the privileges it carries. The practice is not a primitive one, Tertullian simply advises Christians to avoid vanity in dressing their hair, and Jerome deprecates both long and closely cropped hair. According to Prudentius (Περιστ. xiii 30) it was customary for the hair to be cut short at ordination Paulinus of Nola (*c.* 490) alludes to the tonsure as in use among the (Western) monks, from them the practice quickly spread to the clergy For Gaul about the year 500 we have the testimony of Sidonius Apollinaris (iv. 13), who says that Germanicus the bishop had his hair cut "in rotae speciem"

The earliest instance of an ecclesiastical precept on the subject occurs in can 41 of the Council of Toledo (A D 633): "omnes clerici, detonso superius capite toto, inferius solam circuli coronam relinquant." Can 33 of the Quinisext council (692) requires even singers and readers to be tonsured Since the 8th century three tonsures have been more or less in use, known respectively as the Roman, the Greek and the Celtic The first two are sometimes distinguished as the tonsure of Peter and the tonsure of Paul. The Roman or St Peter's tonsure prevailed in France, Spain and Italy. It consisted in shaving the whole head, leaving only a fringe of hair supposed to symbolize the crown of thorns Late in the middle ages this tonsure was lessened for the clergy, but retained for monks and friars In the Eastern or St Paul's tonsure the whole head was shaven, but when now practised in the Eastern Church this tonsure is held to be adequately shown when the hair is shorn close. In the Celtic tonsure (tonsure of St John, or, in contempt, tonsure of Simon Magus) all the hair in front of a line drawn over the top of the head from ear to ear was shaven (a fashion common among the Hindus). The question of the Roman or Celtic tonsure was one of the points in dispute in the early British Church, settled in favour of the Roman fashion at the Council of Whitby (664) The tonsure at first was never given separately, and even children when so dedicated were appointed readers, as no one could belong to the clerical state without at least a minor order From the 7th century, however, children were tonsured without ordination, and later on adults anxious to escape secular jurisdiction were often tonsured without ordination. Till the 10th century the tonsure could be given by priests or even by laymen, but its bestowal was gradually restricted to bishops and abbots.

TOOKE, JOHN HORNE (1736–1812), English politician and philologist, third son of John Horne, a poulterer in Newport Market, London, was born on June 25, 1736 He was educated at Westminster school, Eton, and St John's college, Cambridge. He had been entered at the Inner Temple, but his father wished him to take orders and he was ordained to a curacy at New Brentford in 1760. He travelled in France in 1765–67, where he met John Wilkes (*q.v*). In 1767 he returned and became Wilkes' most energetic and ingenious supporter. In 1771, however, he quarrelled violently with his leader, to the damage of their cause. Horne's supporters took the name of the Constitutional Society.

In 1773 he was placed beyond the reach of want by the gratitude of William Tooke, of Croydon, whose rights in an enclosure case he had protected by turning attention to his case

But Horne was now involved in serious trouble For signing the advertisement soliciting subscriptions for the relief of the relatives of the Americans "murdered by the king's troops at Lexington and Concord," he was tried at the Guildhall on July 4, 1777, before Lord Mansfield, found guilty, and committed to the King's Bench prison in St George's Fields, from which he only emerged after a year's durance, and after a loss in fines and costs amounting to £1,200. Soon after his deliverance he applied to be called to the bar, but his application was negatived on the ground that his orders in the Church were indelible Horne thereupon tried his fortune, but without success, on farming some land in Huntingdonshire. He also published two influential reforming pamphlets. *Facts Addressed to Landholders,* etc. (1780), and *A Letter on Parliamentary Reform* (1782)

On his return from Huntingdonshire he became once more a frequent guest at Mr. Tooke's house at Purley, and in 1782 assumed the name of Horne Tooke In 1786 Horne Tooke gave his philological treatise of Ἔπεα πτερόεντα (2 pts. 1786–1805), the sub-title of *The Diversions of Purley,* as a tribute to his friend.

Between 1782 and 1790 Tooke supported Pitt, and in the election for Westminster, in 1784, threw all his energies into opposition to Fox After the Westminster election of 1788 Tooke depicted the rival statesmen (Lord Chatham and Lord Holland, William Pitt and C. J Fox) in his pamphlet of *Two Pair of Portraits* At the general election of 1790 he was a candidate for Westminster, in opposition to Fox and Lord Hood, but was defeated; and, at a second trial in 1796, he was again at the bottom of the poll Meantime the excesses of the French revolution had provoked reaction in England, and the Tory ministry adopted a policy of repression. Horne Tooke was arrested early on the morning of May 16, 1794, and conveyed to the Tower His trial for high treason lasted for six days (Nov 17–22) and ended in his acquittal, the jury only taking eight minutes to settle their verdict Through the influence of the second Lord Camelford, he was returned to parliament in 1801 for the pocket borough of Old Sarum Efforts to secure his exclusion on the ground of his clerical orders failed, but an act was passed rendering all persons in holy orders ineligible, and he sat for that parliament only.

The last years of Tooke's life were spent in retirement in a house on the west side of Wimbledon Common, where he gave the Sunday parties, attended by Thurlow, Bentham, Coleridge, Paine and others, which became a legend He died on March 18, 1812

The *Life of Horne Tooke*, by Alexander Stephens, is written in an unattractive style and was the work of an admirer only admitted to his acquaintance at the close of his days The notice in the *Quarterly Review,* June 1812, of W. Hamilton Reid's compilation, is by J W. Ward, Lord Dudley The main facts of his life are set out by Mr. J E Thorold Rogers, in his *Historical Gleanings,* 2nd series. Many of Horne Tooke's wittiest sayings are preserved in the *Table Talk* of Samuel Rogers and S T Coleridge.

TOOKE, THOMAS (1774–1858), English economist, was born at St Petersburg on Feb 29, 1774 Entering a large Russian house in London at an early age, he acquired sound practical experience of commercial matters and became a recognized authority on finance and banking He was one of the earliest advocates of free trade and drew up the *Merchants' Petition* presented to the House of Commons by Alexander Baring, afterwards Lord Ashburton. He gave evidence before several parliamentary committees, notably the committee of 1821, on foreign trade, and those of 1832, 1840 and 1848 on the Bank Acts He was elected F.R S. in 1821. He died in London on Feb 26, 1858

Tooke is known for his *History of Prices and of the State of the Circulation during the Years 1793–1856* (6 vols, 1838–1857) In the first four volumes he treats (*a*) of the prices of corn, and the circumstances affecting prices; (*b*) the prices of produce other than corn, and (*c*) the state of the circulation The two final volumes, written in conjunction with W. Newmarch (*q.v.*), deal with railways, free trade, banking in Europe and the effects of new discoveries of gold

TOOL, an implement or appliance used by a worker in the treatment of the substances used in his handicraft, whether in

the preliminary operations of setting out and measuring the materials, in reducing his work to the required form by cutting or otherwise, in gauging it and testing its accuracy, or in duly securing it while thus being treated. (For the tools of prehistoric man *see* ARCHAEOLOGY: *Flint Implements;* and EGYPT.)

In beginning a survey of tools it is necessary to draw the distinction between hand and machine tools. The former class includes any tool which is held and operated by the unaided hands; *e.g.,* a chisel, plane or saw. Attach one of these to some piece of operating mechanism, and it, with the environment of which it is the central essential object, becomes a machine tool Simple examples are the common power-driven hack saw for metal, the small high-speed drill, and the wood-boring auger held in a frame and turned by a winch handle and bevel-gears. The difference between these and a big frame-saw cutting down a dozen boards simultaneously, or the immense machine boring the cylinders of an ocean liner, etc, is so vast that the relationship is hardly apparent. Often the tool itself is absolutely dwarfed by the machine, of which nevertheless it is the central object and around which the machine is designed and built. A milling machine weighing several tons will often be seen rotating a tool of but two or three dozen pounds' weight. Yet the machine is fitted with elaborate slides, self-acting movements and provision for taking up wear, and is worth some hundreds of pounds sterling, while the tool may not be worth two pounds. Such apparent anomalies are in constant evidence. This article is a survey of the principles that underlie the forms of tools. The subject of their embodiment in machine tools will be found and treated under MACHINE TOOLS, LATHES, PLANING MACHINES, MILLING MACHINES, SAWING MACHINES, WOOD-WORKING MACHINERY, etc

An analysis of the essential methods of operation gives a broad grouping as follows:

I The chisel group	Typified by	the chisel of the woodworker.
II. The shearing group	,, ,,	scissors.
III. The scrapers	,, ,,	cabinet-maker's scrape.
IV. The percussive and detrusive group	,, ,,	hammer and the punch.
V. The moulding group	,, ,,	trowel.

The first three are generally all regarded as cutting tools, notwithstanding that those in II and III. do not operate as wedges, and therefore are not true chisels; but many occupy a border-

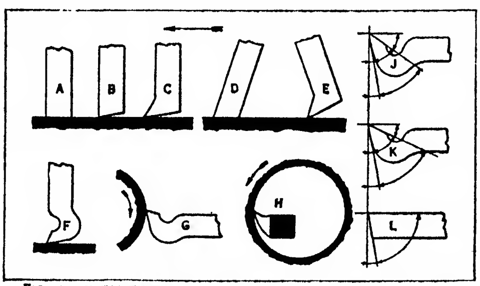

FIG. 1—METAL WORKING TOOLS (SEE TEXT FOR PARTICULARS)

line where the results obtained are practically those due to cutting, as in some of the shears, saws, milling cutters and grinding wheels.

CUTTING TOOLS

Keenness of edge, equivalent to a small degree of angle between the tool faces, would appear at first sight to be the prime element in cutting, as indeed it is in the case of a razor, or in that of a chisel for soft wood But that is not the prime condition in a tool for cutting iron or steel. Strength is of far greater importance, and to it some keenness of edge must be sacrificed. All cutting tools are wedges; but a razor or a chisel edge, included between angles of 15° or 20°, would be turned over at once if presented to iron or steel, for which angles of from 60° to 75° are required. Further, much greater rigidity is necessary in the latter, to resist spring and fracture. A workman can operate a turning tool by hand, even on heavy pieces of metal-work. Formerly all turning, no matter how large, was done by hand-operated tools, and after great muscular exertion a few pounds of metal might be removed in an hour. With a similarly formed tool, in a rigid guide or rest, driven by the power of ten or twenty men, it becomes possible to remove say a hundredweight of chips in an hour; or with

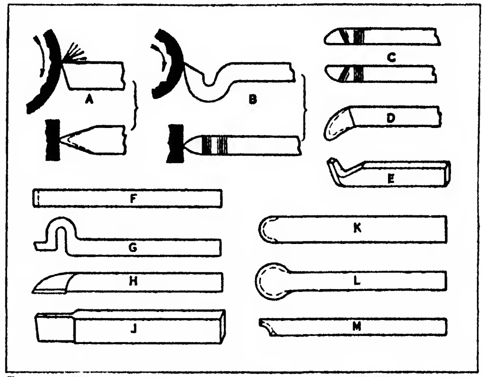

FIG 2—METAL-TURNING TOOLS (A) FOR SCRAPING BRASS, (B) FOR TURNING METALS, (C) RIGHT- AND LEFT-HAND TOOLS; (D) BETTER FORM OF SAME, (E) DIAMOND OR ANGULAR-EDGE, FOR CUTTING; (F) FINISHING TOOL; (G) SPRING FINISHING TOOL; (H) SIDE OR KNIFE TOOL; (J) PARTING OR CUTTING-OFF TOOL, (K, L) ROUND NOSE TOOLS, (M) RADIUS

a larger and more durable tool driven by the power of 40 or 60 horses, half a ton of chips may be removed in an hour

All machine tools of which the chisel is the type operate by cutting; *ie,* they act on the same principle and by the same essential method as the knife, razor or chisel, and not by that of the grindstone A single tool, however, may act as a cutting instrument at one time and as a scrape at another.

Clearly, in order that a tool shall cut, it must possess an incisive form In fig. 1, *A* might be thrust over the surface of the plate of metal, but no cutting action could take place. It would simply grind and polish the surface If it were formed like *B,* the grinding action would give place to scraping, by which some material would be removed. Many tools are formed thus, but there is still no incisive or knife-like action, and the tool is simply a scrape and not a cutting tool. But *C* is a cutting tool, possessing penetrative capacity If now *B* were tilted backwards as at *D,* it would at once become a cutting tool. But its bevelled face would rub and grind on the surface of the work, producing friction and heat, and interfering with the penetrative action of the cutting edge On the other hand, if *C* were tilted forwards as at *E* its action would approximate to that of a scrape for the time being But the high angle of the hinder bevelled face would not afford adequate support to the cutting edge, and the latter would therefore become worn off almost instantly, precisely as that of a razor or wood-working chisel would crumble away if operated on hard metal It is obvious therefore that the correct form for a cutting tool must depend upon a due balance being maintained between the angle of the front and of the bottom faces—"front" or "top rake," and "bottom rake" or "clearance"—considered in regard to their *method of presentation* to the work Since, too, all tools used in machines are held rigidly in one position, differing in this respect from hand-operated tools, it follows that a constant angle should be given to instruments which are used for operating on a given kind of metal or alloy. It does not matter whether a tool is driven in a lathe, or a planing machine, or a sharper or a slotter; whether it is cutting on external or internal surfaces, it is always maintained in a direction perpendicularly to the point of application as in fig. 1, *F, G, H,* planing, turning and boring respectively. It is consistent with reason and with fact

that the softer and more fibrous the metal, the keener must be the formation of the tool, and that, conversely, the harder and more crystalline the metal the more obtuse must be the cutting angles, as in the extremes of the razor and the tools for cutting iron and steel already instanced. The three figures *J, K, L* show tools suitably formed for wrought iron and mild steel, for cast iron and cast steel, and for brass respectively. Cast iron and cast

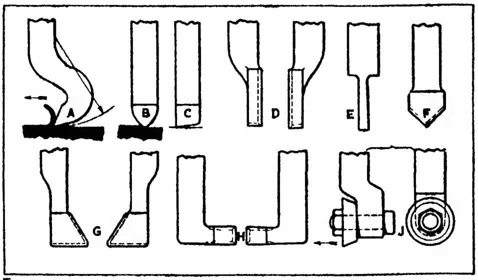

FIG 3 —PLANER TOOLS (A) CRANKED TO AVOID DIGGING INTO METAL. (B) FACE OF ROUGHING TOOL. (C) FACE OF FINISHING TOOL. (D) RIGHT- AND LEFT-HAND KNIFE OR SIDE TOOLS. (E) PARTING, CUTTING-OFF OR GROOVING TOOL. (F) V TOOL. (G) RIGHT- AND LEFT-HAND TOOLS FOR V-SLOTS. (H) SAME FOR T-SLOTS. (J) RADIUS TOOL IN HOLDER

steel could not be cut properly with the first, nor wrought iron and fibrous steel with the second, nor either with the third The angles given are those which accord best with general practice

The *angle of clearance*, or *relief*, fig 1 J, K & L, is an important detail of a cutting tool It is of greater importance than an exact angle of top rake, but, given some sufficient angle of clearance, its exact amount is not of much moment Neither need it be uniform for a given cutting edge It may vary from say 3° to 10°, or even 20°, and under good conditions little or no practical differences will result Actually it need never vary much from 5° to 7°. The object in giving a clearance angle is simply to prevent friction between

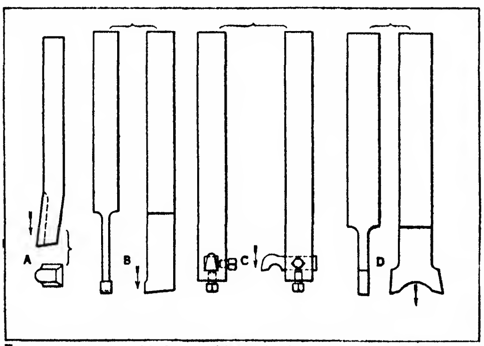

FIG. 4.—SLOTTER TOOLS. (A) COMMON ROUGHING. (B) PARTING-OFF OR GROOVING; (C) ROUGHING OR FINISHING TOOL IN HOLDER. (D) DOUBLE-EDGED FOR CUTTING OPPOSITE SIDES OF SLOT

the non-cutting face immediately adjacent to the edge and the surface of the work. The limit to this clearance is that at which insufficient support is afforded to the cutting edge.

The *front*, or *top rake*, *b* in fig. 1, is the angle or slope of the front, or top face, of the tool; it is varied mainly according as materials are crystalline or fibrous. In the turnings and cuttings taken off the more crystalline metals and alloys, the broken appearance of the chips is distinguished from the shavings removed from the fibrous materials. It indicates too that extra work is put on the tool in breaking up the chips, following immediately on their severance, and when the comminutions are very small they indicate insufficient top rake. This is a result that turners try to avoid when possible, or at least to minimize Now the greater the slope of the top rake the more easily will the cuttings come away, with the minimum of break in the crystalline materials and absolutely unbroken over lengths of many feet in the fibrous ones. The breaking up or the continuity of the cuttings, therefore affords an indication of the suitability of the amount of top rake to its work. However, compromise often has to be made between the ideal and the actual. The amount of top rake has to be limited in the harder metals and alloys in order

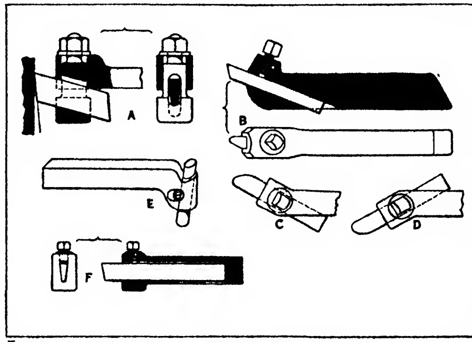

FIG. 5 —TOOL-HOLDERS (A) SWIVELLING HOLDER. (B) SQUARE STEEL HOLDER. (C, D) RIGHT- AND LEFT-HAND FORMS OF SAME. (E) ROUND STEEL HOLDER. (F) NARROW PARTING-OFF TOOL HOLDER

to secure a *strong tool angle*, without which tools would lack the endurance required to sustain them through several hours without regrinding.

The *tool angle*, *c*, is the angle included between top and bottom faces, and its amount, or thickness expressed in degrees, is a measure of the strength and endurance of any tool At extremes it varies from about 15° to 85° It is traceable in all kinds of tools, having very diverse forms

Tools of the Chisel Type.—The grouped illustrations (figs. 2 to 6) show some of the types, but it will be understood that each is varied in dimensions, angles and outlines to suit all the varied kinds of metals and alloys and conditions of operation For, as every tool has to be gripped in a holder of some kind, as a slide-rest, tool-box, turret, tool-holder, box, cross-slide, etc, this often determines the choice of some one form in preference to another A broad division is that into roughing and finishing tools Generally though not invariably the edge of the first is narrow, of the second broad, corresponding with the deep cutting and fine traverse of the first and the shallow cutting and broad traverse of the second The following are some of the principal forms The round-nosed roughing tool (fig 2) *B* is of straight-forward type, used for turning, planing and shaping As the correct tool angle can only occur on the middle plane of the tool, it is usual to employ cranked tools, *C, D, E*, right- and left-handed, for heavy and moderately heavy duty, the direction of the cranking corresponding with that in which the tool is required to traverse Tools for boring are cranked and many for planing (fig. 3). The slotting tools (fig. 4) embody the same principle, but their shanks are in line with the direction of cutting. Many roughing and

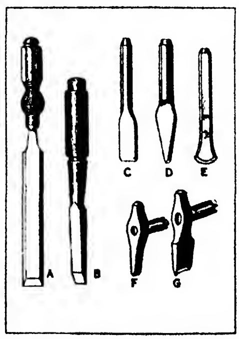

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FIG 6 —CHISELS· (A) PARING. (B) SOCKET, HEAVY DUTY (C) COMMON CHIPPING; (D) NARROW CROSS-CUT OR CAPE. (E) COW-MOUTH; (F) STRAIGHT. (G) HOLLOW

finishing tools are of knife type *H* Finishing tools have broad edges, *F, G, H*. They occur in straightforward and right- and left-hand types These as a rule remove less than $\frac{1}{16}$ in. in depth, while the roughing tools may cut an inch or more into the metal

Solid Tools v. Tool-holders.—It will be observed that the foregoing are solid tools; that is, the cutting portion is forged from a solid bar of steel This is costly when the best tool steel is used,

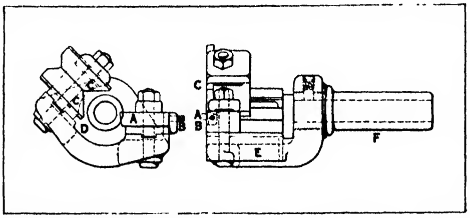

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FIG. 7 —BOX TOOL FOR TURRET LATHE (A) CUTTING TOOL, (B) SCREW FOR ADJUSTING RADIUS OF CUT, (C C) V-STEADIES, (D) DIAMETER OF WORK; (E) BODY OF HOLDER, (F) STEM

hence large numbers of tools comprise *points* only, which are gripped in permanent holders in which they interchange Tool steel usually ranges from about ½ in to 4 in square, most engineers' work is done with bars of from ½ in to 1½ in square It is in the smaller and medium sizes of tools that holders prove of most value Solid tools, varying from 2½ in to 4 in square, are used for the heaviest cutting done in the planing machine Tool-holders are not employed for very heavy work, because the heat generated would not get away fast enough from small tool points There are scores of holders, perhaps a dozen good approved types are in common use They are divisible into three great groups those in which the top rake of the tool point is embodied in the holder, and is constant, those in which the clearance is similarly embodied; and those in which neither is provided for, but in which the tool point is ground to any angle Charles Babbage designed the first tool-holder, and the essential type survives in several modern forms Fig 5 includes two forms of tool holder. In one *E* the tool is a bit of round steel set at an angle which gives front rake, and having the top end ground to an angle of top rake In

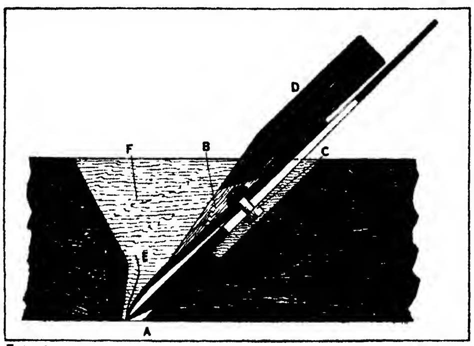


FIG 8 —SECTION THROUGH PLANE· (A) CUTTING IRON, (B) BACK IRON, (C) CLAMPING SCREW; (D) WEDGE, (E) BROKEN SHAVING, (F) MOUTH

the other *A* the tool has the section of a truncated wedge, set for constant top rake, or cutting angle, and having bottom rake or clearance angle ground This round tool is not applicable for all classes of work. It will turn plain work, and plane level faces, but will not turn or plane into corners or angles Hence the invention of the tool of V-section, and the swivel tool-holder The round tool-holders are made right- and left-handed, the swivel tool-holder has a universal movement The amount of projection of the round tool points is very limited, which impairs their utility when some overhanging of the tool is necessary The V-tools can be slid out in their holders to operate on faces and edges situated well inward from the end of the tool-holder.

Box Tools.—In one feature the box tools of the turret lathes resemble tool-holders. The small pieces of steel used for tool

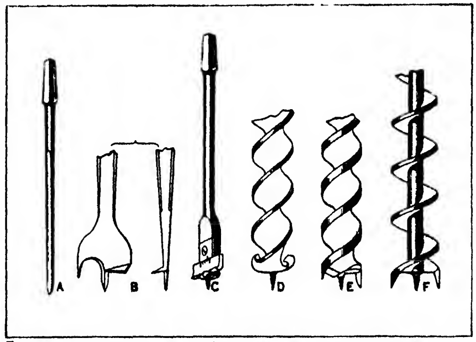


FIG 9 —WOOD BORING BITS (A) SPOON BIT, (B) CENTRE-BIT, (C) EXPANDING CENTRE-BIT, (D) GILPIN OR GEDGE AUGER, (E) JENNINGS AUGER, (F) IRWIN AUGER

points are gripped in the boxes, as in tool-holders, and all the advantages which are derived from this arrangement of separating the point from its holder are thus secured (fig 7) But in all other respects the two are dissimilar Two or three tool-holders

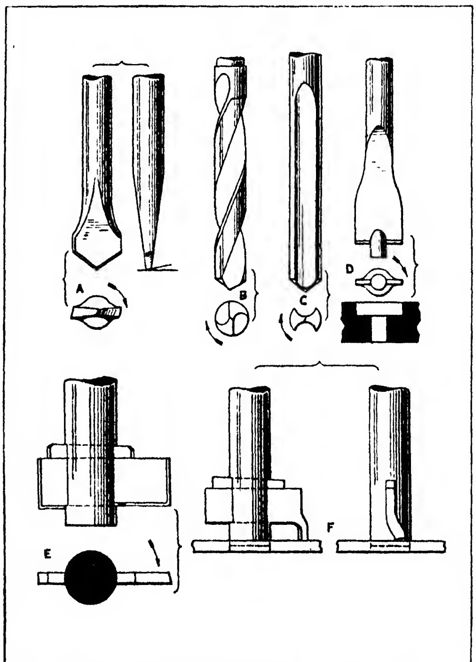


FIG 10 —METAL DRILLS: (A) FLAT, (B) TWIST, (C) STRAIGHT FLUTED, (D) PIN; (E) ARBORING; (F) TOOL FOR BORING SHEET METAL

of different sizes take all the tool points used in a lathe, but a new box has to be devised in the case of almost every new job, with the exception of those the principal formation of which is the turning down of plain bars. The explanation is that, instead of a single point, several are commonly carried in a box. As com-

plexity increases with the number of tools, new designs and dimensions of boxes become necessary, even though there may be family resemblances in groups. A result is that there is not, nor can there be, anything like finality in these designs. Turret work has become one of the most highly specialized departments of machine-shop practice, and the design of these boxes is already the work of specialists. More and more of the work of the common lathe is being constantly appropriated by the semi- and full-automatic machines, a result to which the magazine feeds for

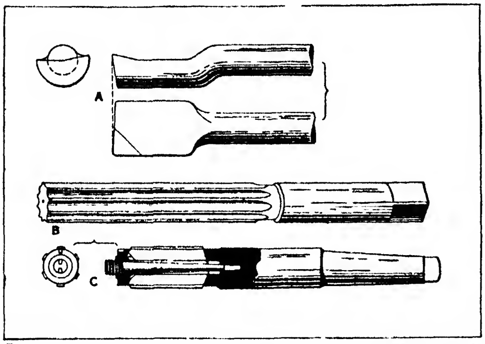


FIG 11.—(A) D-BIT, (B) SOLID REAMER, (C) ADJUSTABLE REAMER

castings and forgings that cannot pass through a hollow spindle have contributed to a great extent. A great deal of the efficiency of the box tools is due to the support which is afforded to the cutting edges in opposition to the stress of cutting. **V**-blocks are introduced in most cases as in fig. 7. In many tools a shearing operation takes place, by which the stress of cutting is lessened.

Planes.—Generally the tool angles of the chisel group lie between 15° and 25°. They include the chisels proper, and the gouges in numerous shapes and proportions, used by carpenters, cabinet-makers, turners, stone-masons, etc. These are mostly thrust by hand to their work, without any mechanical control. Other chisels are used percussively, as the stout mortise chisels, some of the gouges, the axes, adzes and stone-mason's tools.

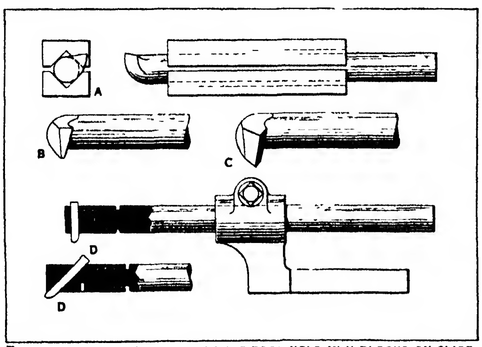


FIG 12.—BORING TOOLS (A) ROUND TOOL HELD IN V BLOCKS ON SLIDE-REST, (B, C) SQUARE AND V-POINTED, (D) BORING BAR WITH REMOVABLE CUTTERS

The large family of planes embody chisels coerced by the mechanical control of the wooden (fig. 8) or metal stock.

Drilling and Boring Tools.—Metal and timber are bored with equal facility; the tools (figs. 9 and 10) embody similar differences to the cutting tools already instanced for wood and metal. All the wood-working bits are true cutting tools, and their angles, if analysed, will be found not to differ much from those of the razor and common chisel. The drills for metal furnish examples both of scrapers and cutting tools. The common drill is only a scraper, but all the twist drills cut with good incisive action. An advantage possessed by all drills is that the cutting forces are balanced on each side of the centre of rotation. The same action is found in the best wood-boring bits—improved forms of the old centre-bit. But the balance is impaired if the lips are not absolutely symmetrical about the centre. This explains the

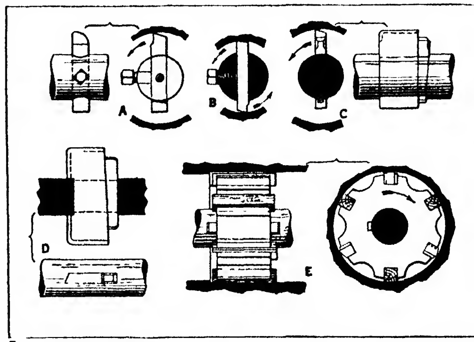


FIG 13.—SUPPORTED BORING TOOLS (A) SINGLE-ENDED CUTTER IN BORING BAR (B) SAME, DOUBLE-ENDED (C) FLAT SINGLE-ENDED FINISHING CUTTER, (D) SAME, DOUBLE-ENDED, (E) BORING HEAD WITH THREE CUTTER AND THREE STEADY BLOCKS

necessity for the substitution of machine grinding for hand grinding of the lips, and great developments of twist drill grinding machines. Allied to the drills are the **D**-bits, and the reamers (fig. 11). The first-named both initiate and finish a hole; the second are used only for smoothing and enlarging drilled holes, and for correcting holes which pass through adjacent castings or plates. The reamers remove only a mere film, and their action is that of scraping. The foregoing are examples of tools operated from one end and unsupported at the other, except in so far as they receive support within the work. One of the objectionable features of tools operated in this way is that they tend to "follow the hole," and if this is cored, or rough-drilled out of truth, there is risk of the boring tools following it to some extent at least. With the one exception of the **D**-bit there is no tool which can be relied on to take out a long bore with more than an approximation to concentricity throughout. Boring tools (fig. 12) held in the slide-rest will spring and bend and chatter, and unless the lathe is true, or careful compensation is made for its want of truth, they will bore bigger at one end than the other.

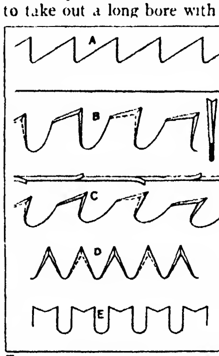


FIG 14.—SAW TEETH (A) BAND AND RIPPING, (B) CIRCULAR FOR HARD WOOD, (C) CIRCULAR FOR SOFT WOOD, (D) CROSS-CUT, (E) M-TEETH FOR CROSS-CUT

This brings us to the large class of boring tools which are supported at each end by being held in bars carried between centres. There are two main varieties: in one the cutters are fixed directly in the bar (fig. 13, *A* to *D*), in the other in a head fitted on the bar (fig. 13, *E*), hence termed a "boring head." As lathe heads are fixed, the traverse cannot be imparted to the bars as in boring machines. The boring heads can be traversed, or the work can be traversed by the mechanism of the lathe saddle. The latter must be done when cutters are fixed in bars. A great deal of difference exists in the details of the fittings both of bars and heads, but they are not so arbitrary as they might seem at first sight. The principal differences are those due to the number of cutters used, their shapes, and their method of fastening. Bars receiving their cutters direct include one, two or four, cutting on opposite sides, and

therefore balanced Four give better balance than two

Saws.—The saws are a natural connecting link between the chisels and the milling cutters. Saws are used for wood, metal and stone. Slabs of steel several inches in thickness are sawn

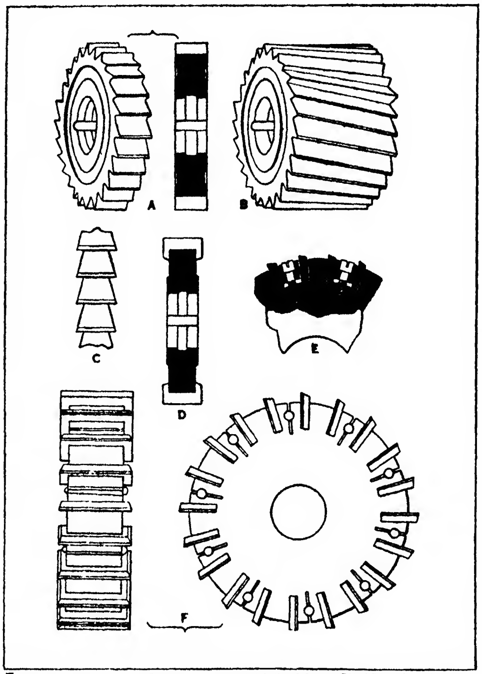


FIG. 15.—MILLING CUTTERS. (A) NARROW EDGE WITH STRAIGHT TEETH; (B) WIDE EDGE WITH SPIRAL TEETH. (C) TEETH ON FACE AND EDGES, (D) CUTTER WITH TEETH LIKE C. (E) FLAT TEETH, (F) INSERTED TOOTH

through as readily as. though more slowly than, timber planks. Circular and band saws are common in the smithy and the boiler and machine shops for cutting off bars, forgings and rolled sections. But the tooth shapes are not those used for timber, nor is the cutting speed the same In the individual saw-teeth both cutting and scraping actions are illustrated (fig 14) Saws which cut timber continuously with the grain, as rip, hand, band, circular, have incisive teeth, for though many are destitute of front rake, the method of sharpening at an angle imparts a true shearing cut. But all cross-cutting teeth scrape only, the teeth being either of triangular or of M-form, variously modified. Teeth for metal cutting also act strictly by scraping The pitching of the teeth is related to the nature of the material and the direction of cutting. It is coarser for timber than for metal, coarser for ripping or sawing with the grain than for cross cutting, coarser for soft than for hard woods The *setting* of teeth, or the bending over to right and left, by which the clearance is provided for the blade of the saw, is subject to similar variations. It is greatest for soft woods and least for metals, where in fact the clearance is often secured without set, by thinning the blade backwards.

Milling Cutters.—Between a circular saw for cutting metal and a thin milling cutter there is no essential difference. Increase the thickness as if to produce a very wide saw, and the essential plain edge milling cutter for metal results. In its simplest form the milling cutter is a cylinder with teeth lying across its periphery, or parallel with its axis—the *edge mill* (fig. 15), or else a disk with teeth radiating on its face, or at right angles with its axis—the *end mill* (fig. 16). Each is used indifferently for producing flat faces and edges, and for cutting grooves which are rectangular in cross-section

When more than about an inch in width, surfacing cylindrical cutters are formed with spiral teeth (fig. 15, B), a device which is

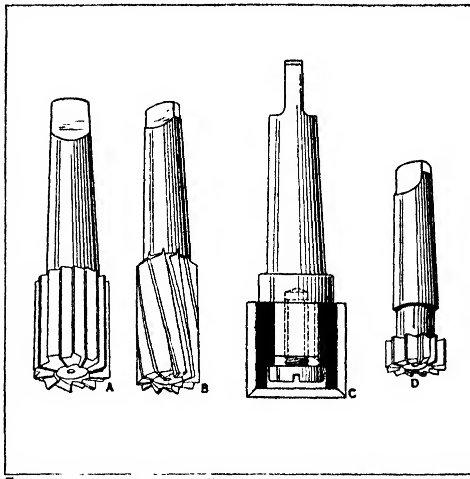


FIG. 16—END MILLS (A) WITH STRAIGHT TEETH, (B) WITH SPIRAL TEETH, (C) HOLDING SHELL CUTTER ON ARBOR WITH SCREW AND KEY, (D) T-SLOT CUTTER

essential to sweetness of operation, the action being that of shearing These have their teeth cut on universal machines, using the dividing and spiral head and suitable change wheels, and after hardening they are sharpened on universal grinders When cutters

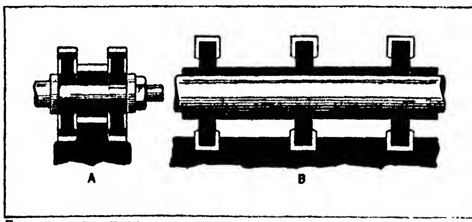


FIG 17—(A) STRADDLE MILL, (B) SET OF THREE MILLS FOR CUTTING GROOVES

exceed about 6 in in length the difficulties of hardening and grinding render the "gang" arrangement more suitable Thus, two, three or more similar edge mills are set end to end on an arbor, with the spiral teeth running in reverse directions, giving a broad face

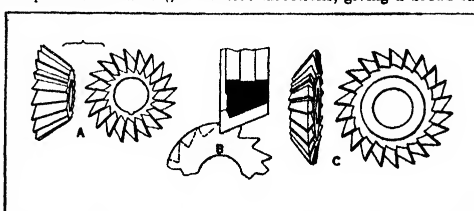


FIG. 18—ANGULAR MILLS (A) SINGLE SLOPE CUTTER: (B) CUTTER WITH SINGLE SLOPE PRODUCING TEETH IN ANOTHER CUTTER, (C) DOUBLE SLOPE MILL WITH UNEQUAL ANGLES

with balanced endlong cutting forces From these are built up the numerous gang mills, comprising plane faces at right angles with each other, of which the straddle mills are the best known (fig. 17, A). A common element in these combinations is the key seat

type B having teeth on the periphery and on both faces as in fig 15, C, D. In a single cutter of the face type, but having teeth on back and edge also, T-slots are readily milled (fig. 16, D).

When angles, curves and profile sections are introduced, the capacity of the milling cutter is infinitely increased. The making of the cutters is also more difficult. Angular cutters (fig. 18) are used for producing the teeth of the mills themselves, for shaping the teeth of ratchet wheels, and, in combination with straight cutters in gangs, for angular sections. With curves, or angles and curves in combination, taps, reamers and drills can be fluted or grooved, the teeth of wheels shaped, and in fact any outlines imparted (fig 19)

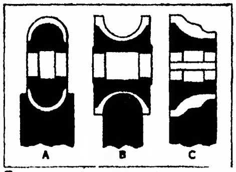


FIG 19 —CUTTERS (A) CONVEX, (B) CONCAVE; (C) PROFILE

One of the greatest advances in the practice of milling was that of making backed-off cutters The sectional shape behind the tooth face is continued identical in form with the profile of the edge, the outline being carried back as a curve equal in radius to that of the cutting edge (fig. 20) The result is that the cutter may be sharpened on the front faces of the teeth without interfering with the shape which will be milled, because the periphery is always constant in outline After repeated sharpenings the teeth would assume the form indicated by the shaded portion on two of the teeth The limit of grinding is reached when the tooth becomes too thin and weak to stand up to its work.

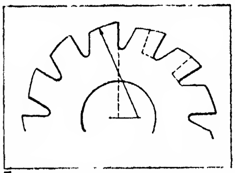


FIG 20 — RELIEVED TEETH OF MILLING CUTTER

Scrapes and Files.—The tools which operate by scraping (fig 21) include many of the broad finishing tools of the turner in wood and metal (*cf* fig 2), and the scrape of the wood worker and the fitter The practice of scraping surfaces true, applied to surface plates, machine slides and similar objects, was due to Sir Joseph Whitworth. It superseded the older and less accurate practice of grinding to a mutual fit. Now, with machines of precision, the practice of grinding has to a large extent displaced the more costly scraping

Files are classed with scrapes, for, although the points are keen, there is never any front rake. Collectively there is a shearing action because the rows of teeth are cut diagonally. The sectional forms (fig 22) and the longitudinal forms (fig 23) of the files are numerous, to adapt them to all classes of work In addition, the method of cutting, and the degrees of coarseness of the teeth, vary, being single, or float cut, or double cut (fig 24) The rasps are another group. Degrees of coarseness are designated as rough, middle cut, bastard cut, second cut, smooth, double dead smooth, the first named is the coarsest, the last the finest. The terms are relative, since the larger a file is the coarser are its teeth, though of the same name as the teeth in a shorter file, which are finer.

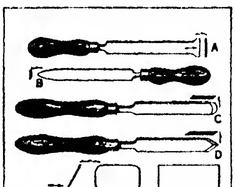


FIG. 21 —SCRAPES (A, B) METAL-WORKER'S SCRAPE; (C, D) ROUND NOSED AND DIAMOND POINT FOR WOOD-TURNING; (E, F) CABINET-MAKERS' SCRAPES

Shears and Punches.—These may be of cutting or non-cutting types. Shears (fig 25) have no front rake, but only a slight clearance. They generally give a slight shearing cut, because the blades do not lie parallel, but the cutting begins at one end and continues in detail to the other. But strictly the shears, like the punches, act by a severe detrusive effort; for the punch, with its bolster (fig. 26), forms a pair of cylindrical shears. The effect of shearing is practically identical with that of punching, and likewise planing and annealing shorn edges has substantially the same influence as reamering punched holes. *See* also SCREW.

HAMMERS AND MOULDING TOOLS

Hammers.—These form an immense group, termed percussive, from the manner of their use (fig. 27) Every trade has its own peculiar shapes, the total of which number many scores, each with its own appropriate name, and ranging in size from the minute forms of the jeweler to the sledges of the smith and boiler maker and the planishing hammers of the coppersmith Wooden hammers are termed mallets, their purpose being to avoid bruising tools or the surfaces of work Most trades use mallets of some form or another Hammer handles are rigid in all cases except certain percussive tools of the smithy, which are handled with withy rods, or iron rods flexibly attached to the tools, so that when struck by the sledge they shall not jar the hands The fullering tools, and flatters, and setts, though not hammers strictly, are actuated by percussion The dies of the die forgers are actuated percussively, being closed by powerful hammers The action of caulking tools is percussive, and so is that of moulders' rammers

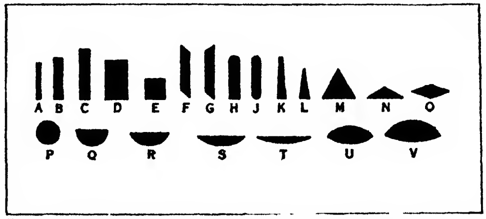


FIG. 22 —CROSS-SECTIONAL SHAPES OF FILES (A) WARDING, (B) JILL, (C) FLAT, (D) PILLAR, (E) SQUARE, (F, G) SWAGED REAPERS, (H) MILL, (J) TOPPING, (K) REAPER, (L) KNIFE, (M) THREE-SQUARE, (N) CANT, (O) SLITTING OR FEATHER EDGE, (P) ROUND, (Q) PIT-SAW OR FRAME-SAW; (R) HALF-ROUND, (S, T) CABINET; (U) TUMBLER, (V) CROSSING

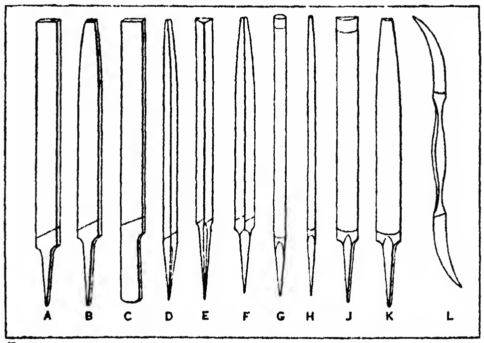


FIG 23 —LONGITUDINAL SHAPES OF FILES (A) PARALLEL, (B) TAPER BELLIED, (C) KNIFE REAPER, (D) TAPERED SQUARE (E) PARALLEL TRIANGULAR; (F) TAPERED TRIANGULAR, (G) PARALLEL ROUND, (H) TAPER; (J) PARALLEL HALF-ROUND, (K) TAPERED HALF-ROUND, (L) RIFFLER

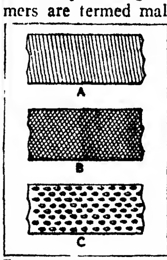


FIG 24 —FILE TEETH. (A) FLOAT CUT: (B) DOUBLE CUT: (C) RASP CUT

Moulding Tools.—This is a group of tools which, actuated either by simple pressure or percussively, mould, shape and model forms in the sand of the moulder, in the metal of the smith, and in press work. All the tools of the moulder (fig 28) with the exception of the rammers and vent wires act by moulding the sand into shapes by pressure. They are made in iron and brass. The fullers, swages and flatters of the smith, and the dies used with hammer and presses, all mould by percussion or by pressure, the

work taking the counterpart of the dies, or of some portion of them. The practice of die forging consists of moulding processes

For a discussion of Tool Steels see the article under that heading.

MEASUREMENT

An advance of the greatest importance made in mechanical engineering is that of measurement Since the beginning of the 19th century steady movement has been going on in this direction Methods of measurement adopted in woodworking have but little application in high-class engineers' work They are adopted, however, to a considerable extent in the metal trades which are allied to engineering, as sheet metal working, girder work, etc. When a carpenter or joiner sets about constructing a door, window sash, roof or box he takes a two-foot rule, a marker and possibly compasses Whether the tool used be saw, chisel, gouge or plane, the woodworker estimates by sight alone whether or not the lines marked are worked by.

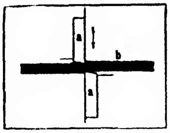


Fig 25.—Shear Blades (a, a) Blades. (b) Plates being sheared

The broad difference between his method and that of the engineer's machinist lies in this, that while the first tests his work by the eye, the second judges of its accuracy or otherwise by the sense of touch. It may seem that there cannot be very much difference in these two methods, but there is To the first, the sixty-fourth part of an inch is a fine dimension, to the second one-thousandth of an inch is rather coarse. In what are called "limit gauges" the plugs and rings are made of slightly different dimensions If a plug is made a thousandth of an inch less than its ring, it will slip through it easily with very perceptible slop The common rule is therefore scarcely seen in modern machine shops, while the common calipers fill but a secondary place, their function having been invaded by the gauges. A minute dimension cannot be tested by lines of division on a rule, neither can a dimension which should be fixed be tested with high precision with a movable caliper of ordinary type Yet it must not be supposed that the adoption of the system of gauging instead of the older methods of rule measurement relieves men of responsibility The instruments of precision require delicate handling. Rough forcing of gauges will not yield correct results. Without correctness of measurement mechanical constructions would be impossible, and the older device of mutual fitting of parts is of lessening value in face of the growth of the interchangeable system, of international standards, and of automatic machine tools.

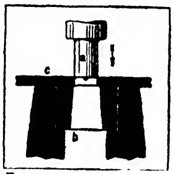


Fig 26.—Punching (a) Punch. (b) Bolster (c) Plate being punched

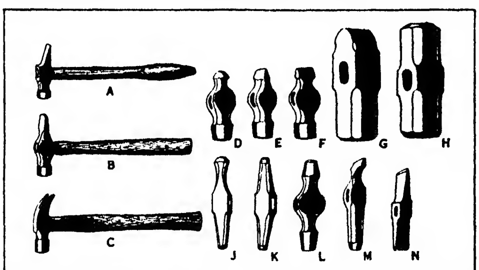


Fig 27—Hammers (A) Exeter. (B) Joiner's. (C) Canterbury Claw. (D, E, F) Engineer's (Ball, Cross and Straight Pane [Peen]). (G, H) Sledge Hammer, Straight Pane (Peen) and Double Faced. (J, K, L, M) Boiler Makers'. (N) Sealing

The two broad divisions of measurement by sight and by contact are represented in a vast number of instruments. To the first named belong the numerous rules in wood and metal and with English and metric divisions, and the scales which are used for setting out dimensions on drawings smaller than those of the real objects, but strictly proportional thereto. The second include all the gauges These are either fixed or movable, an important subdivision. The first embrace two groups—one for daily workshop service, the other for testing and correcting the wear of these, hence termed "reference gauges" They are either made to exact standard sizes, or they embody "limits of tolerance," *i.e*, allowances for certain classes of fits, and for the minute degrees of inaccuracy which are permissible in an interchangeable system of manufacture The movable group includes a movable portion, either corresponding with one leg of a caliper or having an adjustable rod, with provision for precise measurement in the form of a vernier or of a screw thread divided micrometrically These may be of general character for testing internal or external diameters, or for special functions as screw threads. Subtitles indicate some particular aspect or design of the gauges, as "plug and ring," "caliper," "horseshoe," "depth," "rod," "end measure," etc. So severe are the requirements demanded of instruments of measurement that the manufacture of the finer kinds remains a speciality in the hands of a very few firms The cost and experience necessary are so great that prices rule high

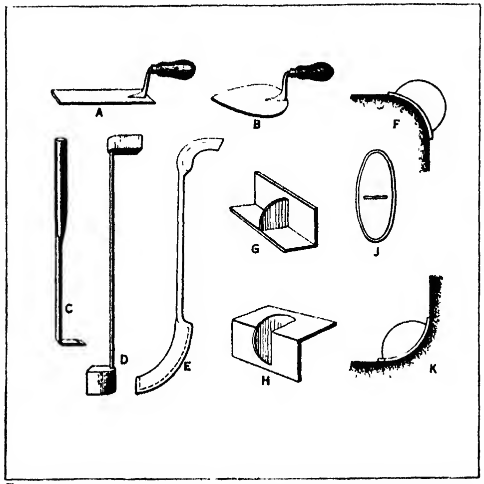


Fig 28—Moulding Tools. (A) Square Trowel. (B) Heart Trowel. (C, D) Cleaners. (E) Flange Bead. (F) Hollow Bead. (G, H) Square Corner Sleeker. (J) Button Sleeker. (K) Pipe Smoother

Rules and Scales.—The rules are used for marking off distances and dimensions in conjunction with other instruments, as scribers, compasses, dividers, squares, and for testing and checking dimensions when marked, and work in course of reduction or erection, directly or from calipers. They are made in boxwood and in steel, the latter being either rigid or flexible, as when required to go round curves Rules are fitted in combination with other instruments, as sliding calipers, squares, depth gauges, etc The scales are of boxwood, or ivory, the value of which is discounted by its shrinkage, and of paper They are fully divided, or open divided; in the first case each division is alike subdivided, in the second only the end ones are thus treated.

The Gauges. *Fixed Gauges*—These now embrace several kinds, the typical forms being represented by the cylindrical or plug and ring gauges and by the caliper form or snap gauges. The principle in each is that a definite dimension being embodied in the gauge, the workman has not to refer to the rule, either directly or through the medium of a caliper. This distinction, though slight, is of immense importance in modern manufacturing. Broadly it corresponds with the difference between the older heterogeneous and the present interchangeable systems.

Plug and Ring Gauges.—The principal ones and the originals

of all the rest, termed Whitworth gauges after the inventor, are the plug and ring gauges (fig. 29, *A* and *B*). The principle on which they depend is that if the two gauges are made to fit with perfect accuracy, without tightness on the one hand or slop on the other, then any work which is measured or turned and bored or ground by them will also fit with equal accuracy Bored holes are tested by the plug gauge, and spindles are tested by the ring gauge, and such spindles and holes make a close fit if the work is done carefully Of course, in practice, there is very much variation in the character of the work done, and the finest gauges are too fine for a large proportion of engineers' work. It is possible to make these gauges within $\frac{1}{50\,000}$ of an inch But they are seldom required so fine as that for shop use, $\frac{1}{6,000}$ is generally fine enough For general shop work the gauges are made to within about $\frac{1}{1,000}$ of an inch Standard gauges in which the plug and ring are of the same diameter will only fit by the application of a thin film of oil and by keeping the plug in slight movement within the ring Without these precautions the two would "seize" so hard that they could not safely be separated

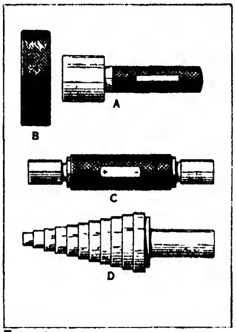


FIG 29 —GAUGES (A, B) PLUG AND RING, (C) DIFFERENCE, (D) STEPPED REFERENCE

Plug and Ring v. *Horseshoe Gauges*—The horseshoe, snap or caliper gauges (fig 30) are often used in preference to the plug and ring types

Limit Gauges—Some fits have to be what is termed in the shops "driving fits," that is, so tight that they have to be effected by driving with a hammer or a press, while others have to be "working fits," suitable, say, for the revolution of a loose pulley on its shaft or of an axle in its bearings The "limit" or "difference gauges" (figs 29 and 30) are designed for producing these working fits; that is, the plug and ring gauges differ in dimensions so that the work bored will drive tightly, or slide freely over the work turned These are variously sub-classified The system

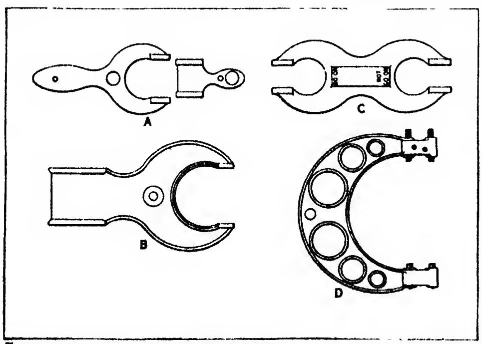


FIG 30 —GAUGES (A) SEPARATE CALIPER, (B) COMBINED INTERNAL AND EXTERNAL, (C) DIFFERENCE, (D) NEWALL ADJUSTABLE LIMIT GAUGE

which is generally accepted embraces *force fits*, which require the application of a screw or hydraulic press; *driving fits*, that require less power, as that of a hammer; *push fits*, in which a spindle can be thrust into its hole by hand, and *running fits*, such as that of shafts in bearings Fixed gauges are made for each of these, but as this involves a heavy outlay there are also adjustable limit gauges (fig. 30, *D*) for external dimensions, the standard plug being used for holes. The setting is done by screwed plugs or anvils adjusted by reference bars. In all these gauges the "go on" and "not go on" ends respectively are stamped on the gauge.

Reference Discs and End Measuring Rods—Shop working gauges become in time so damaged by service that they fail to measure so accurately as when new. To correct these errors

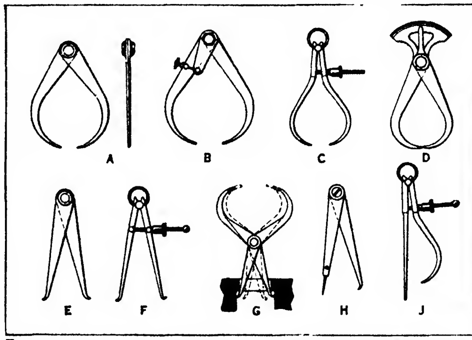


FIG 31 —CALIPERS (A) EXTERNAL, (B) TYPE ADJUSTED BY SCREW IN AUXILIARY LEG, (C) SCREW, (D) SELF-REGISTERING, (E) COMMON INTERNAL, (F) SCREW TYPE WITH SPRING, (G) COMBINED INTERNAL AND EXTERNAL (H) COMPASS, (J) KEYHOLE

reference gauges are provided These are never used in the shops for actual measurement of work, but are only kept for checking the truth of the working gauges They include disc,

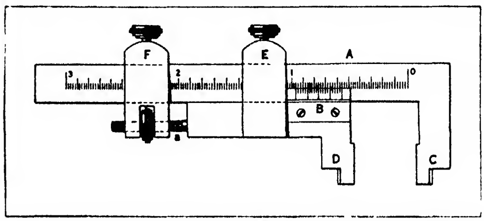


FIG. 32 —VERNIER CALIPER (A) BEAM, (B) VERNIER, (C) FIXED JAW, (D) MOVABLE JAW, (E) CLAMPING HEAD, (F) ABUTMENT HEAD WITH ADJUSTING SCREW, a, FOR ADJUSTMENT OF D

stepped and end measurement gauges The disc and the stepped are used for testing the ring gauges, the stepped kind comprising essentially a collection of discs in one piece (fig 29 *D*) The end

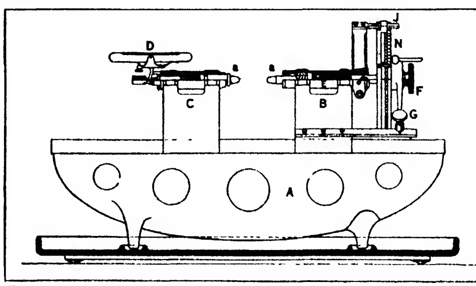
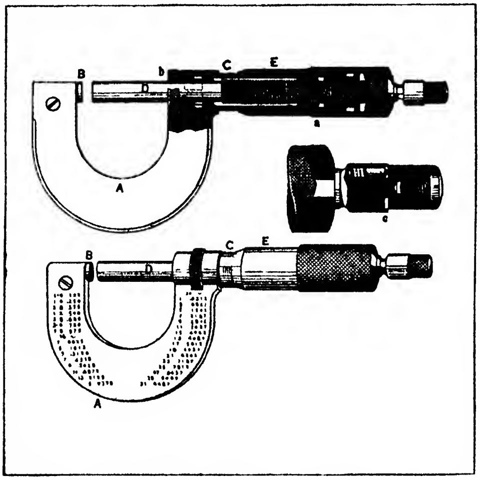


FIG 33 —MEASURING MACHINE (A) HOLLOW BASE, (B) MEASURING HEADSTOCK, (C) MOVABLE HEAD, (D) SPIRIT-LEVEL, (E) MEASURING SCREW, (F) NUT FOR ADJUSTMENT OF E, (G) KNOB FOR SLOW MOVEMENT OF E, (J) VERNIER a, a. POINTS BETWEEN WHICH CONTACT IS MADE

measure pieces test the external gauges. Some end measure standard lengths are so accurate that any sizes taken at random in any numbers from ¼ in to 4 in, varying by sixteenths of an inch, will, when placed end to end, make up an exact length.

Movable Gauges.—This extensive group may be regarded as compounded of the common caliper and the Whitworth measuring machine. They are required when precise dimensions have

to be ascertained in whole numbers and minute fractional parts. They combine the sense of touch by contact, as in the calipers, with the exact dimensions obtained by inspection of graduated scales, either the vernier or the micrometer screw. If gauges must not vary by more than $\frac{1}{10,000}$ of an inch, which is the limit



BY COURTESY OF BROWN AND SHARPE MFG CO

FIG 34.—MICROMETER CALIPERS (A) FRAMES. (B) ANVIL; (C) HUB. (D) SPINDLE WITH MICROMETER SCREW. (E) THIMBLE. a, ADJUSTING NUTS. b, CLAMPING NUT. c, RATCHET STOP

imposed by modern shop ideals, then instruments must be capable of measuring to finer dimensions than this. Hence, while the coarser classes of micrometers read directly to $\frac{1}{1000}$ part of an inch, the finest measure up to $\frac{1}{100,000}$ of an inch, about 200 times as fine as the diameter of a human hair.

Calipers.—Common calipers (fig. 31) are adjusted over or within work, and the dimensions are taken therefrom by a rule or a gauge

Vernier Calipers.—The vernier fitting, so named after its inventor, Pierre Vernier, in 1631, is fitted to numerous calipers and caliper rules. It is applied to calipers for engineers' use to read to $\frac{1}{1,000}$ of an inch without requiring a magnifier The beam of the caliper is divided into inches and tenths of the inch, and each tenth into fourths and the vernier into twenty-five parts, or the beam is divided into fiftieths of an inch (fig. 32) and the vernier has 20 divisions to 19 on the rule.

Micrometer Calipers are the direct offspring of the Whitworth measuring machine In the original form of this machine a screw of 20 threads to the inch, turned by a worm-wheel of 200 teeth and single-threaded worm, had a wheel on the axis of the worm with 250 divisions on its circumference, so that an adjustment of $\frac{1}{1,000,000}$ of an inch was possible. The costly measuring machines made to-day have a dividing wheel on the screw, but they combine modifications to ensure freedom from error, the fruits of prolonged experience. Such machines (fig. 33) are used for testing purposes, but there are immense numbers of small instruments, the micrometer calipers (fig 34), made for general shop use, measuring directly to $\frac{1}{1,000}$ of an inch, and in the hands of careful men easily to half and quarter thousandths. In these the subdivision of the turns of the screw is effected by circular graduations. Usually the screw pitch is 40 to the inch, and the circular divisions number 25, so that a movement of one division indicates that the screw has been advanced $\frac{1}{25}$ of $\frac{1}{40}$ or $\frac{1}{1,000}$ of an inch. Provision for correcting or taking up the effects of wear is included in these designs (*e.g.*, at *a* in fig. 34), and varies with different manufacturers. A vernier is sometimes fitted in addition, in very high class instruments, to the circular divisions, so that readings of ten thousandths of an inch can be taken. Beam micrometer calipers (fig. 35) take several inches in length, the micrometer being reserved for fractional parts of the inch only.

Depth and Rod Gauges.—It is often necessary to measure the depth of one portion of a piece of work below another part, or the height of one portion relatively to a lower one. To hold a rule perpendicularly and take a sight is not an accurate method, because the same objections apply to this as to rule measurement

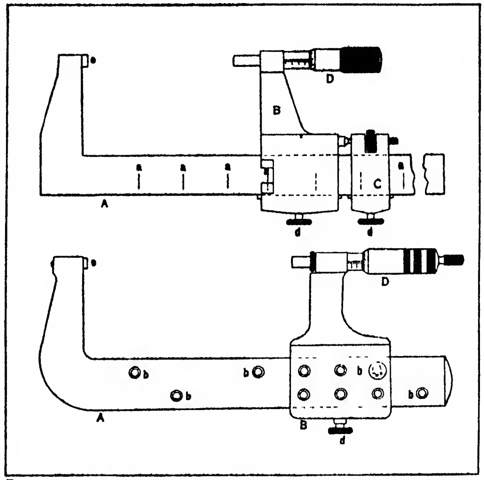


FIG. 35.—BEAM MICROMETER CALIPERS. (A) BEAM; (B) HEAD, ADJUSTABLE BY EQUAL INCH DIVISIONS, BY LINES a, a, OR HOLES b, b, AND PLUG b' HOLES. (C) ABUTMENT BLOCK WITH SCREW c FOR FINE ADJUSTMENT. d, CLAMPING SCREWS; (D) MICROMETER. e, ANVIL

in general There are many depth gauges made with rule divisions simply. These have the marked advantage of a shouldered face which rests upon the upper portion of the work, from which the rule measurement is taken (fig 36) These generally have

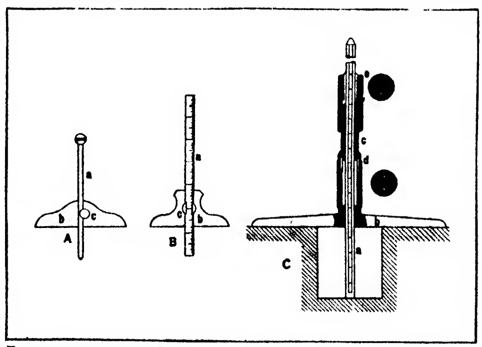


FIG 36.—DEPTH GAUGES: (A) PLAIN ROUND ROD a, SLIDING IN HEAD b, AND PINCHED WITH SCREW c; (B) GRADUATED RULE a, SLIDING ON HEAD b, IN GROOVED HEAD OF CLAMPING SCREW c; (C) SLOCOMB DEPTH GAUGE, FITTED WITH MICROMETER, a ROD, SLIDING IN HEAD, b, c HUB, d THIMBLE CORRESPONDING WITH SIMILAR DIVIDED PARTS IN MICROMETER CALIPERS, e CLAMPING SCREW

a clamping arrangement. For very accurate work either the vernier or the micrometer fitting is applied. For larger diameters are the rod gauges (fig. 37) to which the micrometer is fitted

Screw Thread Gauges.—The taking of linear dimensions, though provided for so admirably by the systems of gauging just discussed, does not cover the important section of screw measurement. This is a department of the highest importance. In most English shops the only test to-day of the size of a screw or nut

is the use of a standard screw or a standard nut. This method may suffice in many classes of work, but it is utterly unsuited to an interchangeable system; and when there is a fair amount of the latter firms sometimes make thread gauges of their own, in general form like the plug and ring gauges, using a hard quality of steel for small sizes or a tough quality of cast iron for the larger. These, though not hardened, will endure for a long time if treated carefully; but though very useful and far better than none at all they lack two essentials They are simply accommo-

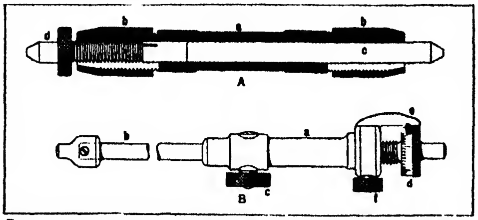
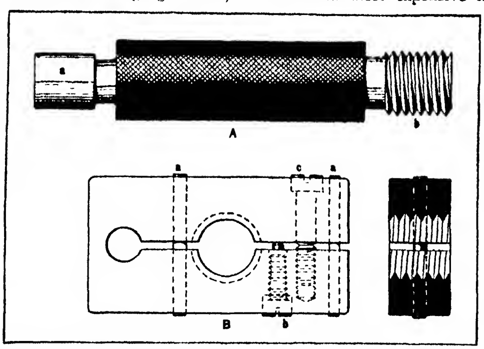


FIG 37.—ROD GAUGES. (A) PRATT & WHITNEY GAUGE, a. TUBE SPLIT AT ENDS, b, b. CHUCKS CLAMPING TUBE ON PLAIN ROD c, AND SCREWED END d, FINE ADJUSTMENT MADE BY SCREWED END d: (B) SAWYER GAUGE, a. BODY, b. EXTENSION ROD, d. SCREWED END WITH GRADUATED HEAD, e. READING ARM EXTENDING FROM BODY OVER GRADUATIONS, f. CLAMPING SCREW

dation gauges, made to an existing tap or die, and do not therefore embody any precise absolute measurement, nor do they include any means for measuring variations from standard, nor are they hardened The essence of a screw gauge is that it measures the sides of the threads without risk of a possible false reading due to contact on the bottom or top of the V This is fulfilled by flatting the top and making the bottom of the gauge keen Some gauges are made as a plug and ring (fig 38), the plug being solid and the ring capable of precise adjustment round it There is a plain round end, ground and lapped exactly to the standard size of the bottom of the thread, a dimension which is obliterated in the threaded end because of the bottoms of the angles being made keen for clearance There are three kinds of this class of gauge made; the first and most expensive is



BY COURTESY OF THE PRATT AND WHITNEY CO

FIG. 38—SCREW THREAD GAUGES. (A) PLUG GAUGE, (a) SIZE OF TAPPING HOLE, (b) THREAD; (B) RING GAUGE, (a) PINS TO PREVENT LATERAL MOVEMENT, (b) SCREW FOR OPENING GAUGE, (c) SCREW FOR CLOSING GAUGE

hardened and ground in the angle, while the second is hardened but not ground. The first is intended for use when a very perfect gauge is required, the second for ordinary shop usage. The third is made unhardened for purposes of reference simply, and it is not brought into contact with the work to be tested at all, but measurements are taken by calipers; in every detail it represents the standard threads. An appliance of quite a different character is a micrometer caliper having a fixed V and a movable point between which the screw to be measured is embraced.

Indicators are a small group of measuring instruments of a rather peculiar character. They magnify the most minute error by adaptations of long and short lever arms Some simply magnify inaccuracy, but in one type an index reads to thousandths of an inch (fig. 39). They are used in some lathe chuck work, but their principal value is in fitting and erecting the finer mechanisms

Surface Plates and Cognate Forms.—Allied to the gauges are the instruments for testing the truth of plane surfaces. the sur-

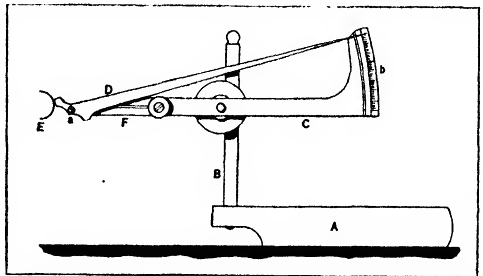


FIG 39—INDICATOR (A) BASE, (B) STEM, (C) ARM; (D) POINTER, PIVOTED AT a, AND MAGNIFYING MOVEMENT OF THE WORK E UPON THE SCALE b, (F) SPRING TO RETURN 'D' TO ZERO

face plates, straight-edges and winding strips The origination of plane surfaces by scraping, until the mutual coincidence of three plates is secured, was due to Whitworth These surface plates (fig 40, *A*) fill an important place in workshop practice, since in the best work plane surfaces are tested on them and corrected by scraping To a large extent the precision grinding

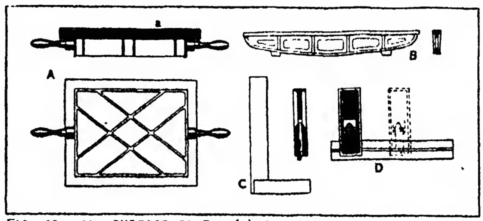


FIG 40—(A) SURFACE PLATE, (a) PROTECTING COVER FOR PLATE WHEN NOT IN USE, (B) LARGE RIBBED STRAIGHT-EDGE, (C) SQUARE; (D) SQUARE WITH ADJUSTABLE BLADE

machines have lessened the value of scraping, but it is still retained for machine slides and other work of a similar class In the shops there are two classes of surface plates those employed daily about the shops, the accuracy of which becomes impaired in time, and the standard plate or plates employed for test and correction Straight-edges are derived from the surface plates, or may be originated like them The largest are made of cast iron, ribbed and curved on one edge, to prevent flexure, and provided with feet (fig 40, *B*) The smaller straight-edges are generally parallel, and a similar pair constitutes "winding strips," by which any twist or departure from a plane surface is detected Squares, of which there are numerous designs (fig 40, *C* and *D*), are straight-edges set at right angles. Bevels or bevel-squares (fig. 41), are straight-edges comprising a stock and a blade, which are adjustable for angle in relation to each other. Shop protractors often include a blade adjustable for angle, forming a bevel with graduations Spirit-levels test the horizontal truth of surfaces. Many levels have two bubble tubes at right angles with each other, one of which tests the truth of vertical faces. Generally levels have flat

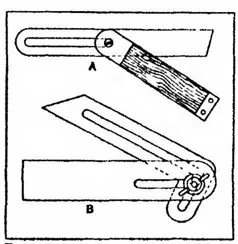


FIG 41—BEVELS (A) COMMON, (B) UNIVERSAL

feet, but some are made of V-section to fit over shafting. The common plumb-bob is in frequent use for locating the vertical position of centres not in the same horizontal plane When a plumb-bob is combined with a parallel straight-edge the term plumb-rule is applied It tests the truth of vertical surface more accurately than a spirit-level (J. G. Ho.)

TOOLE, JOHN LAWRENCE (1832–1906), English actor, was born in London on March 12, 1832 He was educated at the City of London School He definitely took to the stage in 1852, appearing in Dublin as Simmons in *The Spitalfields Weaver* In 1854 he made his first professional appearance in London at the St. James's theatre, acting Samuel Pepys in *The King's Rival* and Weazel in *My Friend the Major*. In 1857, he met Henry Irving in Edinburgh, and recommended him to go to London; and their friendship remained thenceforth of the closest kind In 1858 Toole joined Webster at the Adelphi, and established his popularity as a comedian In 1868 he was engaged at the Gaiety, appearing among other pieces in *Thespis*, the first Gilbert and Sullivan collaboration. In 1879 he took the "Folly" theatre in London, which he renamed "Toole's" in 1882. He died at Brighton on July 30, 1906. Toole excelled in what may be called Dickens parts—combining humour and pathos.

TOOL STEEL. This term includes steels used for machine tools, hand tools and cutlery. Prior to 1870 these were exclusively high carbon steels made by crucible or cementation process; since then alloy steels have been introduced for cutting metals Plain carbon steels of high quality are still pre-eminent for wood working, stone cutting and cutlery The amount of carbon ranges from 0.60 to 1 30% the lower carbon content giving a moderate hardness but great toughness Sledges, chisels, picks, rock drills, axes, woodworking tools, files, cutlery and razors, each item needs greater and greater hardness and more ability to maintain a cutting edge, with toughness progressively less important as the carbon content increases.

With carbon steels, if worked at high rates of speed, the friction between chip and tool-nose generates enough heat to "draw the temper" of the tool, that is, to soften it to a lesser hardness than the material being cut This is avoided by using special alloys that temper very slowly, retain their hardness at high heats, or are intrinsically hard and require no heat treatment. Mushet steel (*q v*) is of the first category, and was introduced about 1870 High speed steel (*q v*), which has the property of hardness at a red heat, is now widely used in machine shops for mass production of iron and steel parts Stellite (although really not a steel) is an example of the third class of hard tool material Another material of the greatest hardness, introduced in 1928, is an alloy of tungsten carbide with up to 12% cobalt, that has already proven very useful for tough or abrasive substances like aluminium bronze, Hadfield's manganese steel and non-metallic electrical insulation.

As explained in the last paragraphs of the article on "Iron and Steel," carbon steels owe their hardness after quenching to submicroscopic particles of hard iron carbide cemented together with the softer ferrite (pure iron). Mushet found that the metals tungsten and chromium combined with high-carbon steel slowed down the softening reactions, so that a drastic quenching from a high heat was unnecessary. In 1900, Taylor and White disclosed the fact that, if Mushet's air-hardening tungsten-chromium steels were cooled from a sweating temperature and then tempered at a high heat, they would retain their hardness at a red heat. Progress since then has come in working out the optimum composition in tungsten, chromium, carbon and vanadium The revolution in machine shop practice was primarily due to the hardening and stabilizing effect of tungsten, chromium and iron carbides in tool steel. More recently the addition of the metal cobalt in amounts up to 15% has been found to give a more durable cutting edge at a red heat. Meanwhile Elwood Haynes had discovered stellite, a family of alloys essentially of tungsten, chromium and cobalt This alloy soon established itself for machining hard cast iron ("semi-steel") and for rough turning medium steels Variants of the composition have been used for wire-drawing dies. But this swing to hard *metals* seems to be a passing phase The newest tool material is a hard carbide of tungsten with a softer cobalt metal as a binder

Chemical composition of the commonly used tool steels are as shown in table at bottom of this page Sulphur and phosphorus are held to the lowest possible content

See Iron and Steel (E E T)

TOOMBS, ROBERT (1810–1885). American political leader, was born near Washington, Wilkes county, Ga, on July 2, 1810 He was educated at Franklin college (University of Georgia), at Union college, Schenectady (N Y), from which he graduated in 1828, and at the law school of the University of Virginia He was admitted to the bar in 1830, served in the Georgia House of Representatives (1838, 1840–41 and 1843–44), in the U S House of Representatives (1845–53), and in the United States Senate (1853–61). He opposed the annexation of Texas, the Mexican War, President Polk's Oregon policy, and the Walker Tariff of 1846 He supported the Compromise Measures of 1850, denounced the Nashville Convention, opposed the secessionists in Georgia, and helped frame the Georgia platform (1850) He and the Southern Unionists thought secession not wrong but inexpedient When the Whig party dissolved, Toombs went over to the Democrats. He favoured the Kansas-Nebraska Bill, the admission of Kansas under the Lecompton Constitution, the English Bill (1858), and June 24, 1856, introduced in the Senate the Toombs Bill, which proposed a constitutional convention in Kansas under conditions, acknowledged by anti-slavery leaders as fair and marking the greatest concessions by the pro-slavery senators during the Kansas struggle. The failure of the bill to provide for the submission of the constitution to popular vote was the crux of the Lecompton struggle (*see* Kansas) On December 22nd after the election of Lincoln, he sent a telegram to Georgia which asserted that "secession by the 4th of March next should be thundered forth from the ballot-box by the united voice of Georgia"

With Governor Joseph E Brown he led the fight for secession against Stephens and Herschel V. Johnson (1812–80). His influence induced the "old-line Whigs" to support immediate seces-

	Carbon	Silicon	Manganese	Chromium	Tungsten	Vanadium
Sledges and Hammers	0·60 to 0·70	0 25 to 0·30	0·25 to 0 35	All alloy metals (except perhaps vanadium) should be excluded		
Pneumatic Tools	0·80 to 0 90	0 10 to 0·40	0 15 to 0·35			
Keen Edged Tools	1 1 to 1 3	0 10	0 10 to 0 20			
Non-deforming Oil-hardening Steels Gauges	0·80 to 0·95	0·30 max.	1 0 to 1·1	0·40 to 0·50	0 40 to 0·50	0· to 0·20
"Finishing Steels"	1·1 to 1·2	0·20 to 0·40	0·20 to 0·35	0·40 to 0·50	1·4 to 1·7	0 10 to 0·20
"Fast Finishing Steel" (Mushet)	1·0 to 1·3	0·20 to 0·40	0·20 to 0·35	0·20 to 0·40	3·0 to 4·0	
Battering Tools	0·35 to 0·55	0·30 max	0·20 to 0·30	1·3 to 1·6	2·0 to 2·3	0·20 to 0·30
Hot-Working Dies	0 30 to 0·35	0·30 max	0·20 max.	3·2 to 3·4	9 5 to 10·5	0·40 to 0·50
Cold Drawing Dies	2·1 to 2·5	0·35 max.	0·50 max.	13·0 to 15·0		
High Speed Steel (High Tungsten)	0 65 to 0·70	0·25 to 0·30	0·25 to 0·30	4·0	18·0	0·80 min
High Speed Steel (Low Tungsten)	0·60 to 0·75	0·25	0·25	4·0 to 4·5	14·0	1·6 to 2·0
High Speed Steel (Cobalt Bearing)	0 60 to 0·75	0·25	0·25	4·0	17·5	1·0 Cobalt 4·0 to 5·0 Molybdenum 0· to 1·0

sion He was secretary of State in President Davis' cabinet, and then entered the army (July 21, 1861), served as a brigadier-general in the army of Northern Virginia, after 1863 as adjutant and inspector-general of General G. W. Smith's division of Georgia militia. After two years in exile in Cuba, France and England, he returned to Georgia, 1867, and practised law He died in Washington (Georgia), on December 15, 1885

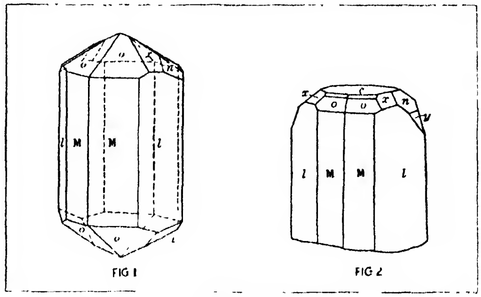
See Pleasant A. Stovall, *Robert Toombs, Statesman, Speaker, Soldier, Sage* (New York, 1892), "Robert Toombs," *Watson's Jeffersonian Mag.* (1912); Gamaliel Bradford, "Confederate Portraits," *Atlantic Monthly* (1913); U. B Phillips, *Life of Robert Toombs*; "Robert Toombs," a review, *Nation*, vol 54; *Atlantic Monthly*, Aug. 1913, *American Hist. Rev*, June 1914, W. P. Trent, *Southern Statesmen of the Old Régime;* James U Vincent, *A Pen-picture of G R. Toombs*, A. H Stephens and H. Cobb, *Correspondence of Robert Toombs;* B. J. Kendric, "Toombs and Stevens," *Pol. Sci Quarterly*, Sept. 1914

TOOTHWORT, the popular name for a small British plant of curious form and growth, known botanically as *Lathraea squamaria* (family Orobanchaceae). It grows parasitically on roots, chiefly of hazel, in shady places such as hedge sides It consists of a branched whitish underground stem closely covered with thick fleshy colourless leaves, which are bent over so as to hide the under surface; irregular cavities communicating with the exterior are formed in the thickness of the leaf On the inner wall of these chambers are stalked hairs. The only portions that appear above ground are the short flower-bearing shoots, which bear a spike of two-lipped dull purple flowers The scales which represent the leaves secrete water *Lathraea* is closely allied to broomrapes (*Orobanche*), of which seven species occur in Great Britain, they also are parasitic In the United States various species of *Dentaria*, family Cruciferae, are called toothwort

TOOWOOMBA, a city in the south-east of Queensland, Australia, situated at an altitude of nearly 2,000 ft on the Darling Downs, 101 m by rail west of Brisbane Toowoomba is an industrial centre, it is also a well-known summer resort ("The Garden City of Queensland"), is situated upon the Main Southern and Western Railway lines which connect it with Brisbane and Sydney, and it is also a centre of radiating lines which concentrate upon it much of the agricultural and pastoral produce of the Darling Downs, besides timber, and the wheat, fruit, and pastoral products of the farther West, Roma (*q v*) and Charleville areas

TOP (*cf* Dan *top*, Ger *Topf*, also meaning pot), a toy consisting of a body of conical, circular or oval shape with a point or peg on which it turns or is made to whirl Greek terms for the toy are *βέμβιξ*, which was evidently the whipping or peg-top (Arist. *Birds*, 1461), and *στρόβιλος*, a humming top, spun by a string (Plato, *Rep.* iv 436 E) In Homer (*Il.* xiv 413) the word *στρόμβος* seems to point to the humming top The Latin name for the top was *turbo* This word and the Greek *ῥόμβος* are sometimes translated by "top" when they refer to the instrument used in the Dionysiac mysteries, which, when whirled in the air by a string, produced a booming noise This was no doubt the equivalent of the "bull roarer" (*q v*) Strutt (*Games and Pastimes*, 491) says that the top was known in England as early as the 14th century For the scientific properties of the top *see* GYROSCOPE

TOPAZ, a mineral of some importance as a gemstone, but apparently having no practical application. It usually occurs in association with cassiterite in connection with granitic rocks, and it is thus often a valuable indicator of the presence of tin-ore. It is usually found as bright, well-developed crystals, or as clear water-worn pebbles, though granular masses of topaz-rock are also known The crystals belong to the orthorhombic system and are usually prismatic in habit, with several dome and pyramid faces (figs. 1 and 2). The prism faces (*M* and *l*) are striated vertically, in contradistinction to quartz in which the prism faces are striated horizontally Doubly terminated crystals (fig. 1) are extremely rare; usually the crystals are attached at one end in the rock cavities in which they grew, and when detached from the matrix they often break along a flat surface parallel to the basal plane (*c* in fig 2) This perfect cleavage is a very important character, and enables topaz to be distinguished at sight from other minerals of similar appearance. The cleavage flakes when examined in convergent polarized light show a good biaxial interference-figure. Chemically, topaz is a fluo-silicate of aluminium $(AlF)_2SiO_4$, in which the fluorine is in part replaced isomorphously by hydroxyl, the formula then being $(Al[F,OH])_2SiO_4$. With this range in chemical composition there is a slight variation in the specific gravity (3 574 to 3 523) and in the optical constants



FIGS 1 AND 2

(refractive indices and optic axial angle), but the difference is of little practical importance

The crystals are often perfectly colourless and water-clear, but owing to the presence of traces of various colouring matters they may show a wide range of colours—red, yellow, brown, green, blue Further, it is an interesting fact that some of these colours are by no means stable The fine brown crystals from pegmatite veins in Transbaikalia, Siberia, and the smaller wine-yellow crystals occurring in rhyolite in Colorado and Utah, fade on exposure to light, and the sherry-yellow crystals from Brazil assume a fine pink colour when they are heated The deceptive trade-names—"Scotch topaz," "Spanish topaz," or "occidental topaz" for yellow quartz (citrine), and "oriental topaz" for yellow corundum ("yellow sapphire") represent three distinct minerals whose characters and differences are set out in the following table

	Topaz	Quartz	Corundum
Chem. comp	$(AlF)_2SiO_4$	SiO_2	Al_2O_3
Cryst system	Orthorhombic	Rhombohedral	Rhombohedral
Specific gravity	3·55	2·65	4 0
Hardness	8	7	9
Optical character	Biaxial positive	Uniaxial positive	Uniaxial negative
Refractive indices	1 61–1·63	1 54 1·55	1·76–1·77

The sherry-yellow crystals of topaz, which in the past have been cut and extensively used in jewellery, are all from the neighbourhood of Ouro Preto, in Brazil, and it is this material that has supplied the pink ("burnt") topaz Brazil also supplies colourless and pale-blue topaz Good crystals of pale blue and green colours have come from the Ural Mountains and from Nerchinsk in Siberia. Colourless water-worn crystals and clear pebbles resembling rock-crystal are abundant in the alluvial deposits of tin-ore in Northern Nigeria, and small colourless crystals are well known from the Cornish tin mines A large rough crystal weighing 137 lb of opaque topaz, from a felspar quarry in Norway, is shown in the mineral collection of the British Museum (Natural History), with many other interesting crystals from various localities (L J. S)

TOPE, name given to various tumulus-like structures in India almost always connected with Buddhist shrines or sites and forming, undoubtedly, the most primitive type of Buddhist temple They are usually built over, enclose one or more relics of Buddha, and consist of a low, vertical, cylindrical wall or drum surmounted by a solid conical mass of carefully built masonry The most famous of the Indian topes is the largest of a group at Sanchi, which is generally attributed to the time of Asoka (3rd century B C) In this the tope proper is surrounded by a circular walk around which is a richly decorated stone fence, pierced by four lavishly sculptured gateways, the whole designed in forms mani-

festly reminiscent of wooden construction. (*See* INDIAN ARCHITECTURE.) The Sanskrit word for a tope, *stupa*, is used generally of various types of sacred Buddhist structures in China, Japan, Java, etc., which all have the common characteristic of being high circular masses of solid masonry. Those of Tibet and China are often remarkable for their fantastic profiles

TOPEKA, the capital city of Kansas, U.S A., and the county seat of Shawnee county; on the Kansas (Kaw) river, in the eastern part of the State, 70 m. W. of Kansas City. It is on Federal highways 40 and 75; has a municipal airport; and is served by the Missouri Pacific, the Rock Island, the Santa Fe and the Union Pacific railway systems. Pop (1920) 50,022 (83·4% native white, 8·0% foreign-born white and 8·5% Negro); estimated locally in 1928 at 62,000 (within the city limits) and 72,500 including adjacent suburbs. The city lies on both sides of the river, at an elevation from 880 to 1,000 ft. above sea-level. It is laid out on the rectangular plan, with broad, well-paved, beautifully shaded streets, substantial business blocks, many playgrounds for children, and 300 ac of public parks. The State Fair grounds, on the edge of the city, cover 78 ac. and include a fine half-mile race-track and numerous permanent exhibition buildings The State capitol (built 1866–1903, at a cost of $3,200,589) stands in the center of parked grounds covering four squares. Topeka is the seat of a Protestant Episcopal cathedral, a State hospital for the insane, a State reform school, the collections of the State historical society, several hospitals (including one for employees of the Santa Fe lines) and private schools, the Kansas Vocational school for negroes (1895), and Washburn college (established in 1865 as Lincoln college, and renamed in 1865 in recognition of a gift of $25,000) which has an enrolment of over 1,200. The city is an important manufacturing center, with an output in 1926 valued at $37,457,732 The Santa Fe has its principal construction shops here, employing 3,500 men, and its offices have a staff of 1,500 officials and clerks The flour-mills make 1,500,000 bbl of flour and 400,000 bbl. of corn-meal annually. Printing and publishing (20 houses) is one of the leading industries. The assessed valuation of property for 1928 was $93,683,060.

Topeka is an Omaha Indian word signifying the so-called Indian potato The first white settler came in 1852, and in 1854 the site was chosen by a group of anti-slavery colonists from Lawrence. It was the scene of many riots during the conflict between the abolitionists and the advocates of slavery in the Territory (*see* KANSAS). The "Topeka Constitution" was framed by a convention here in 1855. In 1856 the Free Soil legislature, meeting here, was dispersed by U S. troops under orders from President Pierce. Under the Wyandotte Constitution (1859) Topeka was made the temporary seat of government, and in 1861 (when Kansas was admitted to the Union) it became the permanent State capital. The city was chartered by the pro-slavery Territorial legislature in 1857. It became a city of the first class in 1881. It was from Topeka that the Santa Fe company began building a railway westward in 1869, and the establishment here in 1878 of its locomotive and car construction shops was an important factor in the city's development. The population increased rapidly from 759 in 1860 to 5,790 in 1870, 15,452 in 1880 and 31,007 in 1890. In 1880, just after the great negro migration to Kansas, 31% of the total population of the city was coloured, but in 1928 the proportion was not more than 7%.

TOPETE, JUAN BAUTISTA (1821–1885), Spanish naval commander and politician, was born in Mexico on May 24, 1821. His father and grandfather were also Spanish admirals. He entered the navy at the age of 17, cut out a Carlist vessel in 1839, became a midshipman at 22, obtained the cross of naval merit for saving the life of a sailor in 1841 and became a lieutenant in 1845. He served on the West Indian station for three years, and was engaged in repressing the slave trade before he was promoted frigate captain in 1857. He was chief of staff to the fleet during the Morocco War, 1859, after which he got the crosses of San Fernando and San Hermenegildo. Having been appointed chief of the Carrara arsenal at Cádiz, he was elected deputy and joined the Union Liberal of O'Donnell and Serrano. He was sent out to the Pacific in command of the frigate "Blanca," and was present at the bombardment of Valparaiso and Callao, where he was badly wounded, and in other engagements of the war against Chile and Peru. On his return to Spain, Topete was made port captain at Cádiz, which enabled him to assume the leadership of the conspiracy in the fleet against the Bourbon monarchy. He sent the steamer "Buenaventura" to the Canary isle for Serrano and the other exiles; and when Prim and Sagasta arrived from Gibraltar, the whole fleet under the influence of Topete took such an attitude that the people, garrison and authorities of Cádiz followed suit. Topete took part in all the acts of the revolutionary government, accepted the post of marine minister, was elected a member of the *cortes* of 1869, supported the pretensions of Montpensier, opposed the election of Amadeus, sat in several cabinets of that king's reign, was prosecuted by the Federal republic of 1873 and again took charge of the marine under Serrano in 1874. After the Restoration Topete for some years held aloof, but finally accepted the presidency of a naval board in 1877, and sat in the Senate as a life peer until his death on Oct. 29, 1885 at Madrid.

TÖPFFER, RODOLPHE (1799–1846), Swiss writer and artist, son of the painter Adam Topffer, was born at Geneva on Jan. 31, 1799. Abandoning his art studies on account of weak eyesight, he became a teacher, eventually establishing a school of his own (1824), which attracted boys from England and America as well as from other European countries He was the first to introduce schoolboy tramps in the Alps, and he described these in his *Voyages en Zigzag*, illustrated by clever drawings by himself. From 1832 till his death, on June 8, 1846, he was professor of belles-lettres at the university of Geneva He wrote various novels and short stories, including the exquisite little masterpiece, *La Bibliothèque de mon Oncle* (1833). His tales were collected under the title *Nouvelles Génevoises* (1841), and several have been translated into English. His series of humorous drawings with explanatory text (*Doctor Festus, Monsieur Vieux-Bois*, etc.), collected under the title of *Histoires en Estampes* (1846–47), were very popular and earned the cordial approbation of Goethe.

See the lives by Relave (1886), A. Blondel (1887) and Glöckner (1891). Also E Rambert, *Écrivains nationaux* (1874), E Javelle, *Souvenirs d'un alpiniste* (1886, Engl. trans, 1899), and notices in Ste. Beuve's *Causeries du lundi* (1852–62), *Derniers portraits littéraires* (1852) and *Portraits contemporains* (1846).

TOPOLOGY: *see* ANALYSIS SITUS.

TORADJA, a group of tribes occupying central Celebes, in the Indonesian archipelago. They possess in common a phallic fertility cult and some of them practise terraced cultivation, erect menhirs and bury their dead in rock-cut tombs They possess, among others, a culture hero who is believed to have introduced the buffalo and to have ascended to heaven by a creeper; they believe in an underground home of the dead, and have a class of male priests who dress in women's clothes; the soul, which is also connected with the sky, takes the form of a manikin, insect, small animal, etc., located in the head, but is also confused with shadow and is in some sense a material substance coextensive with body and liable to impregnate objects (*see* METEMPSYCHOSIS).

See Kruijt, *Het Animisme in den Indischen Archipel.* (1906); Kruijt and Adriani—*De Bare'e—sprekende Toradj's* (1914).

TORBERNITE, (or cupro-uranite), a hydrous uranium and copper phosphate, $Cu(UO_2)_2(PO_4)_2+12H_2O$, one of the "uranium micas." Crystals are tetragonal and have the form of square plates, often very thin. There is a perfect micaceous cleavage parallel to the basal plane, and on this face the lustre is pearly. The bright grass-green colour is characteristic. The hardness is 2·5 and specific gravity 3 5. The radio-activity of the mineral is greater than that of some specimens of pitchblende. It was first observed in 1772 at Johanngeorgenstadt in Saxony, but the best examples are from Gunnislake near Calstock and Redruth in Cornwall. The name torbernite is after Torbern Bergman: *chalcolite* is a synonym. The crystals readily lose part of their water, passing over into "meta-torbernite" $Cu(UO_2)_2(PO_4)_2+8H_2O$, with changes in the optical characters. (L. J. S.)

TORCELLO, an island of Venetia, Italy, in the lagoons, 6 m. to the N.W. of Venice. It was a flourishing city in the early middle ages, but now has 171 inhabitants and two interesting churches.

PHOTOGRAPH, WIDE WORLD PHOTOS

VIEW OF AN APPROACHING TORNADO

Tornado approaching Vulcan, Alberta, Canada. The destructive power is not in the straight wind, but in the counter-clockwise rotating mass which always moves in an easterly, and generally in a north-easterly direction. Barometric pressure in the vicinity of a tornado falls very rapidly

TORNADO

TORNADO VIEWED AT AN ANGLE FROM ITS PATH

Side view of a funnel-shaped tornado cloud sweeping in a path 50 ft. wide across the country near Jasper, Minnesota. The violent local whirl characterized as a tornado is set up in the south-east quadrant of a slowly moving cyclone. The clouds and the earth, having opposite charges of electricity, are attracted. The tornado pictured here travelled only three miles

The former cathedral of S. Maria was founded in 641. The present building, a basilica with columns, dates from 864; the nave was restored in 1008, in which year the now ruined octagonal baptistery was built. It contains large mosaics of the 12th century, strongly under Byzantine influence; those on the west wall represent the Resurrection and Last Judgment. The seats for the priests are arranged round the semicircular apse, rising in steps with the bishop's throne in the centre—an arrangement unique in Italy. Close by is S. Fosca (*ca.* 1011), octagonal outside, with colonnades on five sides and a rectangular interior intended for a dome which was never executed, beyond which is a three-apsed choir.

See B. Schulz, *Kirchenbauten auf dem Insel Torcello* (Berlin and Leipzig, 1927)

TORDENSKJOLD, PEDER (1691–1720), Danish naval hero, son of Jan Wessel of Bergen, in Norway, was born at Trondhjem on Oct. 28, 1691. Wessel ran away from home as a stowaway in a ship bound for Copenhagen, made a voyage to the West Indies, and finally gained a cadetship. In 1712 he was promoted to a 20-gun frigate. Wessel was renowned for his audacity and his unique seamanship. The Great Northern War had now entered upon its later stage, when Sweden, beset on every side, employed her fleet principally to transport troops and stores to her distressed German provinces. The audacity of Wessel impeded her at every point He was continually snapping up transports, dashing into the fjords where her vessels lay concealed.

When in 1715 the return of Charles XII. from Turkey to Stralsund put a new life into the jaded Swedish forces, Wessel fought numerous engagements off the Pomeranian coast, and did the enemy infinite damage by cutting out their frigates and destroying their transports On returning to Denmark in the beginning of 1716 he was ennobled under the title of "Tordenskjold" (Thundershield). When Charles XII invaded Norway and besieged Fredrikshald (1716) Tordenskjold compelled him to raise the siege and retire to Sweden by pouncing upon the Swedish transport fleet laden with ammunition and other military stores which rode at anchor in the narrow and dangerous strait of Dynekil, utterly destroying the Swedish fleet with little damage to himself For this, his greatest exploit, he was promoted to the rank of commander

Tordenskjold's last feat of arms (he was now rear-admiral) was his capture of the Swedish fortress of Marstrand, when he partially destroyed and partially captured the Gothenburg squadron which had so long eluded him He was rewarded with the rank of vice-admiral Tordenskjold did not long survive the termination of the war. On Nov 20, 1720, we was killed in a duel with a Livonian colonel, Jakob Axel Stael von Holstein. Although, Dynekil excepted, Tordenskjold's victories were of far less importance than Sehested's at Stralsund and Gyldenlöve's at Rügen, he is certainly, after Charles XII, the most heroic figure of the Great Northern War

See Carstensen and Lütken, *Tordenskjold* (Copenhagen, 1887).
(R. N. B.; X.)

TORELL, OTTO MARTIN (1828–1900), Swedish geologist, born in Varberg on June 5, 1828, studied the glacial phenomena of Switzerland, Spitsbergen and Greenland, making two Arctic expeditions in company with A. E Nordenskiöld. In 1866 he became professor of zoology and geology in the University of Lund, and from 1871 to 1897 he was chief of the Swedish Geological Survey. His Arctic experiences enabled him to interpret the method of origin of the drift deposits in northern Europe, and to show that they were largely of glacial or fluvio-glacial origin. In the English drifts he recognized many boulders of Scandinavian origin. He died on Sept. 11, 1900.

TORENO, JOSÉ MARIA QUEIPO DE LLANO, COUNT OF (1786–1843), Spanish politician and historian, born at Oviedo, Nov. 25, 1786. He saw service in the Peninsular war, was leader of the party which compelled the regency to summon the *cortes*, and one of the well-meaning men who framed the Constitution of 1812, which was made as if it was meant for some imaginary republic and not for Catholic and monarchical Spain. On Ferdinand VII.'s return from prison in France in 1814, Toreno exiled himself until 1820; served in the restored *cortes* until 1823; and lost much of his radical ardour. From 1823 when the French intervened until the amnesty (Oct. 15, 1832), he had to go into exile; he returned home in July 1833, and as hereditary standard bearer of Asturias (Alferez mayor), it fell to him to proclaim the young queen Isabella II. Prime minister in 1834 from June 7–Sept. 14, when the regent's attempt to retain a despotic government under a constitutional veil broke down, he retired into voluntary exile and died in Paris, Sept. 16, 1843

TORGAU, a town in the Prussian province of Saxony, situated on the left bank of the Elbe, 30 m. E N.E of Leipzig and 26 m. S.E. of Wittenberg by rail. Pop (1925) 12,616. Torgau is said to have existed as the capital of a distinct principality in the time of the German king Henry I., but early in the 14th century it was in the possession of the margraves of Meissen and later of the electors of Saxony. In 1526 John, elector of Saxony, Philip, landgrave of Hesse, and other Protestant princes formed a league against the Roman Catholics, and the Torgau articles, drawn up here by Luther and his friends in 1530, were the basis of the confession of Augsburg. Torgau was formally ceded to Prussia in 1815. The Schloss Hartenfels, on an island in the Elbe, was built by John Frederick the Magnanimous, of Saxony.

Battle of Torgau, 1760.—This, the last great battle of Frederick the Great, and the last of his victories, was so truly Pyrrhic that it paralysed his offensive power and left him in a gravely weakened condition to meet his gathering foes The battle and the events which rescued him from his critical position are dealt with under SEVEN YEARS WAR

TORNADO, the name originally applied to the violent squall blowing outwards from the front of a thunderstorm on the Gold Coast of Africa; it is now used for small-diameter, but extremely violent, revolving storms which are specially frequent in the Mississippi basin, but are also experienced elsewhere, in Australia especially, Europe and many other places, but commonly in a less violent form They normally occur in the spring and early summer months in association with cyclones The most violent tornadoes are always accompanied by a tornado-cloud, a funnel-shaped mass depending from the storm-cloud above, and when fully developed tapering downward to the earth. A tornado has an advancing movement of from 20 to 50 m. an hour, and its narrow path is strewn with wreckage; the storm is of short duration; it passes in a minute or so and often runs its entire course in less than an hour.

See A. Wegner, *Wind und Wasserhosen in Europa* (Braunschweig, 1917); and for Mississippi tornadoes *see* R. de C. Ward, *Q.J.R. Met. Soc.* (1917); also *Monthly Weather Review*, v. 54, p. 501 (1926).

TORNADO AND WINDSTORM INSURANCE. Windstorm damage is one of the major sources of economic loss in many localities. In the United States windstorm insurance should be general and considered an essential form of contingency protection against unavoidable losses inherent to the climate. The policies cover tornado, cyclone and windstorm but do not provide for snow, blizzards, cold or hail even when driven by wind (*See* INSURANCE, MISCELLANEOUS: *Hail Insurance.*) Many forms are issued to cover a great variety of structures, such as "farm form," "builders risk form," "mercantile property form." Rates vary with the kind of property insured, the section of the country in which it is situated, co-insurance and special endorsements. The premiums in the United States with 50% co-insurance ranged, in 1925, from 6 cents to $3 per $100 insurance, depending on position and type of structure. The rates are computed on a basis of 50% co-insurance, and special provision is made for other percentages. By endorsement the policies may be made to cover use and occupancy.

TORO, a town of Spain, in the province of Zamora, on the right bank of the river Duero (Douro), and on the Zamora-Medina del Campo railway. Pop. (1920), 7,541. Toro is an ancient fortified town, with picturesque narrow streets. A fine bridge spans the river. The cathedral church is Romanesque; it dates from the 12th century but has been partially restored The palace of the marquesses of Santa Cruz was the meeting place of the Cortes of 1371, 1442 and 1505, which made Toro and its code of laws celebrated.

TORONTO, the capital of the province of Ontario, and the second largest city in the Dominion of Canada, situated on the northern shore of Lake Ontario, almost due north from the mouth of the Niagara river. It lies on a plateau gradually ascending from the lake shore to an altitude of 300 ft, and covers approximately forty square miles, including the bay and the island stretching along the south of the city. The river Don flows through the eastern part of the city, and the river Humber forms its western limit

Toronto, as the seat of government for the province of Ontario, contains the parliament buildings, the lieutenant-governor's residence, and the courts of law. In Queen's park (area 40 ac.) almost in the centre of the city, stand the parliament buildings, imposing structures of red sandstone; and immediately opposite there was opened in 1928 a large and beautiful addition in blue dolomite stone, called the "Whitney block"

The university, with a roll of 6,000 students in 1928, is federal in constitution, and is composed mainly of four colleges, though maintaining important university functions conjointly. It has made very important developments in the study of problems of health This has been made possible largely by gifts of $1,148,901 for the faculty of medicine from the Rockefeller Foundation, $650,000 from the International Health Board of the Rockefeller Foundation, and $400,000 from the E. C. Whitney Bequest A special building has been devoted, as a branch of the Connaught laboratories, to the study of insulin Recently a faculty of music, a school of engineering research and a department of social science and administration have been organized. There is a University press, and in Hart House and Queen's Park House respectively the men and women students have centres for social and athletic activities Affiliated with the university are denominational colleges near by, the agricultural college at Guelph, etc.

Toronto is rich in other institutions for higher education Upper Canada college, founded in 1829, in many respects resembles an English public school There are 9 collegiate institutes, 2 high schools of commerce, and 2 technical schools, having some 35,000 pupils (1927), about 150 public and separate schools, with an attendance of over 100,000 (1927), and several large private schools for girls Osgood hall houses the higher courts of law and appeal, and also a law school The city hall and courthouse contains civic offices, the board of education, police and county courts, etc There are in Toronto 72 hospitals, asylums and public homes, including ten public hospitals, the largest of which is the Toronto General Hospital in the centre of the city, which in 1927 accommodated approximately 15 000 patients

Toronto is essentially a residential and widespread city The houses of the better class stand separate, not in long rows, and have about them lawns and many trees There are over 90,000 homes, 65% owned by the occupiers An electric railway system and 9 motor bus routes, owned by the city, provide means of communication. There are no underground or overhead railways. Lighting is provided by the publicly owned Hydro-electric Power Commission. There are 69 parks with a total area of 2,065 acres. In Exhibition park (240 acres) there is held each year for a fortnight in the late summer a large annual exposition.

Government and Industries.—The government of the city is vested in a council consisting of the mayor and four controllers elected annually, and twenty-four aldermen, three from each of the eight wards into which the city is divided. The council as a whole is the legislative body, and the board of control is the executive body, and as such is responsible for the administration of the city, except the departments of education and of police Education is under the control of the board of education elected annually by the citizens, and the department of police is under the board of police commissioners, consisting of the mayor, the county judge, and the senior police magistrate.

Because of its geographical position, its cheap electric power, and its nearby sources of raw material, Toronto is one of the chief industrial and commercial centres of the dominion. It is also considered the publishing centre. It has eleven miles of water-front and the largest vessels of the lakes can use its harbour, which is under an extensive scheme of improvements, and will eventually be equipped to handle ocean shipping. In 1927 the magnificent new union station was opened, although the raising of the level of the tracks has not yet been completed.

Bank clearings for 1927 were $6,484,985,045, an increase over the previous year of $1,288,556,862 There are approximately 2,000 industries, in which capital to the amount of $448,839,685 is invested, and which employ 85,229 persons

The population in 1927 was 569,899, predominantly British; and it is estimated at 600,000 for 1928 More than 110,000 people reside in suburbs immediately adjacent to the city boundaries In 1885 the total assessment was $69,000,000; in 1906 it was $167,861,755; in 1926 it was $886,839,808; and in 1928 it was $926,027,622 The rate for 1928 was 31 80

History.—The name Toronto is of Indian origin, and means "a place of meeting," the site being an established rendezvous among the neighbouring Indian tribes long before the coming of the white man It first appears in history in 1749 as a centre of trade when the French built a small fort and established a trading post called Fort Rouillé Before long, however, British traders came up from the south and entered into rivalry with the French, and in 1793 the fort was burned by the latter to prevent its occupation by their foes A year later John Graves Simcoe, the governor of the new province of Upper Canada, transferred the seat of government from the town of Newark at the mouth of the Niagara river to Toronto, giving the new capital the name of York, in honour of the second son of George III. In 1812, the buildings which housed the legislature were burned and the town pillaged After the restoration of peace the work of creating a capital for the province of Upper Canada had to be begun anew In 1834 its population numbered about 10,000; and an act of the provincial legislature conferred on it a charter of incorporation, with a mayor, aldermen and councilmen Under this charter it was constituted a city with the name of Toronto

TORONTO, a village of Jefferson county, Ohio, U S A, on the Ohio river, 40 m W. of Pittsburgh; served by the Pennsylvania railroad, interurban trolley and motor-bus lines, and river steamboats Pop (1920) 4,684 (88% native white) It has a power plant and various manufacturing industries, including steel works, paper mills and factories making sewer pipe, etc.

TORPEDOES. In 1805 Robert Fulton, an American citizen, demonstrated a method of destroying ships by exploding a charge of gunpowder against the hull under water This charge was called a "torpedo" and the difficulty of getting it to a ship retarded for many years its progress as a practical weapon Attempts were first made to bring the torpedo into contact with the vessel by allowing it to drift down with the tide or current, or to fix it from some form of diving boat, but successive failures led to torpedoes being restricted to the form of submarine mines (*q v*) in which the charge is stationary and is fired when the ship strikes or passes over it. The inherent limitations of mines revived efforts to take the torpedo to the ship and the first practical weapon was the *spar, or outrigger, torpedo* This consisted of an explosive charge fixed to the end of a long pole carried in a boat, the pole being run out over the bow and the charge immersed on arriving near the ship Directly the charge came into contact with the hull it was exploded electrically. Frequent use of this weapon was made during the American Civil War On one occasion Lieutenant Cushing took a steam launch equipped with spar torpedo up the Roanoke River in which lay the Confederate ironclad "Albemarle." Cushing found her surrounded by logs but charging this barricade he got the launch partly over, immersed his spar, and exploded the charge in contact with the hull under heavy fire Ship and launch sank together but the gallant officer jumped overboard, swam away and escaped. When numbers of small guns and searchlights were added to a ship's equipment to counter such attacks the odds against success became prohibitive.

Locomotive Torpedoes.—Attention next turned to giving motion to the torpedo and steering it as necessary from the shore, or from another vessel, by means of wires. Of this type were the Lay, Sims-Edison and Brennan torpedoes. The first two were electrically steered through a wire which trailed behind the torpedo. The Brennan torpedo travelled under water and was pro-

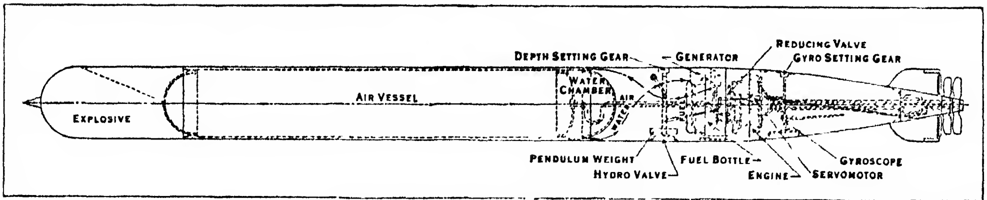


Diagram showing mechanism of a torpedo

pelled by unwinding two drums of fine steel wire inside the torpedo The rotation of these drums was communicated to propellers, causing the torpedo to advance, and it was steered by varying the speed of unwinding each wire. This torpedo was used for the defence of certain harbours by the British War Office The obvious unsuitability of this weapon for use by a ship during action led to the development of locomotive torpedoes of the uncontrolled type The Howell torpedo is of interest Motive power was provided by connecting up an engine outside to the axle of a heavy fly-wheel contained inside the torpedo When sufficiently spun up the engine was disconnected and the fly-wheel was connected up to the propellers so that on entering the water the torpedo was driven ahead until the energy was exhausted

In 1862 Captain Luppis of the Austrian Navy sought the assistance of Robert Whitehead, a Scotsman (then manager of an engineering factory at Fiume) to perfect a self-propelling floating torpedo which he had designed Mr. Whitehead modified this first suggestion and after two years of incessant labour the first Luppis-Whitehead torpedo was produced To preserve secrecy it was made by Mr Whitehead himself, his son and one trusted workman The torpedo weighed 300 lb travelled under the water, and a speed of 6 m per hour was attained for a short distance, the engine being driven by compressed air contained in a portion of the torpedo The charge carried was 18 lb of dynamite As the Austrian government were not prepared to purchase the exclusive rights of this invention it was offered to other powers From this beginning developed the modern weapon which, in its latest types, is capable of speeds up to 36 m per hour for 7,000–8,000 yd and carries an explosive charge of 500 lb of T N T The early lack of speed was overcome by the adoption of an engine designed by the British firm of Brotherhood. The inaccuracy in direction was cured by the introduction of the gyroscope apparatus designed by Ludwig Obry, an Austrian subject.

Construction.—The modern torpedo is a cigar shaped body, the diameter being usually about one-twelfth of the length, the diameter has grown from 14 in. in early types to 21 in in the latest types Generally it is divided into six compartments viz head, airvessel, balance chamber, engine room, buoyancy chamber and tail

The British 21 inch Mark IV. torpedo is briefly described below as a typical modern torpedo (*See* diagrammatic sketch above)

Head.—Three types are made. (1) The *warhead* is a thin steel or bronze shell containing 500 lb of T.N.T which is detonated on contact by a device, called a pistol, screwed into the nose (2) The *blowing head,* used for ordinary practice running, is a steel shell filled with water to make it of the same weight as a warhead and containing a flask of compressed air and the necessary mechanism for blowing the water out at the end of a run so making the torpedo buoyant and enabling it to be recovered (3) The *collision head,* used for practice when it is desired to hit a target vessel, is a steel shell partially filled with cork to give buoyancy and brought up to war head weight by filling with water. On impact with target the fore end collapses thus cushioning the blow on target and torpedo. An indicating light of calcium phosphide is fitted in a pocket to facilitate recovery. These heads are secured by screws to the *airvessel* which is made of special forged nickel steel and contains air compressed to 2,500 lb per sq.in. This air provides the oxygen for combustion of the fuel supplying the motive power. The *Balance Chamber* is a watertight compartment, with thin steel shell, permanently attached to the air vessel and contains the flasks of fuel and water and the heater apparatus Fuel and air are burnt in the generator and turn the water into steam there. The steam and products of combustion thus formed pass to the engine, combining to provide the motive power In this compartment, also, is the depth keeping mechanism which consists of a pendulum weight so interlinked with a hydrostatic valve that the weight corrects departure from the horizontal, whilst the valve maintains the set depth, their joint action operating the horizontal rudders through the medium of a small air engine termed the servomotor This combination was one of Robert Whitehead's principal secrets and was responsible for much of the success of his design

The *engine room* is the next compartment abaft the balance chamber and together with the buoyancy chamber, to which it is permanently attached, forms what is known as the afterbody This afterbody is secured to the balance chamber by a number of screwed bolts which allow of the torpedo being parted for examination of mechanism in the engine room The engine room contains (a) an engine of the four cylinder, single acting, Brotherhood type, (b) the steering engine or servomotor; (c) the starting valve and counter gear, (d) the reducing valve which maintains an approximately constant working pressure at the engine irrespective of air vessel pressure, (e) oil bottles for lubricating working parts, (f) sinking valve The starting valve is operated by the "air lever" which projects through the shell of the torpedo and is thrown aft on discharge by a downward projecting bolt in the torpedo tube In addition to opening the starting valve the air lever releases the gyroscope The counter is a piece of mechanism, driven off the engine, for stopping the torpedo at a definite range, or permitting it to run away Off the counter is driven the ignition gear, whose function is to fire the igniters in the generator at a predetermined moment and start the combustion of air and fuel The torpedo can be set to float for practice or to sink for action; in the latter case a small valve is lifted at the end of the run admitting water to the buoyancy chamber, thus sinking the torpedo which might otherwise remain a floating mine

The *buoyancy chamber* provides a large portion of the buoyancy of the torpedo It consists of thin sheet steel, strengthened up internally to enable it to withstand impulse pressure on discharge, or immersion at great depth The engine is secured to the foremost bulkhead of this compartment, and two watertight tubes run through it, one carrying the propeller shaft and the other carrying a rod connecting the servomotor and horizontal rudders The gyroscope is fixed to suitable brackets in this compartment, and connected to the vertical rudders. This piece of mechanism is a comparatively heavy bronze wheel mounted horizontally and vertically in gimbals When the air lever is thrown aft, the wheel is spun up to a high rate of revolution, due to the release of a strong spiral spring in torsion, or by air jets playing into pockets formed in the rim of the wheel At the same time the whole system is freed from external constraint, and, following the dynamical laws of rotating bodies, the spinning axis tends to maintain its direction in space Thus the axis of the spinning wheel provides a datum line, the direction of the gyro wheel on release Subsequent deviations of the torpedo are corrected by the relative movements of the spinning axis and the fore and aft line of the torpedo. These relative movements control the air supply to a small steering engine which operates vertical rudders, always acting to bring the torpedo back to its original direction. The gyroscope can be set at an angle to the axis of the torpedo when

required. In this case the torpedo turns through this angle before commencing its straight course The *tail* carries the horizontal and vertical rudders which are mounted on corresponding fins; it also contains gearing to enable two four-bladed propellers to be driven in opposite directions off the engine shaft and this ensures that the torpedo keeps its upright condition without heel, the turning effect of one propeller being balanced by the other.

Torpedo Discharge.—The earliest method of discharging Whitehead torpedoes from ships was by sliding them off a gunport, this naturally caused inaccuracy of direction Later the torpedo was put in a skeleton frame opposite an aperture specially cut in the vessel's side and was pushed out by a ram pressing on its tail Then the air gun was introduced and later the powder and cordite guns. In these the torpedo fits closely in a tube whose rear end can be closed by a gas-tight door. When it is desired to fire the torpedo, air or the gas from the powder or cordite charge is admitted to the rear end of the tube and blows the torpedo out Above water tubes of these types are fitted in all torpedo-craft and many cruisers. The danger of the torpedo's head being detonated, or air vessel burst, by hostile shell fire is accepted for these vessels To avoid this danger systems of under water discharge were devised. Right ahead or right astern fire offered little difficulty and was employed from the earliest days of torpedo development The torpedo tube is secured to the stem or stern structure in which an orifice is formed This orifice can be closed by a water-tight door and then the rear door can be opened and the torpedo placed in the tube. The rear door is then closed and the outer door opened. On firing, air pressure is admitted and blows the torpedo and water together out of the tube. Tubes in submarines are of this type. Without angled gyroscopes right ahead or right astern fire was of very limited value in large ships and consequently broadside discharge was required The difficulty was to get the torpedo clear of the ship undamaged as the water rushing past the tube orifice acts on the head as it emerges tends to force it aft and the torpedo is liable to be damaged It must, therefore, be held rigidly till its tail is clear of the ship's side. This is accomplished by pushing out a shield bar on the fore side of the tube to which the torpedo hooks itself by brackets working in grooves in the shield bar.

Torpedoes are also discharged from aircraft. Here they are secured to the under side of the fuselage by securing straps fitted with quick release gear. To fire, these straps are released together and at the same time the air lever is pulled aft to start the engines and the torpedo drops with the forward speed of the aeroplane instead of speed due to impulse from a tube.

Use of the Locomotive Torpedo in Action.—Owing to the comparatively slow speed of the torpedo it must be aimed at a point ahead of the ship attacked which will be reached by ship and torpedo after they have travelled a certain distance In order to obtain a hit the speed and course of the attacked vessel must, therefore, be estimated correctly, also the speed of the torpedo must be regular and accurate within narrow limits. Owing to the difficulty of exact estimation it is usually considered that torpedo fire at a single ship free to alter course is only justified at short ranges and that long range attacks should be confined to cases where a group of ships forms the target Prior to the World War of 1914–18 the occasions of torpedo attacks were few. On April 23, 1891 at dawn the Chilean insurgent battleship "Blanco Encalada," 3,500 tons, was attacked while at anchor and was sunk by one torpedo fired from a Government torpedo gunboat Again on April 5, 1894 the insurgent Brazilian battleship "Aquidaban" was sunk by one torpedo from a torpedo vessel. In the Chino-Japanese war of 1895 Japanese torpedo boats twice attacked the Chinese ships lying in Wei-Hai-Wei harbour and sank four of them. In the Russo-Japanese war, the initial success on February 8, 1904 was scored by Japan with a torpedo attack on the Russian ships at Port Arthur. Three ships were severely damaged although all were eventually repaired. After the battle of Tsushima, Japanese torpedo craft gave the *coup-de-grace* to several partially disabled ships.

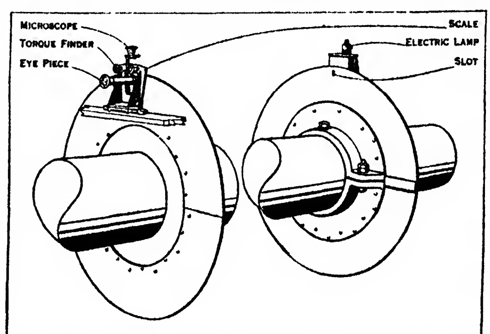
The advent of the submarine gave a new impetus to torpedo warfare as the submarine was the ideal carrier of this weapon owing to its ability to approach unseen within close range of its intended victim. If the victim is a slow ship the submarine has little difficulty in attaining the desired position but with fast moving vessels this becomes difficult and it is only when the ship is steaming more or less towards the submarine's initial position that the latter has much chance of success. The normal speed of the tramp cargo steamer rendered her peculiarly liable to attack in the World War of 1914–18, and of British merchant vessels some 1,381 were sunk by this weapon alone. The best defence against torpedo attack by submarine is high speed and a zig-zag course (*See* also SUBMARINE CAMPAIGN.)

At the battle of Jutland (*q.v*) May 31, 1916, concentrated attacks by groups of torpedo craft were delivered by both British and German fleets but comparatively few hits were obtained During the night following the battle the British Twelfth Flotilla, commanded by Captain A. J. B. Stirling, made a deliberate attack on the German Second Squadron and sank the pre-Dreadnought battleship "Pommern." The British Fourth Flotilla fell in with German cruisers; the "Rostock" was torpedoed and in the confusion of the action the "Elbing" collided with a battleship Both "Rostock" and "Elbing" were later abandoned and sunk A successful attack with torpedoes was carried out by British coastal motor boats upon the Bolshevist ships lying at Kronstadt in September 1919, four ships being hit. (A. H W.)

TORQUAY, a municipal borough, seaport and watering place, in the Torquay parliamentary division of Devon, England, on Tor bay of the English channel, 26 m S of Exeter, by the G W railway Pop (1921) 39,431 Owing to the beauty of its site and the equability of its climate, it has high repute as a winter resort There are some remains of Tor or Torre abbey, founded for Praemonstratensians by William, Lord Brewer, in 1196, including a beautiful pointed arch portal. On the south of the gateway is a 13th-century building, known as the Spanish barn. On Chapel hill are the remains of a chapel of the 12th century, dedicated to St. Michael, and supposed to have formerly belonged to the abbey.

There was a village at Torre even before the foundation of the abbey, and in the neighbourhood of Torre evidence has been found of Roman occupation The manor was granted by William the Conqueror to Richard de Bruvere or de Brewere, and was subsequently known as Tor Brewer. After the defeat of the Spanish Armada, Don Pedro's galley was brought into Torbay; and William, prince of Orange, landed at Torbay on Nov. 5, 1688.

TORQUE, the twist or torsion which a shaft undergoes when transmitting power. The degree of twist is very slight,



CHADBURN FLASHLIGHT TORSION METER, WHICH MEASURES THE HORSE POWER TRANSMITTED BY A TURBINE SHAFT

but it can be measured and the horse-power that is transmitted can thus be ascertained, the method being applied particularly to steam turbines. There are several types of torsion-meters for measuring horse-power, electrical, mechanical and flash-light. One of the last-named type is here described; its principle depends primarily on the straightness and great speed of a ray of light. Two discs (*see* fig.) are fastened to the shaft a measured

distance apart. Each disc has a small slit in it, about ¼ in. by ⅛ in., and a lamp is attached near one disc by a rigid support; the torque-finder is also rigidly secured. The light from the lamp is limited by a slit of similar size to those in the discs, and the torque-finder comprises a casting with a small telescopic eyepiece screwed to a brass plate which also has a slit of the same size as the others The plate and eyepiece can be moved circumferentially by means of a micrometer apparatus, reading to ·01 of a degree If the lamp, discs and torque-finder are set so that the four slits are in line, the observer looking through the eyepiece parallel to the axis of the shaft will see the light shining in the lamp If the shaft starts to revolve, at each rotation as the two slits in the discs pass the sight line between lamp and finder the light will be seen momentarily The persistence of this flash with the rapidly revolving shaft makes it appear as a continuous light. When however the shaft commences to transmit power the torque throws the disc slits out of line and the light is obscured The observer now adjusts the micrometer and the eyepiece until a sight is again taken through the disc slits By noting the amount of the displacement thus made the degree of twist is measured, and therefrom the horse-power transmitted *See* DYNAMOMETER (F H)

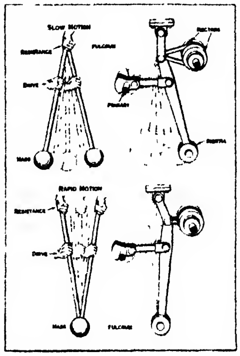
TORQUE AMPLIFIER. The torque amplifier consists of a mechanism provided with a control-shaft at one end and a work-shaft at the other, the control-shaft requiring only a feeble torque to operate it in either direction, while the work-shaft yields a torque of sufficient amount to accomplish any purpose desired, at the same time accurately following the control-shaft in all its angular movements Its broad purpose is to perform the functions of an electrical or hydraulic servo-motor

The torque amplifier was invented by Henry W. Nieman, an engineer for the Bethlehem Steel Co It was originally developed for the control of anti-aircraft gun batteries from a remote control station The torque amplifier has three elements: "work-shaft," "control-shaft" and "drive-shaft" The drive-shaft is driven by any outside source of power, and revolves continuously in one direction The control-shaft is actuated by any mechanical or manual control means, or by such weak forces as can be delivered through electrical recording instruments or telemetric transmission systems The work-shaft is directly coupled to the work to be done, as for instance the elevating or training gears of a gun, a ship's rudder or the steering gear of an automobile The control-shaft can be freely revolved in either direction, with only a small amount of effort; the work-shaft maintains at all times its angular synchronism with the control-shaft, and in addition exerts a heavy torque to overcome outside resistance Unlike other forms of servo-motor, there is always a definite ratio between the torque applied at the control-shaft and that delivered at the work-shaft, this ratio being known as the "amplification"

Fundamentally, the torque amplifier consists of two oppositely rotating drums provided with friction bands which may be brought into contact with the drums through actuation of the control-shaft, this frictional contact causing the friction bands to exert pressure on the work-shaft. The force applied to the control-shaft is thus enhanced, or amplified, when it reaches the work-shaft by the extent to which the bands are urged forward because of their frictional contact with the rotating drums.

TORQUE CONVERTER is an apparatus for transmitting power automatically from an engine or other source of power to a secondary shaft, the torque and speed of the secondary being variable according to the load between wide limits It was invented by George Constantinesco. The principle of the torque converter consists in dividing an oscillatory movement derived from a primary shaft which is driven by the engine, into two component oscillatory motions of the same frequency. One of these components oscillates an inertia device and the other oscillates unidirectional driving devices mounted on the secondary. The alternating impulses received by the secondary through the unidirectional devices are thus rectified into continuous rotation of the secondary.

Such unidirectional driving devices, shortly named "rectors," comprise any such devices which will drive in one direction and be free in the opposite direction. The rectors perform what may be termed a "mechanical valve" action very much like an ordinary hydraulic valve or electric valve, or rectifiers allowing the flow of energy only in one direction The left hand figures of each of the two pairs of illustrations, depict two phases of an experiment which will illustrate the principle of the torque converter The operations performed by each hand are then translated in the right hand figures into the functions of a "torque converter" in which the lower hand is replaced by a connecting rod moved by a crank, and the upper hand by two rectors which are connected to the secondary shaft where the resistance occurs



A slow oscillatory motion at the "drive" merely swings the mass to and fro, the fulcrum of oscillation remaining at the point of resistance If a rapid oscillatory motion is applied at the "drive" the inertia of the mass will oppose its motion, and the resistance is overcome The upper hand moves then, almost as if it were driven directly, the fulcrum being right down at the mass Such a combination is a four dimensional mechanism as the element "time" is essential to its performance The ordinary rules of static mechanics do not apply to the torque converter, and it is only by the consideration of the elements "time" and "mass" that the behaviour of the converter can be explained.

The torque converter has many possible applications to traction problems and industry in general as in transmission for applying the power of internal combustion engines, turbines, electromotors and prime movers which lack flexibility, to uses where wide and unexpected fluctuations in the load occurs The torque converter provides automatically for the adjustment of the speed and torque on the secondary, no matter how the resistance changes or fluctuates between very wide limits, while the prime mover continues to run steadily, with very little variation, at its most efficient torque and speed. In practice the inertia systems and the rectors are so arranged that the various parts balance each other dynamically as much as possible so that no vibrations are imparted on the casting of the machine

A petrol (gasolene) engine may be combined with mechanism so as to form one single unit; the only control required being the throttle of the engine Vehicles driven by such units have no clutches nor gear change boxes By opening wide the throttle of the engine the vehicle will accelerate from rest and attain a certain maximum speed on the level. When a hill is encountered, the vehicle slows down while the tractive force increases automatically according to the gradient For example, a vehicle fitted with a torque converter may travel at 40 m per hour on a level or climb at 10 m per hour a gradient of one in four, while the torque and the speed of the engine remains the same in both cases.

TORQUEMADA, JUAN DE (1388–1468), or rather JOHANNES DE TURRECREMATA, Spanish ecclesiastic, was born at Valladolid, in 1388, and was educated in that city. At an early age he joined the Dominican order, and soon distinguished himself for learning and devotion. In 1415 he accompanied the general of his order to the Council of Constance, whence he proceeded to Paris for study, and took his doctorate in 1423 In 1431 Eugenius IV. called him to Rome and made him "magister sancti palatii." At the Council of Basel he was one of the ablest supporters of the view of the Roman curia, and he was rewarded with a cardinal's hat in 1439 He died at Rome Sept 26, 1468

His principal works are *In Gratiani Decretum commentarii* (4 vols., Venice, 1578), *Expositio brevis et utilis super toto psalterio* (Mainz, 1474); *Quaestiones spirituales super evangelia totius anni* (Brixen, 1498); *Summa ecclesiastica* (Salamanca, 1550). The last named work has the following topics: (1) De universa ecclesia; (2) De Ecclesia romana et pontificis primatu; (3) De universalibus conciliis, (4) De

schismaticis et haereticis. His *De conceptione deiparae Mariae, libri viii* (Rome, 1547), was edited with preface and notes by E. B. Pusey (London, 1869 *seq.*).

TORQUEMADA, THOMAS (1420–1498), inquisitor-general of Spain, son of Don Pedro Ferdinando, lord of Torquemada, a small town in Old Castile, was born in 1420 at Valladolid during the reign of John II He was a nephew of the cardinal noticed above, and joined the Friars Preachers in their convent at Valladolid. His superiors obliged him to take the priorship of the convent of Santa Cruz in Segovia, where he ruled for 22 years The royal family, especially the queen and the infanta Isabella, often stayed at Segovia, and Torquemada became confessor to the infanta, who was then very young He trained her to look on her future sovereignty as an engagement to make religion respected He then began to teach her the political advantages of religion and to prepare the way for the Inquisition.

When Isabella succeeded to the throne (1474), she entrusted Torquemada with the care of her conscience, and with the benefices in the royal patronage. He also became confessor to Ferdinand and was appointed councillor of state also In the lax toleration of religious differences he thought he saw the main obstacle to the political union of the Spains. He represented to Ferdinand and Isabella that it was essential to their safety to reorganize the Inquisition, which had since the 13th century (1236) been established in Spain. In 1473 Torquemada and Gonzalez de Mendoza, archbishop of Toledo, approached the sovereigns. Isabella and Ferdinand saw in the proposed new tribunal a means of overcoming the independence of the nobility and clergy by which the royal power had been obstructed In 1479, as the result of a long intrigue, a papal bull authorized the appointment by the Spanish sovereigns of two inquisitors at Seville, under whom the Dominican inquisitions already established elsewhere might serve In the persecuting activity that ensued the Dominicans, "the Dogs of the Lord" (*Domini canes*), took the lead. The royal Inquisition thus started was subversive of the regular tribunals of the bishops, who much resented the innovation, which, however, had the power of the state at its back.

The Inquisition.—In 1481, three years after the Sixtine commission, a tribunal was inaugurated at Seville, where freedom of speech and licence of manner were rife The inquisitors at once began to detect errors In order not to confound the innocent with the guilty, Torquemada published a declaration offering grace and pardon to all who presented themselves before the tribunal and avowed their fault Some fled the country, but many (Mariana says 17,000) offered themselves for reconciliation The first seat of the Holy Office was in the convent of San Pablo, where the friars, however, resented the orders, on the pretext that they were not delegates of the inquisitor-general Soon the gloomy fortress of Triana, on the opposite bank of the Guadalquivir, was prepared as its palace. Other tribunals were speedily established in Cordova, Jaen and Toledo The sovereigns obliged Torquemada to take as assessors five persons who would represent them in all matters affecting the royal prerogatives. These assessors were allowed a definite vote in temporal matters but not in spiritual, and the final decision was reserved to Torquemada himself, who in 1483 was appointed the sole inquisitor-general over all the Spanish possessions. In the next year he ceded to Diego Deza, a Dominican, his office of confessor to the sovereigns, and gave himself up to the work of reducing heretics

A general assembly of his inquisitors was convoked at Seville in November 1484, and there he promulgated a code of twenty-eight articles for the guidance of the ministers of the faith. For the procedure adopted *see* INQUISITION. During the 18 years that Torquemada was inquisitor-general it is said that he burnt 10,220 persons, condemned 6,860 others to be burnt in effigy, and reconciled 97,321, thus making an average of some 6,000 convictions a year. These figures are given by Llorente, who was secretary of the Holy Office from 1790 to 1792 and had access to the archives; but modern research reduces the list of those burnt by Torquemada to 2,000 The constant stream of petitions to Rome opened the eyes of the pope to the effects of Torquemada's severity. On three separate occasions he had to send Fray Alfonso Badaja to defend his acts before the Holy See. The sovereigns, too, saw the stream of money, which they had hoped for, diverted to the coffers of the Holy Office, and in 1493 and again in 1496 they made complaint to the pope.

Torquemada had urged Ferdinand and Isabella to rid the country of the Moors, and, when war began in 1481, he obtained from the Holy See the same spiritual favours for the Spanish soldiers as had been enjoyed by the Crusaders The Inquisition sometimes met with furious opposition from the nobles and common people At Valentia and Lerida there were serious conflicts At Saragossa Peter Arbuè, a canon and an ardent inquisitor, was slain in 1485 whilst praying in a church, and the threats against the hated Torquemada made him go in fear of his life, and he never went abroad without an escort of forty familiars of the Holy Office on horseback and two hundred more on foot. In 1487 he went with Ferdinand to Malaga and thence to Valladolid, where in the October of 1488 he held another general congregation of the Inquisition and promulgated new laws based on the experience already gained He then hurried back to Andalusia where he joined the sovereigns, who were now besieging Granada

Persecution of Jews.—The Moors being vanquished, now came the turn of the Jews For long before 1490 Torquemada had tried to get the royal consent to a general expulsion; but the sovereigns hesitated, and, as the victims were the backbone of the commerce of the country, proposed a ransom of 300,000 ducats instead The indignant friar would hear of no compromise· "Judas," he cried, "sold Christ for 30 pence; and your highnesses wish to sell Him again for 300,000 ducats" Unable to bear up against the Dominican's fiery denunciations, the sovereigns, three months after the fall of Granada, issued a decree ordering every Jew either to embrace Christianity or to leave the country.

The inquisitor-general issued orders to forbid Christians, under severe penalties, having any communication with the Jews or, after the period of grace, to supply them even with the necessaries of life The former prohibition made it impossible for the unfortunate people to sell their goods which hence fell to the Inquisition The numbers of Jewish families driven out of the country by Torquemada is variously stated from Mariana's 1,700,000 to the more probable 800,000 of later historians The loss to Spain was enormous, and from this act of the Dominican the commercial decay of Spain dates

Torquemada at length took up his residence in Avila, where he had built a convent; and here he resumed the common life of a friar, leaving his cell in October 1497 to visit, at Salamanca, the dying infante, Don Juan, and to comfort the sovereigns in their parental distress. They often used to visit him at Avila, where in 1498, still in office as inquisitor-general, he held his last general assembly to complete his life's work. Torquemada died on Sept. 16, 1498

TORRE, CARLOS DE LA (1858–), Cuban naturalist, teacher, author, was born in Matanzas, Cuba, May 15, 1858 Receiving his education in Havana and Madrid, he had, before he was 21, discovered two new species of mollusc, which were named in his honour *Cylindrella torrei*, Arango, 1876, and *Cyclostoma torreianum*, Gundlach, 1878. He was one of the founders of the School of Arts and Crafts in Havana, taught at the Institute of Havana and in 1884 was appointed to fill the professorships of comparative anatomy and zoography of molluscs and zoophytes in the University of Havana. At the outbreak of the Cuban War for Independence (1895) persecutions of the Spanish government led him to leave the country, and after a brief visit in Mexico he went to Paris to study, where in 1897 he was elected to the Société Zoologique of France. Upon his return to Cuba in 1898 he resumed his career at the university, and entered political life. He was active in founding and organizing the nationalist party which came into power in 1902, under which he held numerous public offices, as he had done under its predecessor, the Government of the American intervention, and when, in 1899, the Cuban public school system was organized, he was an eager collaborator and prepared several of the necessary text-books. In 1909 he proved

the existence of Jurassic strata in the western part of Cuba and in 1910 he discovered Pleistocene fossils, restoring a *Megalocnus rodens*, discoveries "which have revolutionized the geological history of Cuba"

See W B. Parker, *Cubans of To-Day* (New York, 1919)

TORRE ANNUNZIATA, a seaport of Campania, Italy, in the province of Naples, on the east of the Bay of Naples, and at the south foot of Mt Vesuvius, 14 m S E of Naples by rail. Pop (1921), 32,159. town; 32,570, commune It is on the main line to Battipaglia, at the point of junction of a branch line from Cancello round the east of Vesuvius, and of the branch to Castellammare di Stabia and Gragnano It has an arms factory and other ironworks, manufacture of macaroni and breeding of silkworms There are numerous mineral springs

TORRE DEL GRECO, a seaport of Campania, Italy, in the province of Naples, 7½ m S E of that city by rail Pop (1921), 33,915. town; 45,641. commune It lies at the south-west foot of Vesuvius, on the shore of the Bay of Naples. It is built chiefly of lava, and stands on the lava stream of 1631, which destroyed two-thirds of the older town Great damage was done by the eruptions of 1737 and 1794, the earthquake of 1857 and the eruption of Dec. 8, 1861, were even more destructive

TORRENS, ROBERT (1780–1864), English soldier and economist, was born in Ireland in 1780 He entered the Marines in 1797, became a captain in 1806, and major for bravery at Anhalt in 1811 He fought in the Peninsula, becoming lieutenant-colonel in 1835 and retiring as colonel in 1837 He was returned to parliament in 1831 as member for Ashburton He was a prolific writer, principally on financial and commercial policy Almost the whole of the programme which was carried out in legislation by Sir Robert Peel had been laid down in his economic writings He was an early advocate of the repeal of the corn laws

His principal writings of a general character were *The Economist [i e., Physiocrat] refuted* (1808), *Essay on the Production of Wealth* (1821), *Essay on the External Corn-trade* (eulogized by Ricardo) (1827), *The Budget, a series of Letters on Financial, Commercial and Colonial Policy* (1841–1843), *The Principles and Practical Operations of Sir Robert Peel's Act of 1844 Explained and Defended* (1847)

TORRENS, WILLIAM TORRENS M'CULLAGH (1813–1894), English politician and social reformer, son of James M'Cullagh, was born near Dublin on Oct 13, 1813 He was called to the bar, and in 1835 became assistant commissioner on the special commission on Irish poor-relief, which resulted in the extension of the workhouse system in Ireland in 1838 In the 'forties he joined the Anti-Corn Law League, and in 1846 published his *Industrial History of Free Nations* From 1847–52 he represented Dundalk in parliament, in 1857 he was returned for Yarmouth, and from 1865–85 he represented Finsbury Torrens devoted himself mainly to social questions in parliament His amendment to the Education Bill of 1870 established the London School Board, and his Artisans' Dwellings Bill in 1868 facilitated the clearing away of slums by local authorities. He published several books, and his *Twenty Years in Parliament* (1893) and *History of Cabinets* (1894) contain useful material. He died in London on April 26, 1894.

TORRENS, LAKE: *see* SOUTH AUSTRALIA

TORRES VEDRAS, 43 m. N by W of Lisbon, on the Lisbon-Figueira da Foz railway Pop. (1911), 7,911. Roman inscriptions have been found here, but the Latin name of the town, *Turres Veteres*, is probably mediaeval Here were "lines of Torres Vedras," constructed by Wellington in 1810 (*see* PENINSULAR WAR). Here also in 1846 the troops of General Saldanha defeated those of the count de Bomfim (*See* PORTUGAL. *History.*)

TORREVIEJA, a seaport of south-eastern Spain, in the province of Alicante, 3 m S.W. of Cape Cervera, and at the terminus of a railway to Albatera on the Alicante-Murcia line. Pop. (1920), 8,885. The district is famous for its salt beds, which are owned by the state which farms them out for £10,000 a year, the Laguna Grande alone yielding more than 100,000 tons a year.

TORREY, JOHN (1796–1873), American botanist, was born in New York city on Aug. 15, 1796. He graduated (M.D.) in 1818 from the College of Physicians and Surgeons in New York. After holding various positions he became in 1836 New York State botanist and produced his *Flora of the State of New York* in 1843; while from 1838 to 1843 he carried on the publication of the earlier portions of *Flora of North America*, with the assistance of his pupil, Asa Gray From 1853 he was chief assayer to the U S. assay office, but he continued to take an interest in botanical teaching until his death at New York on March 10, 1873 He gave his valuable herbarium and botanical library to Columbia college

TORRICELLI, EVANGELISTA (1608–1647), Italian physicist and mathematician, was born at Faenza on Oct. 15, 1608 In 1627 he went to Rome to study science under the Benedictine Benedetto Castelli (1577–1644), professor of mathematics at the Collegio di Sapienza The perusal of Galileo's *Dialoghi delle nuove scienze* (1638) inspired him with many developments of the mechanical principles there set forth, which he embodied in a treatise *De motu* (printed amongst his *Opera geometrica*, 1644). In 1641 he went to Florence, where he met Galileo, and acted as his amanuensis during the three remaining months of his life After Galileo's death Torricelli was nominated grand-ducal mathematician and professor of mathematics in the Florentine academy. The discovery of the principle of the barometer (*q v.*) which has perpetuated his fame ("Torricellian tube" "Torricellian vacuum") was made in 1643 Torricelli was brought into controversy with G. P de Roberval as to the priority of the solution of a problem on the properties of a cycloid He died at Florence on Oct 25, 1647

Torricelli wrote on fluid motion, on the theory of projectiles and on the motion of two bodies connected by a string passing over a fixed pulley He used and developed B Cavalieri's method of indivisibles

TORRIGIANO, PIETRO (1472–1522), Florentine sculptor, was one of the group of talented youths who studied art under the patronage of Lorenzo the Magnificent in Florence. Torrigiano was invited to England to execute the tomb for Henry VII and his queen, in Westminster Abbey After this Torrigiano received the commission for the altar retable and baldacchino which stood at the west outside the screen of Henry VII 's tomb This work was destroyed by the Puritans in the 17th century Henry VIII also commissioned Torrigiano to make a magnificent tomb, somewhat similar to that of Henry VII, to be placed in a chapel at Windsor; it was, however never completed, and its rich bronze was melted by the Commonwealth The indentures for these various works still exist, and are printed by Neale, *Westminster Abbey*, i 54–59 (1818) The Tomb of Margaret of Richmond in Westminster Abbey is ascribed to Torrigiano. He ended his life in 1522 in the prisons of the Inquisition

See Wilhelm Bode, *Die italienische Plastik* (1902)

TORRINGTON, ARTHUR HERBERT, EARL OF (1647–1716), British admiral was the son of a judge, Sir Edward Herbert (*c* 1591–1657) He entered the navy in 1663, and served in the Dutch wars of the reign of Charles II, as well as against the Barbary pirates From 1680 to 1683 he commanded in the Mediterranean. The known Royalist sentiments of his family and his reputation as a naval officer ensured the favour of James II, who appointed him rear-admiral of England and master of the robes But Herbert refused to support the king's proposal for the repeal of the Test Act, and was dismissed from his places. He now entered into communication with the agents of the prince of Orange After the acquittal of the seven bishops in 1688 he carried the invitation to William of Orange After the Revolution Herbert was named first lord of the admiralty, and took the command of the fleet at home In 1689 he was at sea attempting to present the French admiral Château-Renault (*q v*) from landing the troops sent by the king of France to the aid of King James in Ireland Though he fought an action with the French in Bantry Bay on May 10 he failed to baffle Château-Renault, who had a stronger force. In May 1689 he was created earl of Torrington. In 1690 he was in the Channel with a fleet of 56 English and Dutch vessels, when he found himself confronted with the much more powerful French fleet. He proposed to retire to the Thames, but the council of regency, knowing that the Jacobites were preparing for a rising, and only waiting for the support

of a body of French troops, ordered him not to lose sight of the enemy, but rather than do that to give battle "upon any advantage of the wind." On July 10 Torrington made a half-hearted attack on the French off Beachy Head in which his own ship was kept out of fire, and severe loss fell on his allies Then he retired to the Thames. The French pursuit was fortunately feeble, and the loss of the allies was comparatively slight. Torrington was brought to trial before a court martial in December, and acquitted. He died on April 14, 1716

The unfavourable account of his moral character reported by Dartmouth to Pepys is confirmed by Bishop Burnet, who had seen much of him during his exile in Holland Torrington originated the phrase "a fleet in being"

See Charnock's *Biog. Nav*, i. 258 The best account of the battle of Beachy Head is to be found in "The Account given by Sir John Ashby Vice-Admiral and Rear-Admiral Rooke, to the Lords Commissioners" (1691).

TORRINGTON, GEORGE BYNG, VISCOUNT (1663–1733), English admiral, was born at Wrotham, Kent, and entered the navy in 1678. In 1688 he helped to win the fleet over to the prince of Orange, appointed to the command of the "Nassau" in 1702 he was present at the burning of the French fleet at Vigo, and in 1703 was made rear-admiral of the red. He served in the Mediterranean (1704) and at the battle of Malaga, after which he was knighted. In 1708, as admiral of the blue he prevented the Old Pretender from landing in Scotland; and ten years later defeated the Spaniards off Passaro, after which the king sent him full powers to negotiate with the princes and States of Italy. To his conduct it was owing that Sicily was subdued and the king of Spain forced to accept the terms prescribed by the Quadruple alliance. On his return to England in 1721 he was made rear-admiral and a member of the privy council, and was created Baron Byng of Southill in Bedfordshire, Viscount Torrington in Devonshire and a Knight Companion of the Bath (1725) George II. made him first lord of the Admiralty in 1727 He died on Jan 17, 1733

See *Memoirs relating to Lord Torrington*, Camden Soc new series 46, and *A True Account of the Expedition of the British Fleet to Sicily, 1718–1720*, published anonymously, but known to be by Thomas Corbett of the Admiralty in 1739. Forbin's *Memoirs* contain the French side of the expedition to Scotland in 1708

TORRINGTON (GREAT TORRINGTON), a market town and municipal borough in the South Molton parliamentary division of Devon, England, on the Torridge, 225 m W. by S of London by the S. railway. Pop (1921) 2,929.

Torrington was the site of very early settlement, and possessed a market in Saxon times. In the 16th century it was an important centre of the clothing trade. In 1643 Colonel Digby took up his position at Torrington and put to flight a contingent of Parliamentary troops; but in 1646 the town was besieged by Sir Thomas Fairfax and finally forced to surrender

See *Victoria County History: Devonshire;* F T Colby, *History of Great Torrington* (1878).

TORRINGTON, a city of Litchfield county, Connecticut, U.S.A., on the Naugatuck river, 25 m W. of Hartford It is served by the New York, New Haven and Hartford railroad. Pop. (1920) 22,055 (about a third foreign-born white); 1928 local estimate 25,000. The city is surrounded by the beautiful scenery of the Berkshire foot-hills, with five lakes close by. Ever since brass kettles were first made here in 1834 it has been an important centre of the brass industry, and other products also are now manufactured in great variety The aggregate factory output in 1925 was valued at $26.341,064 In 1740 the town was incorporated. A woollen mill was built in 1813 by members of the Wolcott family, and the village which grew up around it was called Wolcottville. In 1881 it took the name of the town, and in 1887 was incorporated as a borough In 1923 the town (including the borough) was chartered as a city. In 1851 the first condensed-milk plant in the world was established here by Gail Borden.

TORSION BALANCE: *see* BALANCE.

TORSTENSSON, LENNART, COUNT (1603–1651), Swedish soldier, son of Torsten Lennartsson, commandant of Elfsborg, was born at Forstena in Vestergötland. At the age of 15 he became one of the pages of the young Gustavus Adolphus and served during the Prussian campaigns of 1628–29. In 1629 he was set over the Swedish artillery, and contributed to the victories of Breitenfeld (1631) and Lech (1632). The same year he was taken prisoner at Alte Veste and shut up for nearly a year at Ingolstadt Under Banér he rendered distinguished service at the battle of Wittstock (1636) and during the energetic defence of Pomerania in 1637–38, as well as at the battle of Chemnitz (1638) and in the raid into Bohemia in 1639. Illness compelled him to return to Sweden in 1641, when he was made a senator The sudden death of Banér in May 1641 recalled Torstensson to Germany as generalissimo of the Swedish forces and governor-general of Pomerania. He was at the same time promoted to the rank of field marshal The period of his command (1641–45) forms one of the most brilliant chapters in the military history of Sweden. In 1642 he marched through Brandenburg and Silesia into Moravia, taking all the principal fortresses on his way On returning through Saxony he well nigh annihilated the imperialist army at the second battle of Breitenfeld (Oct 23, 1642) In 1643 he invaded Moravia for the second time, but was suddenly recalled to invade Denmark, when his rapid and unexpected intervention paralysed the Danish defence on the land side, though Torstensson's own position in Jutland was for a time precarious owing to the skilful handling of the Danish fleet by Christian IV

In 1644 he led his army for the third time into the heart of Germany and routed the imperialists at Juterbog (Nov 23) At the beginning of Nov 1645 he broke into Bohemia, and the brilliant victory of Jankow (Feb 24, 1645) laid open before him the road to Vienna. Yet, though one end of the Danube bridge actually fell into his hands, his exhausted army was unable to penetrate any farther and, in December the same year, Torstensson, crippled by gout, was forced to resign his command and return to Sweden In 1647 he was created a count. From 1648 to 1651 he ruled all the western provinces of Sweden, as governor-general. On his death at Stockholm (April 7, 1651) he was buried solemnly in the Riddarholmskyrka, the Pantheon of Sweden. Torstensson was remarkable for the extraordinary and incalculable rapidity of his movements, though very frequently he had to lead the army in a litter as his bodily infirmities would not permit him to mount his horse He was also the most scientific artillery officer and the best engineer in the Swedish army

See J. W. de Peyster, *History of the Life of L Torstensson* (Poughkeepsie, 1855); J. Feil, *Torstensson before Vienna* (trans by de Peyster, New York, 1885); Gustavus III, *Eulogy of Torstensson* (trans. by de Peyster, New York, 1872) (R N B)

TORT, the technical term, in the law of England, of those dominions and possessions of the British empire where the common law has been received or practically adopted in civil affairs, and of the United States, for a civil wrong, *i e.*, the breach of a duty imposed by law, by which breach some person becomes entitled to sue for damages A tort must, on the one hand, be an act which violates a general duty The rule which it breaks must be one made by the law, not, as in the case of a mere breach of contract, a rule which the law protects because the parties have made it for themselves On the other hand, a tort is essentially the source of a private right of action An offence which is punishable, but for which no one can bring a civil action, is not a tort It is quite possible for one and the same act to be a tort and a breach of contract, or a tort and a crime; it is even possible in one class of cases for the plaintiff to have the option—for purposes of procedural advantage—of treating a real tort as a fictitious contract; but there is no necessary or general connection. Again, it is not the case that pecuniary damages are always or necessarily the only remedy for a tort; but the right to bring an action in common law jurisdiction, as distinct from equity, matrimonial or admiralty jurisdiction, with the consequent right to damages, is invariably present where a tort has been committed

This technical use of the French word *tort* (which at one time was near becoming a synonym of *wrong* in literary English) is not very ancient, and anything like systematic treatment of the subject as a whole is very modern. Since about the middle of the 19th century there has been a current assumption that all civil

causes of action must be founded on either contract or tort; but there is no historical foundation for this doctrine, though modified forms of the action of trespass—actions *in consimili casu*, or "on the case" in the accustomed English phrase—did in practice largely supplant other more archaic forms of action by reason of their greater convenience The old forms were designed as penal remedies for manifest breach of the peace or corruption of justice; and traces of the penal element remained in them long after the substance of the procedure had become private and merely civil The transition belongs to the general history of English law

In England the general scope of the law of torts has never been formulated by authority. But there is no doubt that the duties enforced by the English law of torts are broadly those which the Roman institutional writers summed up in the precept *Alterum non laedere*. Every member of a civilized commonwealth is entitled to require of others a certain amount of respect for his person, reputation and property, and a certain amount of care and caution when they go about undertakings attended with risk to their neighbours Under the modern law, it is submitted, the question arising when one man wilfully or recklessly harms another is not whether some technical form of action can be found in which he is liable, but whether he can justify or excuse himself. This view, at any rate, is countenanced by a judgment of the Supreme Court of the United States delivered in 1904

The precise amount of responsibility can be determined only by full consideration in each class of cases But what makes the law of torts effective, especially with regard to redress for harm suffered by negligence, is the universal rule of law that every one is answerable for the acts and defaults of his servants (that is, all persons acting under his direction and taking their orders from him or some one representing him) in the course of their employment The person actually in fault is not the less answerable, but the remedy against him is very commonly not worth pursuing But for this rule corporations could not be liable for any negligence of their servants, however disastrous to innocent persons, except so far as it might happen to constitute a breach of some express undertaking We have spoken of the rule as universal, but, in the case of one servant of the same employer being injured by the default of another, an unfortunate aberration of the courts, which started from small beginnings in the second quarter of the 19th century, was pushed to extreme results, and led to great hardship A partial remedy was applied in 1880 by the Employers' Liability Act, and in 1897 a much bolder step was taken by the Workmen's Compensation Act (superseded by later amendment and extension now consolidated in an Act of 1925). The Workmen's Compensation Act includes cases of pure accident, where there is no fault at all, or none that can be proved, and therefore goes beyond the reasons of liability with which the law of torts has to do In fact, it establishes a kind of compulsory insurance, justifiable only on wider grounds of policy

There are kinds of cases, on the other hand, in which the law, without aid from legislation, has imposed on occupiers and other persons in analogous positions a duty stricter than that of being answerable for themselves and their servants. Duties of this kind have been called "duties of insuring safety." Generally they extend to having the building, structure, or works in such order, having regard to the nature of the case, as not to create any unusual danger to persons lawfully frequenting, using or passing by them, which the occupier knows or ought to know and could prevent by reasonable care; but in some cases of "extra-hazardous" risk, even proof of all possible diligence—according to English authority, which is not unanimously accepted in America —will not suffice

Classification.—The classification of actionable wrongs is perplexing We may start either from the character of the defendant's act or omission, with regard to his knowledge, intention and otherwise; or from the character of the harm suffered by the plaintiff Whichever of these we take as the primary line of distinction, the results can seldom be worked out without calling in the other. Taking first the defendant's position, the widest governing principle is that, apart from various recognized grounds of immunity, a man is answerable for the "natural and probable" consequences of his acts; *i e*, such consequences as a reasonable man in his place should have forseen as probable Still more is he answerable for what he did actually forsee and intend Knowledge of particular facts may be necessary to make particular kinds of conduct wrongful Such is the rule in the case of fraud and other allied wrongs, including what is rather unhappily called "slander of title," and what is now known as "unfair competition" in the matter of trade names and descriptions, short of actual piracy of trade-marks But where an absolute right to security for a man's person, reputation or goods is interfered with, neither knowledge nor specific intention need be proved This rule was known some time ago to apply to the exercise of rights of property, and such speculative doubt as remained was removed by the decision of the House of Lords in the leading case of *Allen* v *Flood* (1898, A C 1) We now know that it applies to the exercise of all common rights The exceptions are very few, and must be explained by exceptional reasons Indeed, only two are known to the present writer—malicious prosecution, and the misuse of a "privileged occasion" which would justify the communication of defamatory matter if made in good faith In each case the wrong lies in the deliberate perversion of a right or privilege allowed for the public good, though the precise extent of the analogy is not certain at present It was formerly supposed that an action by a party to a contract against a third person for procuring the other party to break his contract was within the same class, *i e*, that malice must be proved But since *Allen* v. *Flood*, and the later decision of the House of Lords in *Quinn* v *Leathem* (1901, A C 495), this view has ceased to be tenable The ground of action is the intentional violation of an existing legal right; which, however, since 1906, may be practised with impunity in Great Britain "in contemplation or furtherance of a trade dispute". Trade Disputes Act, sec 3 It must be remembered, however, that the presence or absence of personal ill will, and the behaviour of the parties generally, may have an important effect, when liability is proved or admitted in mitigating or aggravating the amount of damages awarded

We have already had to mention the existence of grounds of immunity for acts that would otherwise be wrongful Such grounds there must be if the law is to be enforced and justice administered at all, and if the business of life is to be carried on with any freedom Roughly speaking, we find in these cases one of the following conditions Either the defendant was executing a lawful authority; or he was justified by extraordinary necessity; or he was doing something permitted by legislation for reasons of superior utility, though it may produce damage to others, and either with or without special provisions for compensating damage; or he was exercising a common right in matters open to free use and competition, or the plaintiff had, by consent or otherwise, disabled himself from having any grievance

As Justice Holmes of the Supreme Court of the United States has said, we allow unlimited trade competition (so long as it is without fraud) though we know that many traders must suffer, and some may be ruined by it, because we hold that free competition is worth more to society than its costs A State with different economic foundations might have a different law on this, as on many other points This freedom extends not only to the exercise of one's calling, but to choosing with whom and under what conditions one will exercise it Also the law will not enquire with what motives a common right is exercised, and this applies to the ordinary rights of an owner in the use of his property as well as to the right of every man to carry on his business. The rule that a man's motives for exercising his common rights are not examinable involves the consequence that advising or procuring another, who is a free agent, to do an act of this kind can, *a fortiori*, not be an actionable wrong at the suit of a third person who is damnified by the act, and that whatever the adviser's motives may be. This appears to be included in the decision of the House of Lords in *Allen* v. *Flood*. That decision, though not binding in any American court, is approved and followed in most American jurisdictions. It is otherwise where a system of coercion

is exercised on a man's workmen or customers in order to injure him in his business The extension of immunity to such conduct would destroy the value of the common right which the law protects: *Quinn* v *Leathem*.

Individual Rights.—Owners and occupiers of immovable property are bound to respect one another's convenience within certain limits. The maxim or precept *Sic utere tuo ut alienum non laedas* does not mean that I must not use my land in any way which can possibly diminish the profit or amenity of my neighbour's. That would be false. It is a warning that both his rights and mine extend beyond being free from actual unlawful entry, and that if either of us takes too literally the more popular but even less accurate maxim, "Every man may do as he will with his own," he will find that there is such a head of the law as nuisance

From the point of view of the plaintiff, as regards the kind of damage suffered by him, actionable wrongs may be divided into four groups. We have some of a strictly personal kind; some which affect ownership and rights analogous to ownership; some which extend to the safety, convenience and profit of life generally—in short, to a man's estate in the widest sense, and some which may, according to circumstances, result in damage to person, property or estate, any or all of them. Personal wrongs touching a man's body or honour are assault, false imprisonment, seduction or "enticing away" of members of his family. Wrongs to property are trespass to land or goods, "conversion" of goods (*i.e*, wrongful assumption of dominion over them), disturbance of easements and other individual rights in property not amounting to exclusive possession. Trespass is essentially a wrong to possession, but with the aid of actions "on the case" the ground has been practically covered Then there are infringements of incorporeal rights which, though not the subject of trespass proper, are exclusive rights of enjoyment and have many incidents of ownership. Actions, in some cases expressly given by statute, lie for the piracy of copyright, patents and trade-marks. A wrong to a man's estate in the larger sense above noted is defamation—not a strictly personal wrong, because according to English common law the temporal damage, not the insult, is, rightly or wrongly, made the ground of action and the defendant's intention is immaterial It is even possible to write an actionable libel without knowing that one's words can be thought to reflect on the plaintiff, or (it seems) that there is any such person: so the House of Lords decided in *Hulton & Co* v *Jones* in 1910. Others are deceit, so-called "slander of title" and fraudulent trade competition, which are really varieties of deceit; malicious prosecution; and nuisance, which, though most important as affecting the enjoyment of property, is not considered in that relation only. Finally, we have the results of negligence and omission to perform special duties regarding the safety of one's neighbours or the public, which may affect person, property, or estate.

The law of wrongs is made to do a great deal of work which, in a system less dependent on historical conditions, we should expect to find done by the law of property We can claim or reclaim our movable goods only by complaining of a wrong done to our possession or our right to possess There is no direct assertion of ownership like the Roman *vindicatio* The law of negligence, with the refined discussions of the test and measure of liability which it has introduced, is wholly modern; and the same may be said of the present working law of nuisance, though the term is of respectable antiquity. Most recent of all is the rubric of "unfair competition," which is fast acquiring great importance.

It will be observed that the English law of torts answers approximately in its purpose and contents to the Roman law of obligations *ex delicto* and *quasi ex delicto*. When we have allowed for the peculiar treatment of rights of property in the common law, and remembered that, according to one plausible theory, the Roman law of possession itself is closely connected in its origin with the law of delicts, we shall find the correspondence at least as close as might be expected *a priori*. Nor is the correspondence to be explained by borrowing, for this branch of the common law seems to owe less to the classical Roman or mediaeval canon law than any other. Some few misunderstood Roman maxims have done considerable harm in detail, but the principles have been worked out in all but complete independence.

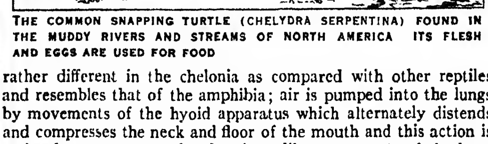
A list of modern books and monographs will be found at the end of the article on "Torts" by the present writer in the *Encyclopaedia of the Laws of England* (2nd ed.). Among recent editions of works on the law of torts and new publications the following may be mentioned here: Addison, by W. E Gordon and W H. Griffith (8th ed, 1906); Clerk and Lindsell, by Wyatt Paine (7th ed., 1921); J. W. Salmond, *The Law of Torts* (7th ed, 1928); Pollock (13th ed., 1929). In America: T. A Street, *The Foundations of Legal Liability* (1906) 3 vols. of which vol. i. is on Tort; F. M. Burdick, *The Law of Torts* (4th ed., 1926). (F. Po.)

TORTOISE, the name applied to some members of the order Chelonia, a group of Reptiles (*q v.*); the name is not consistently applied to any one section of the order but is generally used to designate a terrestrial animal, "turtle" being in Britain the equivalent name for a marine species (though in America it is more generally used), and "terrapin" or "water-tortoise" for a fresh-water chelonian They are toothless reptiles with well-developed limbs and a "shell" covering the body.

The "Shell."—This characteristic "shell" consists of an upper *carapace* and a lower *plastron*, the two being more or less firmly united at the sides by the so-called bridge Both carapace and plastron proper are bony structures built up from a number of elements which are firmly united by sutures, the carapace consists of a central row of from 10–12 plates most of which are fused to the vertebrae, a lateral row of 8 plates on each side fused to the ribs and about 23 small plates bordering its free edge; the plastron contains five paired elements and one unpaired. The union of the upper and lower halves of the shell may be rigid and bony or cartilaginous and flexible and in some forms transverse hinges are also developed In the majority of chelonians the bony shell is overlaid by horny plates, but these do not correspond with the underlying bones although their general arrangement is similar; they are of exactly the same nature as the horny scales which covers the head, limbs and exposed soft parts.

The shape of the "shell" varies in conformity with the habits of the animal; in strictly terrestrial forms it is usually high, domed, and sufficiently large to permit the head and limbs to be withdrawn into it, whereas in aquatic species, it is generally depressed and so much reduced in size that it offers little protection for the limbs Correlated also with the habitat is the shape of the limbs; in terrestrial species they are club-shaped, all the digits being bound together and only externally distinguishable by their claws whereas in the fresh-water dwellers the digits remain distinct and are connected by a web; the marine turtles have the fingers and toes all bound together and the number of claws reduced, but the whole limb is here transformed into a paddle.

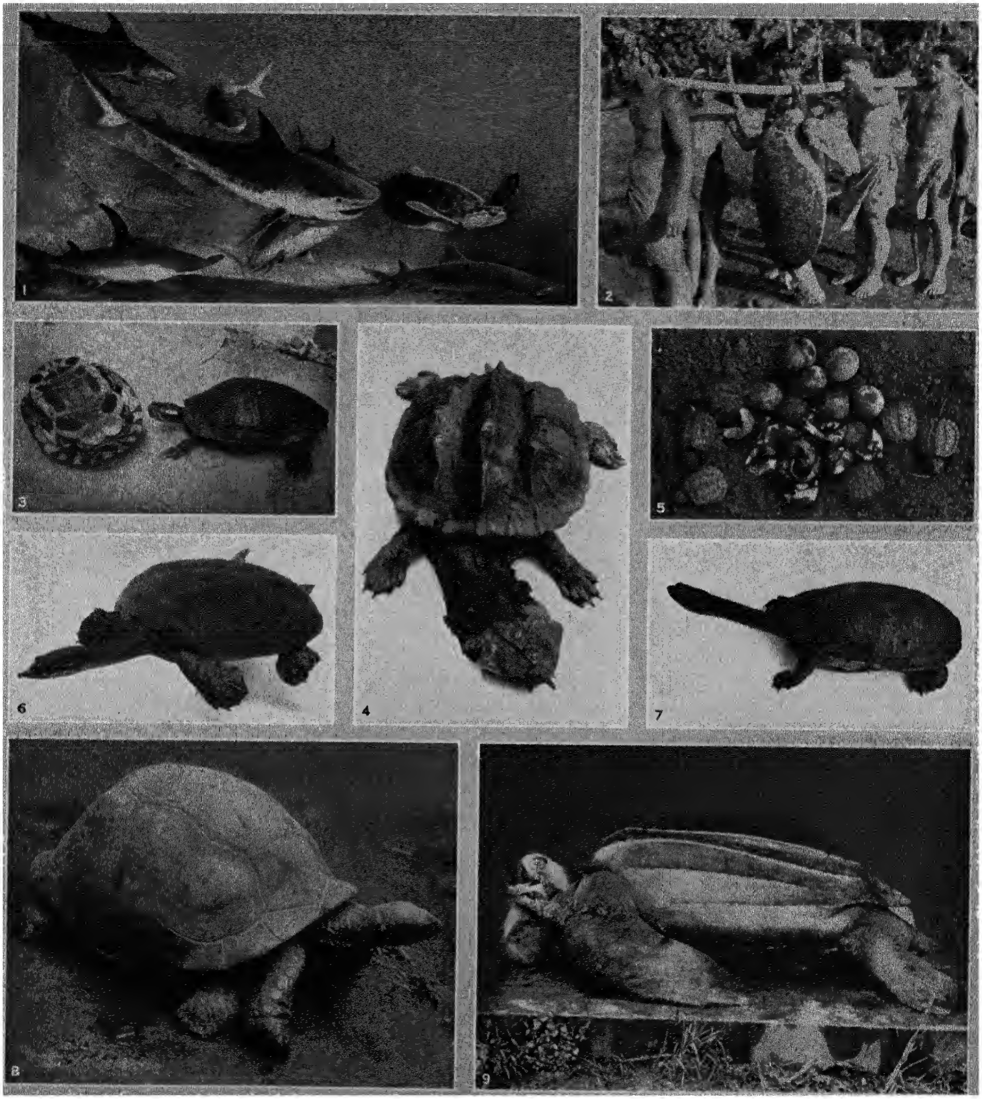
Breathing.—As a result of the development of the shell and the consequent fixation of the ribs the method of breathing is



THE COMMON SNAPPING TURTLE (CHELYDRA SERPENTINA) FOUND IN THE MUDDY RIVERS AND STREAMS OF NORTH AMERICA ITS FLESH AND EGGS ARE USED FOR FOOD

rather different in the chelonia as compared with other reptiles and resembles that of the amphibia; air is pumped into the lungs by movements of the hyoid apparatus which alternately distends and compresses the neck and floor of the mouth and this action is assisted to some extent by the piston-like movements of the head and limbs in and out of the shell when the creature is active. Additional respiratory mechanisms have been developed by some aquatic species by means of which the oxygen dissolved in the water can be utilised

No recent chelonian possesses teeth, the jaws being covered



BY COURTESY OF (1, 5, 6, 9) THE AMERICAN MUSEUM OF NATURAL HISTORY, (2) THE METRO-GOLDWYN-MAYER CORPORATION, (3, 4, 7, 8) RAYMOND L. DITMARS AND THE AMERICAN MUSEUM OF NATURAL HISTORY

MARINE, FRESH-WATER AND TERRESTRIAL TORTOISES

1. Shark group in Fish hall of the American Museum of Natural History, showing a Loggerhead turtle swimming among sharks
2. Green turtle, caught by natives off the island of Tahiti. This marine species weighs as much as 1,000 lb. and furnishes the most edible turtle meat
3. The Cumberland terrapin, a fresh water species also seen on land
4. The South American Matamata, a marine turtle sometimes over a yard long, with a characteristic ridge of skin along its neck
5. Very young snapping turtles and unhatched eggs. The young turtles have the long tails and large heads characteristic of this type
6. Swimming soft shell turtle, a flat, almost circular form entirely covered with soft skin
7. Australian snake-necked turtle, a fresh water species with a long neck
8. Giant or elephant tortoise, a terrestrial species found on the Aldabra islands. Only a few giant tortoises are still in existence, some of which weigh over 600 pounds
9. Leatherback turtle, found off Block Island, R. I. The shell is leathery instead of being horny

with horny beak-like plates which usually have sharp cutting edges; terrestrial species are, as a rule, strictly herbivorous and though many aquatic species are impartial in their feeding habits the majority are carnivorous, many raptorial. The voice is not well developed, females as a rule only being able to hiss; males, however, in the breeding season at least utter cries which in smaller species may be only a feeble piping but in the Giant Tortoises are hoarse bellows Reproduction is always by means of eggs which are spherical and covered by a parchment-like or calcareous shell; they are buried in sand or loose earth

Species.—There are living at the present day some 225 species but these are probably only the surviving remnant of a formerly much more numerous group. They are cosmopolitan in their distribution except for the more recent islands and those northern and southern countries where the winter is too severe; in England their extermination seems to have been relatively recent

One recent chelonian differs from all the others in the structure of its shell, the elements which normally compose this structure being almost all absent and their function being assumed by a mosaic of small polygonal plates. On this account the animal has been placed in a separate group, the ATHECAE, to contrast with the others which are united as the THECOPHORA. This creature, the Luth or Leathery Turtle (*Sphargis coriacea*) is a marine, turtle-like animal inhabiting tropical seas and is the largest living chelonian; it reaches a length of 8 feet and may weigh nearly a ton, the back is devoid of horny plates and is covered by soft skin, the food consists of molluscs, crustaceans and fish and the eggs, like those of the other marine turtles, are laid on land; the female repairs to a sandy beach during the night, digs a shallow hole in which the eggs are deposited, covers them up, and returns to the sea; the chief breeding places appear to be the islands of the West Indies.

Thecophora.—These are subdivisible into 3 main groups, the *Trionychoidea* aquatic forms with a bony carapace and plastron but without horny plates, the *Cryptodira*, terrestrial and aquatic forms with a bony carapace and plastron covered with horny epidermal shields and retracting the neck by a vertical S-shaped bend and the *Pleurodira* resembling the *Cryptodira* but retracting the neck by a simple lateral flexure Of these groups the *Cryptodira* contains the largest number and the majority of the typical tortoises, its various families, based largely on characters of the bony shell, may be recognised by the following key based on external characters only.

I Digits more or less distinct with 4 or 5 claws; terrestrial or fresh-water.

A Pectoral shield (the 3rd paired shield of the plastron) separated from the marginal shields of the carapace by a series of small "infra-marginal" plates

(1) Tail long and crested; plastron small and cruciform American *Chelydridae*

(2) Tail long, covered with rings of scales; plastron large Asiatic *Platysternidae*

(3) Tail short North American *Kinosternidae* *Dermatemydidae.*

B Pectoral shields in contact with the marginals of the carapace *Testudinidae*

II Limbs paddle-shaped with one or two claws; marine. *Chelonidae*

Chelydridae.—Alligator Terrapins or Snapping Turtles Freshwater forms of north and central America, characterised by relatively huge heads, long alligator-like tails, rough shells and numerous soft projecting folds of skin on the neck and limbs. The two better known species, the Common Snapper (*Chelydra serpentina*) of the eastern United States and the Alligator Snapper (*Macrochelys temminckii*) of the Mississippi and Missouri basins, are both large, powerful creatures, and notorious for their vicious nature and the power of their jaws

Platysternidae.—A single species (*Platysternon megacephalum*) found in fresh waters in S China, Burma and Siam. The head is relatively very large and the neck long, a 14-inch specimen only measuring 5 inches along the carapace.

Kinosternidae.—These are the Musk Turtles of North and Central America, so called from the rather offensive odour of the secretion of their inguinal glands; they are small, aquatic creatures, rarely exceeding a total length of one foot and in many the front and hind lobes of the plastron are hinged and can be drawn up to the carapace when the head and legs are withdrawn into the shell *Sternotherus odoratus* the Stink Pot Terrapin of eastern North America is the best known species.

Dermatemydidae—Small Central American terrapins closely allied to and resembling the members of the preceding family

Testudinidae.—This family, containing the majority of tortoises is world wide in its distribution except the Australian region and its members show all gradations between thoroughly aquatic and exclusively terrestrial species The Batagur (*Batagur baska*) of Bengal, Burma and the Malayan region is exclusively aquatic, it attains a length (carapace only) of nearly 2 feet, is rather flattened and has the digits fully webbed. *Chrysemys* of eastern N America is also exclusively aquatic and the species of this and allied genera are extensively eaten, they are sold as "Slider Terrapins" to distinguish them from the Diamond Back Terrapins (*Malaclemys*) beloved by epicures

Clemmys, with species in S. Europe and N. Africa (*C leprosa*), Asia and N America (e.g, *C insculpta* the Wood Terrapin), is less aquatic than the preceding and the digital webs are correspondingly reduced Still less aquatic are the species of *Emys*, *E orbicularis* of Central Europe and Western Asia and *E blandingi* of southern Canada and the north-eastern United States, which have indications of a transverse hinge across the plastron This plastral hinge reaches a high degree of development in the North American Box Turtles (*Terrapene*) which can withdraw completely into their shell and close both openings; in structure these animals are water-tortoises, but they are terrestrial in habits and have the high, domed shell of the exclusively terrestrial genera such as *Kinixys*, *Pyxis* and *Testudo*. *Testudo* is an assemblage of herbivorous, terrestrial forms and contains, among others, the well-known Giant Tortoises, some of which reach a shell length of over 4 feet and may weigh over 600 lb There were three groups of these animals, one confined to the islands of the Galapagos Group where every small island had its own race and the largest several, another to the Mascarene Islands (Bourbon, Mauritius Rodriguez) and the third to the Seychelles-Aldabra Group Before the advent of man these creatures abounded in almost incredible numbers, but it was soon discovered that, on account of their ability to live for months without food, they formed an excellent supply of easily transported fresh meat for sailing vessels and their numbers were rapidly decimated

Somewhat approaching the Giant Tortoises in size are the African *T calcarata* and the South American *T. tabulata* but the remaining species of the genus are relatively small, *T elegans*, the Indian Star Tortoise, is black with yellow streaks radiating from the centre of each shield and the South African *T geometrica* has a similar pattern; in Europe there are 2 species, *T hermanni* of S Europe and Asia Minor and *T. marginata* of Greece the species commonly imported into England being *T graeca* of northern Africa and Asia Minor The N American Gopher Tortoises (*T polyphemus*) are burrowing creatures inhabiting dry, sandy country and constructing their own burrows, but the East African *T. tornieri* is cryptozoic in rocky country and hides in crevices

Chelonidae.—The true Turtles; the three common species are the Hawksbill (*Eretmochelys imbricata*) the Green (*Chelonia mydas*) and the Loggerhead (*Caretta caretta*). Of these, the first mentioned may be distinguished by its smaller size, the overlapping horny plates of the back and the hooked beak: it occurs in all tropical seas and is the source of the "tortoise-shell" of commerce. The horny shields of the carapace are stripped off by heat and when heated in oil or by steam they can be welded together to form slabs thick enough for manufacturing purposes The Green Turtle is the species used so much in the manufacture of turtle soup; it is a larger species than the Hawksbill attaining a length of close on 4 feet and the horny plates of the back do not overlap but meet edge to edge. All these turtles have the same general habits and distribution; the Green Turtle only is partially or entirely herbivorous, feeding on *Zostera* the marine grass, the

others preferring fish or molluscs. All lay their eggs in pits dug by the females on sandy beaches which are visited at night and it is then that large numbers are captured; the eggs, too, are edible so that in some regions the turtles are becoming scarce.

Pleurodira.

I. Shell covered with horny shields; limbs not paddle-shaped

A Neck completely retractile into the shell. *Pelomedusidae.*

B. Neck long, not hidden by the shell when retracted *Chelydidae*

II. Shell covered with soft skin, limbs paddle-shaped *Carettochelydidae*

Pelomedusidae, fresh-water dwellers in Africa and South America, *Pelusios* of Tropical Africa and Madagascar has the front lobe of the plastron hinged but *Pelomedusa* of the same regions lacks this character. *Podocnemis* similar to *Pelomedusa* inhabits the rivers of tropical S. America and reaches a considerable size

Chelydidae, the "Snake-Necked Turtles" of the fresh-waters of S. America, Australia and Papua They are all long-necked creatures with the typical depressed shells of aquatic tortoises, the many species are superficially very similar, the S. American Matamata (*Chelys fimbriata*) alone showing any peculiarities

Carettochelydidae, the single, rare Papuan species of this family, *Carettochelys insculpta,* superficially resembles the marine turtles in its paddle-shaped limbs, but the absence of horny plates is distinctive and suggests affinities with the next group

Trionychoidea.—This contains but a single family, the *Trionychidae.* In this family the bony carapace and plastron are much reduced in size and the whole creature is very flat, almost circular in bodily outline and entirely covered with soft skin; the digits are broadly webbed, only the three inner having claws, the jaws are hidden by fleshy lips and the snout is prolonged into a short, soft proboscis. All the members of the group are dwellers in the mud of slow-running rivers, lakes and ponds and are carnivorous; some species show what appears to be dimorphism connected with their diet, some individuals which appear to be fish-eaters having sharp-edged jaws and others having broad, crushing surfaces which suggest a diet of molluscs The six genera of the family are distributed throughout Africa, Asia and North America and are superficially very similar *Trionyx,* the most widely distributed genus, has species in regions inhabited by the family.

(H W. P.)

TORTOISESHELL. The tortoiseshell of commerce consists of the epidermic plates covering the bony carapace of the hawksbill turtle, *Chelonia imbricata,* the smallest of the sea turtles The plates of the back or carapace, technically called the head, are 13 in number, five occupying the centre, flanked by four on each side These overlap each other to the extent of one-third of their whole size, and hence they attain a large size, reaching in the largest to 8in. x 13in, and weighing as much as 9 ounces The carapace has also 24 marginal pieces, called hoofs or claws, forming a serrated edge round it; but these, with the plates of the plastron, or belly, are of inferior value The plates of tortoiseshell consist of horny matter, but they are harder, more brittle and less fibrous than ordinary horn Their value depends on the rich mottled colours they display—a warm translucent yellow, dashed and spotted with rich brown tints—and on the high polish they take and retain The finest tortoiseshell is obtained from the Eastern Archipelago, particularly from the east coast of Celebes to New Guinea; large supplies come from the West Indian islands and Brazil.

Tortoiseshell is worked precisely as horn; but, owing to the high value of the material, care is taken to prevent any waste in its working. The plates, as separated by heat from the bony skeleton, are keeled, curved and irregular in form They are first flattened by heat and pressure, and superficial inequalities are rasped away. Being harder and more brittle than horn, tortoiseshell requires careful treatment in moulding it into any form, and as high heat tends to darken and obscure the material it is treated at as low a heat as practicable. For many purposes it is necessary to increase the thickness or to add to the superficial size of tortoiseshell, and this is readily done by careful cleaning and rasping of the surfaces to be united, softening the plates in boiling water or sometimes by dry heat, and then pressing them tightly together by means of heated pincers or a vice. The heat softens and liquefies a superficial film of the horny material, and that with the pressure effects a perfect union of the surfaces brought together. Heat and pressure are also employed to mould the substance.

Tortoiseshell has been a prized ornamental material from very early times. It was one of the highly esteemed treasures of the Far East brought to ancient Rome by way of Egypt, and it was eagerly sought by wealthy Romans as a veneer for their rich furniture In modern times it is most characteristically used in the elaborate inlaying of cabinetwork known as buhl furniture, and in combination with silver for toilet articles. It is also employed as a veneer for small boxes and frames It is cut into combs, moulded into snuff-boxes and other small boxes, formed into knife-handles, and worked up into many other similar minor articles. The plates from certain other tortoises, known commercially as turtle-shell, possess a certain industrial value, but they are either opaque or soft and leathery, and cannot be mistaken for tortoiseshell A close imitation of tortoiseshell can be made by staining translucent horn or by varieties of celluloid

TORTONA (anc. *Dertona*), a town and episcopal see of Piedmont, Italy, in the province of Alessandria, from which it is 14 m E by rail, on the right bank of the Scrivia, at the northern foot of the Apennines, 394 ft above sea-level Pop (1921), 12,-494 (town), 20,076 (commune) Tortona is on the main line from Milan to Genoa; from it a main line runs to Alessandria, which branches to Novi and Castelnuovo Scrivia, and a steam tramway to Sale. Its fortifications were destroyed by the French after Marengo (1800); which was fought not far off, as were the battles of Novi (1799) and Montebello (1800–1859) The cathedral contains a remarkably fine Roman sarcophagus

Dertona is spoken of by Strabo as one of the most important towns of Liguria It stood at the point of divergence of the Via Postumia (*see* LIGURIA) and the Via Aemilia, while a branch road ran hence to Pollentia The local museum contains Roman antiquities found here In the middle ages Tortona was zealously attached to the Guelphs, on which account it was twice laid waste by Frederick Barbarossa, in 1155 and 1163 In 1176 it made a treaty with Barbarossa and the people of Pavia, and was taken back into favour by Henry VI. in 1193 It was the base headquarters of the British force in Italy in 1917–19

See F Gabotto, *Per la Storia di Tortona* (Biblioteca della Societa Storica Subalpina, fasc 96, 1922).

TORTOSA, a fortified city of Spain, in the province of Tarragona; 40 m by rail W S W of Tarragona, on the Ebro 22 m above its mouth Pop. (1920), 33,044 Tortosa, the *Dertosa* of Strabo and the *Colonia Julia Augusta Dertosa* of numerous coins was a city of the Ilercaones in Hispania Tarraconensis Under the Moors it was of importance as the key of the Ebro valley It was taken by Louis the Pious in 811, but was soon recaptured Having become a haunt of pirates, it was made the object of a crusade proclaimed by Pope Eugenius III in 1148, and was captured by Ramon Berenguer IV, count of Barcelona, assisted by Templars, Pisans and Genoese An attempt to recapture the city in 1149 was defeated by the women folk, who thenceforth received many privileges Tortosa fell to the duke of Orleans in 1708; during the Peninsular war it surrendered in 1811 to the French under Suchet, who held it till 1814 Tortosa is a walled town with crooked and ill-paved streets, and lofty, granite-built houses. There is a modern suburb on the opposite side of the Ebro. The cathedral occupies the site of a Moorish mosque built in 914. The present structure (1347), has its Gothic character disguised by a classical façade with Ionic pillars There are manufactures of paper, hats, leather, ropes, porcelain, majolica, soap, spirits and ornaments made of palm leaves and grasses. The river fisheries are important. Corn, wine, oil, wool, silk, fruits and liquorice (a specialty of the district) are exported The city is connected with Barcelona and Valencia by the coast railway, and with Saragossa by the Ebro valley line; it is also the terminus of a railway to San Carlos de la Rápita.

TORTURE, the general name for innumerable modes of inflicting pain, and especially for those employed as an incident of judicial process. From this point of view torture was always inflicted either as a means of eliciting evidence from a witness or from an accused person either before or after condemnation; or as a part of the punishment. The second was the earlier use.

Its development in mediaeval times may be traced to the decline of the ordeals and trial by battle While the appeal to God (which is so marked a feature of the ordeals) exists, confession is unnecessary. Thus, the capitularies of Charlemagne make no provision for torture, while including the earlier modes of procedure. When the fourth Lateran Council, in 1215, prohibited the clergy from participating in the ordeal, English law developed trial by jury for crime, and thus rendered the extraction of a confession of guilt from the prisoner unnecessary Continental law, on the other hand, considered a confession the best of all evidence, and all the machinery of the law was organized to obtain it.

Even when torture was a normal incident of judicial procedure, enlightened lay opinion was overwhelmingly opposed to its employment. Cicero (*Pro Sulla*), Seneca and St. Augustine condemn it, although the latter regards it as a necessity, while Ulpian, in Justinian's *Digest,* declares: "Torture (*quaestio*) is not to be regarded as wholly deserving or wholly undeserving of confidence; indeed, it is untrustworthy, perilous and deceptive For most men, by patience or the severity of the torture, come so to despise torture that the truth cannot be elicited from them; others are so impatient that they will lie in any direction rather than suffer torture, so it happens that they depose to contradictions and accuse not only themselves but others" Among later writers, Montaigne, Montesquieu, Bayle, Voltaire, Sonnenfels, Beccaria, Verri and Manzoni all condemn it The influence of Beccaria in rendering the use of torture obsolete was undoubtedly greater than that of any other legal reformer. He emphasizes the unfair incidence of torture, as minds and bodies differ in strength. Moreover it is to confound all relations to expect that a man should be both accuser and accused, and that pain should be the test of truth, as though truth resided in the muscles and fibres of a wretch under torture. Apologists of torture may be found chiefly among jurists, but authors of books of practice, and notably Damhouder, von Rosbach, von Boden and Voet, are aware of its deficiencies. Muyart de Vouglans derives torture from the law of God Other apologists are Simancas, bishop of Badajoz, Engel, Pedro de Castro, and in England Sir R. Wiseman.

Greece.—Both Aristotle and Demosthenes regard torture as the surest means of obtaining evidence. At Athens slaves, and probably at times resident aliens, were tortured, but free citizens only rarely, the practice being forbidden by a psephism passed in the archonship of Scamandrius Torture was sometimes inflicted in open court, and the rack was employed, even for free citizens. A list of tortures is given in the *Ranae* of Aristophanes (V 617) and the wheel is alluded to in *Lysistrata* (V. 846) Isocrates and Lysias refer to torture under the generic name of στρέβλωσις but it was generally called βάσανοι in the plural (*cf.* Lat. *tormenta*). Torture was frequently inflicted by Greek despots, and both Zeno and Anaxarchus are said to have been put to it.

Rome.—The Roman system was the basis of all subsequent European systems which recognized torture as a part of their procedure, and the rules attained a refinement beyond anything approached at Athens Cicero declares that the law of torture rested originally on custom, and no existing fragment of the Twelve Tables alludes to it. It is mentioned frequently by writers both of the republic and the empire. During the republic, a master had power to torture his slaves In the early empire, however, restrictions were imposed. A *lex Petronia* forbade masters to punish slaves by making them fight wild beasts, without magisterial authorization, while Antoninus Pius required a master who ill-treated his slave to sell him. Not until the later empire was the killing of a slave by excessive punishment made homicide. The law of the later empire, relating to torture, is set forth at length chiefly in the titles *De quaestionibus* of the *Digest* and the *Code*—the former consisting largely of opinions from the *Sententiae receptae* of Paulus, the latter being largely a repetition of constitutions contained in the Theodosian Code. Both substantive law and procedure were dealt with, but a large discretion was left to the judges. Torture was used both in civil and criminal trials, but in the former only upon slaves and freedmen or infamous persons (after *Nov* xc 1 i upon *ignoti* and *obscuri* if they showed signs of corruption)—*e.g*, gladiators—and in the absence of *alia manifesta indicia,* as in cases affecting inheritance. Only slaves were tortured during the republic, but in the empire it was extended to freemen accused of crime. Certain persons were exempt by a constitution of Diocletian and Maximian from the liability to torture, *e g*, soldiers, nobles of high rank, and their descendants to the third generation—*decuriones*—and their children under 14, and pregnant women. These exemptions did not extend to accusations of treason or sorcery. A freeman could be tortured only where he had been inconsistent in his depositions, or where there was a suspicion of lying. There were detailed rules concerning the torture of slaves, and the Romans believed that this was the most efficacious means of obtaining the truth. Unlike freemen, they could be tortured as witnesses, always on behalf of their master, against him only in treason, adultery, frauds on the revenue, coining and similar offences, attempts by a husband or wife on the life of the other, and in cases where a master had bought a slave in order that he should not give evidence against him The exemption from accusation by a slave extended to the owner's father, mother, wife or tutor, and a former master; but a slave-owning corporation was not privileged. Where a charge of adultery was brought against the wife, her husband's, her own and her father's slaves could be tortured. Detailed rules governed the application of torture Other modes of proof must first be exhausted, and the evidence (*argumentum* and *indicium*) must have advanced so far that the slave's confession alone was required to complete it The amount was at the discretion of the judge, but it must not injure life or limb, otherwise the judge became *infamis* Except in treason, the unsupported testimony of a single witness was not a sufficient ground for torture. Leading questions could not be asked The *quaesitor* asked the questions, the *tortores* applied the instruments The principal forms of torture were the *equuleus,* or rack, the *plumbatae,* or leaden balls, the *ungulae* or barbed hooks, the *lamina,* or hot plate, the *mala mansio* (comparable with the "Little Ease" of the Tower of London) and the *fidiculae,* or cord compressing the arm. As a part of punishment, torture existed in Rome from earliest times, when it was permitted in respect of defaulting debtors Later, crucifixion, mutilation, exposure to wild beasts in the arena, and other modes were in common use. Through the *leges barbarorum,* Roman doctrines relating to torture were transferred, with modifications, to mediaeval Europe.

The Church.—The Church, although adopting a good deal of Roman law, was at first definitely opposed to torture. Thus the synod at Rome in 384 condemned it. In 1282, a bull of Innocent IV. directed the civil power to torture heretics, but the canon law had little to say upon the subject, holding that although it was no sin in the faithful to inflict torture, a priest might not do so with his own hands In later times, torture was inflicted by the Inquisition. Torquemada's code of instructions (1484) provided that an accused might be tortured if *semiplena probatio* existed against him, *i.e*, so much evidence as to raise a grave presumption of guilt Confessions extracted during torture required subsequent confirmation, but retractation involved further torture or extraordinary punishment. One or two inquisitors, or a commissioner of the Holy Office, were bound to be present at all examinations. Following certain abuses, a decree of Philip II. in 1588 forbade torture without an order from the council, but the decree was not fully observed. An edict of the Inquisitor-General Valdès, in 1561, left torture to the prudence and equity of the judges. They must consider motives and circumstances before decreeing torture, and must declare if it were to be employed *in caput proprium, i.e.,* to extort a confession, or *in caput alienum, i.e.,* to incriminate an accomplice. Torture was not to be decreed until the termination of the process and after defence heard, and the decree was subject to appeal, but only in doubtful cases, to the Council of the Supreme. It was also only in doubtful cases

that the inquisitors were bound to consult the council. On ratification 24 hours afterwards of a confession made under torture, the accused might be reconciled, if sincerely repentant, or if convicted of bad faith he might be delivered to the secular power to be burned Torture had ceased to be inflicted before the suppression of the Inquisition, and a papal bull in 1816 decreed its abolition. The actual rules, *e g*, Torquemada's, were not so cruel as the construction put upon them by inquisitors. Thus Torquemada's direction that torture should only be renewed for retractation was evaded by terming renewed torture a continuation. Besides the two sets of rules already mentioned, those of Nicholas Eymenico, grand inquisitor of Aragon about 1368, and of Simancas, two centuries later, deserve mention In 1545 and 1550, Charles V. issued instructions for the guidance of inquisitors Abuses, however, were exceedingly frequent

England.—The English common law never recognized the legality of torture (except perhaps in the early ordeals) and Coke, commenting on Magna Carta, cap 29, observes. "No man destroyed, etc. that is, forejudged of life or limb, disinherited, or put to torture or death" (2 *Inst* 48 b) The Bill of Rights also provided that cruel and unusual punishments ought not to be inflicted. Judicial opinion was always in theory opposed to it, and in Felton's case (1628) a resolution of the judges declared "that he ought not by the law to be tortured by the rack, for no such punishment is known or allowed by our law" Accordingly, in only two instances was a warrant to torture issued by a common law judge, although it was an incident in criminal procedure for several centuries, being ordered either by the Crown or council, or some extraordinary tribunal, and especially by the star chamber Cases occur as early as the 13th century, and continue down to 1640 One case only is recorded after this date, three Portuguese being tortured at Plymouth during the Commonwealth The rack was introduced in the reign of Henry VI by the duke of Exeter, and was hence known as "the duke of Exeter's daughter" Other varieties of torture were "the scavenger's daughter," or manacles, which pressed the victim's head to his feet, the iron gauntlets or bilboes, and the cell called "Little Ease" In Elizabeth's reign, the rack was in constant use Witnesses were never tortured

One peculiar form of torture was not unknown to the common law—the *peine forte et dure.* If a prisoner refused to plead, remaining mute of malice, he was stretched upon his back, and pressed with heavy weights, until he either consented to plead, or died This practice was abolished by 12 Geo III c. 20, a case having occurred so late as 1726 Tying the thumbs with whipcord was frequently used instead of the *peine* Witch trials also involved incidents of torture, such as throwing the accused into a pond to discover whether she would sink or swim

As a part of punishment, torture by mutilation appears in pre-conquest codes and in the assize of Northampton (1176). Later examples are burning to death for heresy, drawing and quartering for treason, branding in the hand for felony, the pillory, the stocks, branks and ducking stool All these have now been abolished, although corporal punishment for robbery with violence and for juvenile offenders still exists

Scotland.—Torture was long a recognized part of Scottish criminal procedure. Numerous instances occur in the *Register of the Privy Council* The last warrant was issued in 1690, and it was finally abolished in 1708 Among the most celebrated forms employed in Scotland was the "boot." The "boot," comprising a long iron boot in which the foot was inserted, wedges being then driven between the limb and the boot, was not peculiar to Scotland for records are found in French criminal trials, and again in Ireland, where in 1583, Hurley, a priest, was tortured in Dublin by "toasting his feet against the fire with hot boots"; this species of torture was employed, not only for crime, but as an incident in religious persecution (Lecky, *Rationalism in Europe*, 1865, II., p. 45), and sometimes by the nobility for their own ends. Thus in 1605, a suit was brought against the earl of Orkney, for putting a son of Sir Patrick Bellenden in the boots. Other Scottish methods of torture were the rack, the pilniewinkis (known in England as the thumbikins, and resembling the thumbscrew), the caschie-laws (an instrument drawing the body and limbs together, heat being applied in some cases), the lang irnis (heavy weights, sometimes exceeding 50 stones), the harrow-bore (perforations through which the teeth of harrows were inserted), the pynebankis (a variety of the rack) and the artificial prevention of sleep.

Ireland.—Torture was recognized in Ireland neither by statute nor by common law, and few cases are recorded of its infliction. In 1566, however, the president and council of Munster, or any three of them, were empowered to inflict torture "upon vehement presumption of any great offence in any party committed against the queen's majesty"

British Colonies and Dependencies.—In any British possession, the infliction of torture has usually been regarded as contrary to law. In 1806, however, Sir Thomas Picton, the governor of Trinidad, was tried for subjecting Luisa Calderon to the torture of the piquet, in which the sufferer was supported only on the great toe, which rested on a sharp stake, and by a rope attached to one arm One of the grounds for defence was that torture was authorized by the Spanish law of the island The accused was convicted, but sentence was respited Warren Hastings was also charged with extortion from the begums of Oude by means of the torture of their servants. The Indian penal code now expressly forbids torture In Ceylon it was formerly allowed by the Dutch, but was abolished by royal proclamation in 1799.

United States.—In 1692, Giles Cory of Salem, accused of witchcraft, refused to plead, and was subjected to the *peine forte et dure* The American constitution forbids cruel and unusual punishments, on which there have been numerous decisions

CONTINENTAL EUROPEAN STATES

These fall into four main groups, the Latin, Teutonic, Scandinavian and Slav states The principles of Roman law were generally adopted in the first and second groups.

France.—In France, torture does not seem to have existed as a recognized practice before the 13th century. From then until the 17th century it was regulated by a series of royal *ordonnances,* and was applied only in the royal courts, its place in the seigneurial courts being supplied by the judicial combat The earliest *ordonnance* was that of Louis IX in 1254, for the reformation of the law of Languedoc It enacted that persons of good fame, though poor, were not to be put to the question on the evidence of one witness. In 1670, an *ordonnance* of Louis XIV regulated the infliction of torture for more than a century Two kinds were recognized, the *question préparatoire* and the *question préalable* The first was abolished by royal decree in 1780, but in 1788 the parlements refused to register a decree abolishing the *préalable* Torture of all kinds was abolished by an *ordonnance* of Oct 9, 1789, however, and the modern *code pénal* enacts that criminals employing torture to further their ends shall be guilty of assassination, whilst it is also an offence to torture a person under arrest.

Italy.—The law as it existed in Italy is contained in a long line of authorities chiefly supplied by the school of Bologna, beginning with the *glossatores* and continued by the *post-glossatores* until the system attained its perfection in the vast work of Farinaccius in the early 17th century, where every possible question that could arise is treated with revolting completeness. The writings of the jurists were supplemented by a large body of legislative enactments in most of the Italian states, extending from the constitutions of the Emperor Frederick II. down to the 18th century.

Farinaccius was procurator-general to Pope Paul V., and the principal feature of his work is the minute and skilful analysis of *indicia, fama, praesumptio,* and other technical terms. For every infliction of torture a distinct *indicium* is required. A single witness or an accomplice constitutes an *indicium* This rule does not apply where torture is inflicted for discovering accomplices or a crime other than that for which it was originally inflicted. Torture may be ordered in all criminal cases, except small offences, and in certain civil cases, such as denial of a *depositum,* bankruptcy, usury, treasure trove and fiscal cases. It may be inflicted on all persons, unless specially exempted (*e g.,* clergy and minors) and even those exempted may be tortured by command of the sovereign. There are three kinds of torture, *levis, gravis* and *gra-*

vissima, the first and second corresponding to the ordinary torture of French writers, the last to the extraordinary. This last was as much as could possibly be borne without destroying life. The judge could not begin with torture; it was only a *subsidum.* If inflicted without due course of law, it was void as a proof.

Among other important writers was Julius Clarus of Alessandria, a member of the council of Philip II Generally, he follows Farinaccius. He puts the questions for the consideration of the judge with great clearness These are—whether (1) a crime has been committed, (2) the charge is one in which torture is admissible, (3) the fact can be proved otherwise, (4) the crime was secret or open, (5) the object of the torture is to elicit confession of crime or discovery of accomplices The clergy can be tortured only in charges of treason, poisoning and violation of tombs.

Other Italian writers of less eminence are Guido de Suzara, Paris de Puteo, Aegidius Bossius of Milan, Casonus of Venice, Decianus, Follerius and Tranquillus Ambrosianus Torture was abolished in Tuscany in 1786, largely owing to the influence of Beccaria, and other States followed The *puntale*, or piquet, however, existed in practice at Naples until 1859 Savonarola, Machiavelli, Giordano Bruno, Campenella are among those subjected to torture in Italian history Galileo appears only to have been threatened with the *esame rigoroso* The historical case of the greatest literary interest is that of the persons accused of bringing the plague into Milan in 1630 by smearing the walls of houses with poison

Spain.—In Spain, Roman law was carried through the Visigothic code and the *Fuero juzgo* down to the *Siete partidas*, compiled by Alfonzo the Wise in 1243, and promulgated in 1256. Torment is defined as a manner of punishment which lovers of justice use, to scrutinize by it the truth of crimes committed secretly, and not provable in any other manner Repetition was allowed in case of grave crimes There were the usual provisions for the infliction of torture only by a judge having jurisdiction, and for the liability of the judge for exceeding legal limits Subsequent codes did little more than amend the *Partidas* in matters of procedure In Aragon, while it was an independent state, torture was not in use to the same extent as in other parts of Spain. It was abolished in the 13th century by the General Privilege of 1283, except for vagabonds charged with coining A statute of 1335 made it unlawful to put any freeman to the torture. On the other hand, the Aragonese nobility had power to put a criminal to death by cold, hunger and thirst The jurists dealing with the subject are not as numerous as in Italy, no doubt because Italian opinions were received as law in all countries whose systems were based on Roman law Among them are Suarez de Paz, Antonio Gomez and Alvarez de Velasco The Peruvian Juan de Hevia Bolanos, who wrote at the beginning of the 19th century, should also be noted The principal Spanish tortures, according to Suarez de Paz, were the water and cord, the pulley or *strappado*, the hot brick, and the *tablillas*, or thumbscrew and boot combined.

Teutonic States.—Germany (including Austria) possesses the most extensive literature and legislation on the subject The principal writers are Langer, von Rosbach, von Boden, Ulrich Tengler, Remus, Casonus and Carpzow Legislation was partly for the empire, partly for its component states Imperial legislation dealt with the matter in the Golden Bull (1356), the Ordinance of Bamberg (1507) the Carolina (1532) and the *Constitutio criminalis theresiana* (1768) Torture was formally abolished in the empire in 1776. In Prussia it was practically abolished by Frederick the Great in 1740, formally in 1805 Even before its abolition it was in use only to discover accomplices after conviction. In some other states it existed longer, in Baden as late as 1831.

The Netherlands.—The principal legislative enactment was the code of Philip II, known as the *Ordonnance sur le style* (1570). One of its main objects was to assimilate the varieties of local custom, as the *Nueva recopilacion* had done in Spain three years earlier. Certain cities of Brabant, however, still claimed the privilege of torturing in certain cases not permitted by the ordinance, *e.g*, where there was only one witness This law continued to be the basis of criminal procedure in the Austrian Netherlands until 1787, and in the United Provinces until 1798 The principal text-writers are Damhouder, van Leeuwen and Voet, who took the same view as St Augustine as to the uselessness of torture, and compared its effect with that of trial by battle.

Scandinavian Countries.—There is a notice of torture in the Icelandic code known as the Grágás (about 1119). Judicial torture is said to have been introduced into Denmark by Valdemar I. in 1157 In the code of Christian V. (1683) it was limited to cases of treason It was abolished by the influence of Struensee in 1771, but nothwithstanding this he was threatened with it, though it was not actually inflicted, before his execution in 1772. In Sweden torture never existed as a system, and in the code of 1734 it was expressly forbidden It was however occasionally inflicted, as in England, by extrajudicial authorities, called secret committees. The "cave of roses," where reptiles were kept for the purpose of torture, was closed by Gustavus III in 1772

Slav Countries.—The earliest mention of torture is that of the mutilation provided for certain offences by the code of Stephen Dushan in 1349 In Russia torture does not occur in the recensions of the earlier law It was possibly of Tatar origin, and the earliest mention of it in an official document is probably in the Sudebnik of Ivan the Terrible (1497) In the ordinance of 1556 there are elaborate regulations, which were not always observed in periods of political disturbance, and torture was used even as a means of enforcing payment of debts The reaction begins with Peter the Great and culminates with Catherine II, who was largely influenced by the opinions of Beccaria and Voltaire In the instructions to the commission for framing a criminal code (1776) it is declared that all punishments by which the body is maimed ought to be abolished, and that the rack violates the rules of equity and does not produce the end proposed by the laws It was formally abolished by Alexander I in 1801, and in 1832 the *Svod Zakonov* subjected to penalties any judge who presumed to order it. But even as late as 1847 it was inflicted in one or two exceptional cases

ASIATIC COUNTRIES

Numerous accounts of tortures inflicted by Asiatic monarchs survive in the narratives of early travellers Of these, Olearius' *Voyages and Travels of the Ambassadors*, translated by John Davies (1662) is informative From these accounts it is apparent that torture was used regularly in the East both as an incident in judicial process, and as a part of punishment, and in some countries at least there seem to have been few checks on its employment beyond the whim of the monarch In Persia, Olearius records that such punishments as mutilation and sawing asunder were in use In India, again, the local despots employed torture as a mode of extracting evidence

Japan.—Japanese law was particularly severe, both procedurally and in its punishments In trials for theft, a piece of red-hot iron was placed in the hands of the accused, who then flung it away If his hand was unburned, he was innocent, if burned guilty The punishment for theft involved tying the offender to great canes in the form of a cross, and his body was then twice run through diagonally by a spear Confession was usually necessary before conviction, and in order to extract it, a "boot" consisting of heavy wooden planks was employed, and also the bow-strings As a punishment, crucifixion was in general use, and accounts of fiendish tortures inflicted on Christians in the 17th century survive (*See* Olearius 154–5, and Murdoch's *History of Japan*)

China.—In China, and other countries where the Chinese criminal code was accepted with local modifications (*e g*, Annam and Burma) some regulation of the use of torture was attempted, although abuses were frequent. As in Japan, confession by the accused was necessary before punishment. The *Ta T'sing Lu Li*, the code of the Manchu dynasty, therefore, prescribes certain forms of judicial torture. These were applicable to witnesses also, and include the "boot" (which appeared in two forms: [1] boards between which the leg of the accused was crushed, and [2] a receptacle in which the leg was placed and boiling oil poured), the finger-compressor, kneeling on chains and beating the face Those below 15 years of age, or over 70, were exempt

from torture, and also those suffering from permanent disease or other infirmity. Other forms, more cruel than those sanctioned by the code existed, although, according to the code, a magistrate who applied torture wantonly or arbitrarily was liable to prosecution Among the illegal tortures reported by the *Chinese Repository* (vol IV.) to be in use at the beginning of the 19th century were nailing to boards, beds of iron, red-hot spikes, boiling water, knives for cutting the tendon Achilles, the beauty's bar (so named after the wife of a judge, and comprising three cross bars to which the breast, the small of the back, and the legs bent up were fastened), the parrot's beam (in which the prisoner was raised from the ground by strings round the fingers and thumbs, attached to a beam) and the refining furnace. Torture was also an incident in many punishments, execution by slow cutting to pieces being the most famous In addition there were flogging (both with heavy and light bamboo) and the cangue, an instrument resembling, and having the same object as the pillory. Though theoretically abolished at the beginning of the 20th century, torture is still practised in many parts of China

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(J. WIL ; G. W. K)

TORY: *see* WHIG AND TORY

TOSARI, the chief mountain resort in Java, Dutch East Indies It is situated about 25 m from Pasuruan, from which it is reached by a good motor road, with easy gradients, through delightful country, by way of Gondang, Pasrepan and Poespa Tosari is built on a long, winding tree-clad ridge, a spur of the Tengger mountains, at an average altitude of 5,840 ft. above sea-level, with a very steep descent facing north-eastwards to the Straits of Madura It has a marvellous view over the mountains, and is a centre for many excursions

Tosari has a very modern and well equipped sanatorium, situated amidst beautiful gardens and grounds, several hotels, shops and a native (Tenggerese) village, with a temperature which ranges from a mean of 68 6° in August to 62 2° in January, and an absolute maximum of 71·2° and an absolute minimum of 49·5°. The nights are generally cold and clear, and the climate, with abundant sunshine, is very invigorating

TOSCANELLA: *see* TUSCANIA.

TOSTIG (d. 1066), earl of Northumbria, was a son of Earl Godwine, and in 1051 married Judith, sister or daughter of Baldwin V, count of Flanders In the year of his marriage he shared the short exile of his father, returning with him to England in 1052, and became earl of Northumbria after the death of Earl Siward in 1055 He was intimate with his brother-in-law, Edward the Confessor, and in 1061 he visited Pope Nicholas II at Rome in the company of Aldred, archbishop of York. Tostig introduced a certain amount of order into the wild northern district under his rule; but his severity made him exceedingly unpopular, and in 1065 Northumbria broke into open revolt. Declaring Tostig an outlaw and choosing Morkere in his stead, the rebels marched southwards and were met at Oxford by Earl Harold, who, rather against the will of the king, granted their demands. Tostig sailed to Flanders and thence to Normandy, where he offered his services to Duke William, who was related to his wife and who was preparing for his invasion of England. He then harried the Isle of Wight and the Kentish and Lincolnshire coasts, and, after a stay in Scotland and possibly a visit to Norway, joined Harald III. Hardrada, king of Norway, in the Tyne Together they sailed up the Humber and at Gate Fulford, near York, defeated Earls Morkere and Edwine and entered York. But Harold, now king, was hurrying to the north. Taking the Norwegians by surprise at Stamford Bridge he destroyed their army on Sept. 25, 1066, and in this battle both Tostig and the king of Norway were slain. Tostig's two sons took refuge in Norway, and his widow Judith married Welf, duke of Bavaria.

See E. A. Freeman, *The Norman Conquest*, vols. ii. and iii. (1870–1876).

TOTALIZATOR. Betting on horse races, without the aid of bookmakers as intermediaries, is conducted by two methods, known as the totalizator (or tote) and the pari mutuel systems. In principle they are alike. Money staked by backers is pooled, and, when the result of a race is known, shared by those who have backed the winner. But whereas all bets made through a totalizator are at once automatically massed in a single pool, those made through a pari mutuel are in the first instance formed into a series of separate pools, only, however, finally to be amalgamated. The totalizator, when efficiently equipped and worked, is the more expeditious instrument, but it is also the more costly to install. The totalizator building and machinery at Randwick racecourse, Sydney, cost about £80,000 An outfit of a similar character at Longchamp, Paris, used for the first time in March, 1928, entailed an even bigger outlay; but, whereas the Randwick machine deals with only one pool, that at Longchamp provides for two separate pools—one for straight-out, or win, bets, and the other for place bets. Owing to the high cost of installing a totalizator capable of handling a large number of bets it has been the general practice to fit it with machinery for dealing with one pool only The major portion of such pools, say 60 or 75%, is divided among the backers of the winner and the remainder among backers of the second and third horses. In Australia and New Zealand, where the tote originated, this method of distributing the pool has been accepted as fair and satisfactory. In other parts of the world it has not been approved. In the United Kingdom, in France and other continental countries, and in the Americas, speculators demand the opportunity of backing a horse to win only; if they also wish to back it to secure a place that must be another transaction. Hence the widespread popularity of the pari mutuel system which, at a comparatively low cost, gives facilities for both win and place betting, with independent pools.

The Pari Mutuel.—The pari mutuel method was invented about 1872 by a Frenchman named Oller. His apparatus was extremely simple It consisted of blocks of consecutively-numbered tickets or vouchers (the tickets in each block bearing the racecard number of one of the horses running) and a wooden shed, open in front, to accommodate the men selling the tickets or paying out over winners For many years this system was privately conducted in opposition to bookmakers, but eventually it was adopted by the controllers of racing in France, who realized the possibility of obtaining revenue by appropriating a small percentage of the turnover. Then the French Government came in, imposed regulations, banished bookmakers, and, while allowing the turf authorities to work the pari mutuel, received a percentage of the turnover in return for the concession The money handed over to the Government was, and has continued to be, devoted to the furtherance of horse breeding, the provision of drinking water in rural districts, and to other beneficent objects Eleven per cent of the turnover is, in France, deducted before the pools are distributed among the holders of winning tickets. Four-elevenths of this rake-off is retained by the turf authorities who, after meeting the cost of working the pari mutuel, disburse the balance by increasing racecourse amenities for the benefit of the public, paying premiums to breeders of winning horses, enhancing the value of racing stakes, and generally improving the equipment and tone of the French turf. In 1927 the pari mutuel turnover at the racecourses near Paris, together with those at Deauville and Caen, amounted to 1,425,256,462 francs

Origin of the Totalizator.—The application of mechanism to the mutuel system of betting dates from 1880. That year a man in New Zealand named Ekberg, who had studied Oller's procedure, conceived the idea of automatically recording bets. He devised a machine for the purpose, called it a totalizator, and used it for the first time at the Canterbury Jockey Club's meeting at Christchurch, N.Z., in 1880. Before many years had elapsed the tote, which had undergone considerable improvement, drove bookmakers off the New Zealand racecourses, obtained a footing in Australia, India and other eastern countries, and now has reached Europe. The efficiency of the modern electrically-worked totalizator excites admiration and wonderment.

Pari Mutuel in America.—In America the development of Oller's primitive pari mutuel followed more closely the original idea. Instead of there being one large machine for recording bets there are several small ones. The registration of the bets is effected by means of hand levers, operated by a man known as the clicker. While betting on the race is in progress each machine is worked as a separate unit, but when the race is started and betting ceases the totals recorded at each machine are passed on to a central office where the grand aggregates are ascertained. This process may be a trifle slower than that of the modern tote, but the trained calculators are, nevertheless, able to declare the dividends payable with astonishing celerity. The American and Canadian machines, costing little more than £100 ($500) each, mark a tremendous advance on the antiquated method by which the pari mutuel is still operated in France

It was not until 1908 that the pari mutuel system of betting was methodically exploited in the United States In the spring of that year it was adopted in Kentucky. The innovation proved very unpopular. Attendance at race meetings became so small that the executives had to reduce the stakes they offered. Two years later, however, a complete change had taken place. It was then declared that the pari mutuel was "doing more to fortify the sport, safeguard and re-establish it, than all other agencies and influences combined" Subsequently the pari mutuel was adopted in Canada and Maryland, and eventually it came to be used on practically all American racecourses except those in the State of New York, where anti-betting laws are still in force, to be circumvented only by what is called "oral" betting with the aid of bookmakers The amazing progress racing has made in the United States of late years is largely the result of the pari mutuel and the 5 or 6% levy on turnover permitted by the laws of the several States concerned In return for this concession the racecourses pay the State exchequer a daily licence fee of from £1,000 to £1,500 ($5,000 to $7,500). This arrangement also obtains in Canada, where a Government inquiry held after the World War resulted in a report that the pari mutuel form of betting was the one calculated to benefit racing most and do the least harm to the community at large.

From time to time spasmodic efforts have been made to establish the pari mutuel in Great Britain The crudest of methods were employed, and then only by venturesome individuals ignorant of the impediments placed in their way by the Betting Houses Act of 1853, one clause of which prohibits anything in the nature of a "place" at which betting is conducted, and makes it illegal for persons to "resort" to such places. It was obviously impossible to conduct a tote or install pari mutuel apparatus without contravening that law. But in 1928, further experiments both at and away from the course were made in Great Britain, and in the Irish Free State the establishment of a tote or pari mutuel was legalized. (E. Mo.)

TOTANA, a town of eastern Spain, in the province of Murcia, on the Lorca-Murcia railway. Pop. (1920) 14,072. The town consists of two parts, the Barrio de Sevilla and Barrio de Triana. Water is conveyed to Totana from the Sierra de Espuña by an aqueduct 7 m. long. Saltpetre is obtained among the hills, and there is a thriving trade in wheat, oranges, olives, almonds, and wine from the Sangonera valley.

TOTEMISM. The term "totemism" is used for a feature of the religion and social organization of widespread occurrence amongst primitive peoples. The name *totem* is derived from an Ojibway word, but has now been generalized by anthropologists to describe an institution, the Ojibway form of which is not typical. Unfortunately, many writers have used the term totemism very loosely for any beliefs and practices dependent upon some supposed connection between animals and persons. The term should be restricted to those cases where a systematic association of groups of persons with species of animals (occasionally plants or inanimate objects) is connected with a certain element of social organization. In the widest use of the term, we may speak of totemism if: (1) the tribe said to be totemic consists of a number of groups (totem groups) comprising the whole tribe, each of which groups has a certain relationship to a species (totem), animate or inanimate; (2) the relation between each group and species is of the same general kind for each group; and (3) a member of one of these totemic groups cannot (except under special circumstances) change his membership.

By this definition one essential peculiarity of totemism is the association of groups of persons with groups of animals or objects, not of individual persons with individual animals, a cômmon enough phenomenon, which, however, it is desirable not to include under totemism Another peculiarity is the division of the tribe into several totemic groups, so that, while every member of the tribe has a totem, persons living in the same locality may yet differ as to their totems As to the determination of the membership of the totem-group, *i e*, the social side of totemism and the nature of the relationship between totem-group and totem, *i e*, the religious side of totemism, one kind of totem-group is commoner than any other, viz, the clan, an exogamous group (*i e*, a group within which marriage is forbidden), determined by descent, either through the father (patrilineal descent), or through the mother (matrilineal descent)

The clan (*q v*), is a group of great importance in primitive society, for it determines behaviour in a variety of ways, and is often of more importance than smaller groups, such as the family, or wider groups, such as the tribe. Members of a clan generally regard themselves as closely related, whether or not they can trace relationship genealogically, and frequently hold themselves and are held by others to be mutually responsible for the actions of their clan-brothers In some parts of the world, where clans are widely dispersed, the totem serves as the only sign of clan-relationship, and a man will be welcomed, on account of his totem, as a clan-brother by distant members of his clan, whom he has never seen, and will also avoid sexual relations with the women of that group, though unable to trace relationship The discovery of this association of totemism with the clan has given rise to one of the most interesting problems of anthropology, for it would seem that any theory of origin of totemism must also explain exogamy Although totemism is generally associated with the clan, the tribe is also sometimes divided into totemic groups, which are not exogamous For example, the Arunta (*q.v.*), of central Australia are divided into totemic groups, membership of which depends upon the accident of position of the mother at the moment of realization of pregnancy, and there is no exogamic restriction on the members of these groups. There are also totemic groups in Africa and elsewhere that are more or less endogamous (*i e*, required to marry within the group) Furthermore, a tribe may be divided in more than one way into totemic groups; for example, in Australia we sometimes find, in addition to totemic clans, moieties (exogamous halves of the tribe, each of which includes a number of clans), and marriage-classes (groups with indirect descent, which are specially connected with the regulation of marriage), which may be more or less totemic, and even a division of totems according to sex.

Variations of the relationship between totem-group and totem, are considerable in different parts of the world In the first place, the totem shows extraordinary variety. While an animal-species is the most usual form of totem, plant-species are by no means uncommon, and classes of material objects are occasionally found· even abstract qualities, such as "pride," the totem of a clan of a weaver caste in Madras, and "red," the totem of an Omaha clan A peculiar variety of totem is the split totem, in which only part of a thing is the totem: *e g*., instead of buffaloes, buffalo tongues

occur as the totem of one Omaha sub-clan. No doubt, split totems are the result of division of a totemic group into several groups. Cross-totems, however, are less intelligible A cross-totem consists of one part of more than one kind of thing; *e g*, the ends of things are the cross-totem of a certain Samoan group, the ears of animals of any species the totem of a Mahili clan, Bengal. Again, one totemic group may have a number of totems, which are then called linked totems; *e g*, clans in south-east New Guinea are always associated with a species of bird, of plant, of fish and of snake, the last three being subordinate to the bird totem.

Although there are considerable differences in the relation between totem-group and totem, owing to differences in the kind of totem, there are also great differences between tribes, apart from this In one tribe we may find a strong avoidance of the totem-animal, which may neither be killed nor eaten, while in other tribes the same animal may be killed with comparative impunity. Nevertheless, this tabu on killing or eating the totem seems to be typical of totemism, and some avoidances in connection with the totem are probably present in all cases But although these tabus may be of great severity—an offender may be severely punished by his totem-group, and, if not punished by his own totem-group, may yet be supposed to suffer through the action of the totem itself—they apply only to the particular totem-group For example, an Australian, whose totem is the witchetty-grub, will respect and avoid this animal, but will not hinder his friends and relations of other clans from making use of this food, and will even conduct ceremonies of which the avowed object is the increase of the totem, so as to provide food for other clans in the tribe In some cases, the totemic tabus must be observed by persons outside the totem-group; *e g*, in south-east New Guinea, where a man is a member of the totem-group of his mother, the totems of the father are even more rigidly tabu than his own totems, and amongst the totemic peoples of Africa, it is common for a woman to adopt the totem-avoidances of her husband Curiously enough, associated with severe tabus on the killing of the totem a totemic sacrifice has been reported from Australia, in which the totem-animal is cruelly killed and eaten

The totemic tabu is usually associated with a belief in some sort of kinship between the totemic group and the totem, which makes the tabu more intelligible In line with this is the frequent belief in descent from the totem, or of totem and totem-group from some common ancestor Another expression of this attitude towards the totem is the performance of ceremonies, in which the totem is represented symbolically or realistically Badges, masks and mutilations may also be used to make this identification Finally, although worship of the totem or prayer never occurs—animal worship has little in common with totemism—it is not unusual for the totemic group to believe that members of the totem species assist the group by means of omens, or in other ways Such being the general characteristics of totemism in all those cases which it is convenient to regard as totemism, a survey of the chief areas of totemism will reveal the diversity of form which totemism takes

Australia.—Totemism has generally been regarded as occurring in Australia in its most complete and original form, not so much on account of the elaborateness of Australian totemism, but because totemism has been regarded as the most primitive religion, and Australians are the most primitive people that we know Both these propositions can be disputed, but Australian totemism is of exceptional interest, for the greater part of Australian religion may be brought under the heading "totemism." Australian totemism has an equally important economic and social side. Among the tribes of central Australia all those important happenings, such as the origin of man and his customs, and the recurrence of death and birth, are well explained in totemic terms, for in olden (*alcheringa*) days there were only totemic beings, emu, grub, and so on, half animal in form, half human. These spirits were creative and made the stock of souls, which have ever since been the souls of human beings by continual reincarnation, these souls themselves being totemic in nature Birth is thus due to the entry of one of these spirits into the womb of a woman, death to its departure from the body. Between incarnations these spirits abide in certain centres, known as totem-centres, and tend to be associated with certain objects, which are kept in these centres, and which are used in totemic ceremonies. It might seem that such a theory of birth and death would offer difficulties, except in such cases as the Arunta, where the totem of the child is not determined by descent, but the native gets over the difficulty by supposing that these localized spirits, when their time for reincarnation arrives, wander from the totem-centre until they find a woman of the right totem, or a woman whose husband is of the right totem, according as descent is matrilineal or patrilineal In the ceremonies of initiation into manhood, also, totemic ideas are dominant. Initiates become conversant with various sacred objects, such as those connected with the soul, and symbolic objects, constructed for particular ceremonies symbolizing in one way or another the totems of the group. Elaborate decorations of the person, dramatic representations of the activities of the totemic ancestors in *alcheringa times*, continuing often for days, and other symbolic activities, all with more or less of a totemic motive, take place on these occasions. At certain times of the year, most Australian tribes conduct elaborate rites the object of which is to increase the totem species These appear to be mainly of the nature of sympathetic magic

Melanesia and Polynesia.—In this region we find every degree of totemism, from an institution containing the main features mentioned above, to complete absence of all these features. For example, in the Santa Cruz islands we find exogamous clans, each possessing one or more totems, usually animals; the totem may not be killed or eaten, and there is usually a definite belief in descent from the totem In the extreme west of Papua (where there are two moieties) and in south-east New Guinea and parts of the Solomons we find totemism of similar form, yet in other parts of the Solomons and in the New Hebrides and Banks islands totemism is absent, though there are customs which suggest survivals of an earlier totemism; in fact, the Banks islanders, while lacking totemic clans, have certain beliefs very similar to those of the Arunta of central Australia, but unsystematic A number of men and women strictly avoid killing certain species of animals or plants on account of a supposed kinship with them This belief is based on the belief that the mother owed her pregnancy in some way to the entry into her womb of an animal of the species avoided This belief appears to be maintained alongside some understanding of the true nature of the process of procreation In Polynesia we find a religious system, which in places, such as Samoa, appears to have developed out of totemism, for many totemic characters are discernible

India.—As a social system, if little more, totemism appears in parts of India For instance, the Santals of Bengal are divided into a number of patrilineal clans, exogamous and totemic, and each of these into a number of sub-clans, also exogamous and totemic There is avoidance of the totem, in some form or another, by the clan or sub-clan Totemism also occurs in Assam, in Central India and Madras, with traces elsewhere

Africa.—Except for the region of the great lakes, totemism is sporadic in Africa. The Baganda of Uganda may be cited as an example of well-developed totemism. The Baganda are divided into some 40 patrilineal exogamous clans Each of these has a principal and a secondary totem, usually an animal or plant, neither of which is killed or eaten by the clan. There are other avoidances, more or less connected with the totem; for example, members of the leopard clan may not eat meat which has been torn or even scratched by an animal We do not find traditions of descent from the totem amongst the Baganda, and the belief in descent from the totem is uncommon elsewhere in Africa. A nominalistic explanation of the origin of the Baganda totems is given; for example, the lion clan of the Baganda, with the eagle as secondary totem, explain their totems as follows: Kimtu, a royal ancestor of the clan, killed a lion and an eagle, and had their skins made into royal rugs, since when the beast and the bird have been regarded as sacred. There is one curious anomaly in Baganda totemism. While a man normally takes his totem

from his father, there is an exception in the case of royalty, a man taking the totem of his mother in addition, and rarely maintaining the royal totem.

North America.—Throughout the greater part of North America we find totemism in a more or less typical form, and the frequent grouping of totemic clans into moieties reminds one of the Australian variety. Other features of American totemism, however, mark it oft clearly from the Australian variety. While the tie between members of the totemic group may be as strong as anywhere else in the world, the attitude towards the totem is usually quite different, and the theory of totemic souls is wanting Often, in America, the totem is little more than a clan-badge, and the totem is often killed by the totemic clan. Nevertheless, elaborate and picturesque legends of the origin of totemic clans from the totem by some sort of descent are common enough. Totemism is not particularly associated with the less developed tribes of North America—rather the reverse; and we find both matrilineal and patrilineal descent of the totemic clans Amongst the strongly matrilineal Iroquois of the east we find a straightforward division of the various tribes into a small number of exogamous clans, of which the totems are animal species, the clans usually being grouped into two moieties Although a few traditions of direct matrilineal descent from an animal of the totemic species have been recorded, the clans usually deny relationship with their totems, and show no regard whatever for them Passing westward, some of the Siouan tribes provide examples of a more complex totemic system For example, the Ponkas are divided into moieties, the moieties into phratries, the phratries into clans, and the clans into sub-clans, each of these classes being more or less totemic and exogamous Here definite tabus are connected with the totems of the clans In the west, particularly the north-west coast, totemism is not clearly distinguishable from another socio-religious institution, peculiar to North America, the cult of guardian spirits The guardian spirit is acquired individually, sometimes quite late in life, by a process usually of fasting and religious exercise, which causes the guardian spirit to appear to the candidate in a dream or vision. Since the guardian spirit usually has an animal form, it is sometimes called an individual totem—clearly a misnomer. Sometimes the guardian spirits capable of acquirement by members of the tribe are divided out between the clans, or other social groups of the tribe, and sometimes the guardian spirit is not clearly individual in nature, but is rather of the nature of a species of animal. In so far as this is the case we have an approximation to totemism A complication of this sort is found in the totemism of the north-west coast peoples, who make the so-called totem-poles The student will find a mass of data on totemism arranged geographically in Sir J G. Frazer's work *Totemism and Exogamy* (1910)

Prominence was given to the association of totemism with exogamy, found throughout the world with few exceptions Where totemism is not associated with exogamy it is not difficult to suppose that exogamy has been lost With considerably less confidence it may be supposed that tribes, containing exogamous groups, have lost their totemism. Finally there are some peoples, *e g.*, the Andaman islanders, and the Eskimo, at a primitive level of culture, who have neither exogamous groups nor totemism. From this distribution of totemism and exogamy it follows that any theory of totemism must either be a "psychological" theory, explaining both totemism and exogamy, or a "historical" theory, which regards totemism, wherever it occurs, as the result of a spread of cultural influence from some one centre where the totemic complex originated. By a "psychological" explanation is meant an explanation in terms of observed facts about the behaviour of groups, or by means of generalizations about the behaviour of groups deduced from known psychological principles. If, antecedently to the development of a given institution, it could be stated on psychological grounds that an institution of that sort would probably develop, then such an institution can be said to be explained psychologically Early theories of totemism have not explained in this sense, for totemism and exogamy have only been shown to be probable, independently of the development of the one or the other, from which it follows that the distribution of totemism and exogamy, assumed above, would not occur, *e.g.*, if, owing to the nature of man and his attainment of some very simple form of society, it were probable that he should develop totemic ideas and practices, and also that he should develop exogamous groups, but for reasons other than those which lead to his developing totemism, then it would be indeed surprising that most peoples who have the one institution have the other, while those who, although in a primitive state of society, do not have the one do not have the other The difficulty can be got over by supposing that totemism and exogamy are necessarily developed by man in the course of his evolution, but it is difficult in this case to offer a plausible explanation of the disappearance of totemism and exogamy among some very primitive peoples, and its retention by others at a more advanced stage of civilization

Two theorists may be mentioned for their attempts to provide a psychological explanation of both totemism and exogamy; viz, Durkheim and Freud For Durkheim the totem results from the action of the group on the individual. The group is the nearest and most powerful coercive force to which the individual is subject, particularly when the group is in violent activity and the individual is conscious of this overpowering influence, when he loses himself completely in the group Symbolic expression alone can be given to such a force; hence the totem is a sacred symbol, symbolizing that very real force, the clan Hence totemic symbols are sacred rather than the totem-species itself (and this, it must be admitted, is true, at least for Australia).

But why, it may be asked, should there be many clans and totems, and not one totemic group? Here Durkheim becomes obscure If there are already several groups, then only in so far as the effective unity of each group is felt should there be more than one totemic group within the tribe. Passing over this difficulty, we have still to enquire why the totemic group is exogamous: the answer is not very convincing It would take too long to follow the various steps which give unity and intelligibility to the scheme, but it is the tabu on the blood of the clan which is ultimately responsible for exogamy

Freud's attempt to give a single explanation of totemism and exogamy is comparatively recent, and he appears to have indicated the direction in which we are to seek an explanation, whatever the adequacy of his presentation.

Prior to the development of culture, man is supposed to have lived in "cyclopean" families, containing a principal male who monopolized the women, including his own daughters, and prevented his sons from having intercourse within the family. What more natural than that the sons should combine and kill the father? But the attitude of the sons is ambivalent, combining both affection and hostility The murder committed, the sons deny themselves the fruits of the deed, owing to the operation of a psychological process familiar to psycho-analysts, and the group becomes exogamous. The affective ambivalence towards the father has also provided the beginnings of totemism. By substituting an animal for the father, a process of symbolism which psycho-analysts consider fundamental in human nature, the animal becomes a vehicle for that affective attitude towards the father which is for the moment repressed With the killing of the father by the momentary release of this repressed *Oedipus complex*, both totemism and exogamy are born The group with one father, and therefore one totem, is exogamous, and the totem becomes the object of observances, which are really the expression of the *Oedipus complex*, which has now become more completely repressed by means of a social mechanism. The difficulties in the way of this theory are considerable, and have been critically analysed by Profs Kroeber and Malinowski. Freud's theory has recently been elaborated and modified in a comprehensive study of Australian totemism on psycho-analytic lines by Dr. Géza Roheim. While the search for a "psychological" explanation of totemism does not reward us with any convincing theory of its origin, an "historical" explanation is equally elusive, though it has been maintained by one school that the distribution of totemism can only be explained on the assumption of diffusion from a single centre, a conclusion which, as we have already

seen, follows if no psychological explanation of totemism combined with exogamy can be found. No evidence for the existence of exogamy, and only the most slender evidence for totemism is provided in the Egyptian centre from which the totemic complex is supposed to have spread; in fact, on this theory totemic exogamy is derivative in the various parts of the world to which totemism spread from a kind of dual organization with marriage injunctions The only "historical" explanation of totemism which has been elaborated is, therefore, no more, if no less, convincing than the numerous "psychological" explanations which have been offered

Dissatisfied with this impasse that the search for explanations leads to, both in the case of totemism and in that of many other primitive institutions, many anthropologists have renounced the search for psychological or historical explanations, and confine themselves to the search for the functions of institutions Possibly this is the only kind of explanation of totemism within our grasp, and, although there is reason to suppose that totemism without function (occurring as a survival merely), occurs in some places, it must be admitted that, until totemism is understood in this functional sense in those cases where it appears to be a significant part of the culture of the group it is premature to attempt to account for its origin.

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(W E A)

TOTILA (d 552), king of the Ostrogoths, was chosen king after the death of his uncle Ildibad in 541, his real name being, as is seen from the coinage issued by him, Baduila At the beginning of his reign, he collected together and inspired the Goths to win a victory over the troops of the emperor Justinian, near Faenza. Having gained another victory in 542, in the valley of Mugello, he left Tuscany for Naples, captured that city, and then received the submission of the provinces of Lucania, Apulia and Calabria Totila's conquest of Italy was marked not only by celerity but also by mercy Towards the end of 545 the Gothic king prepared to starve Rome into surrender, making at the same time elaborate preparations for checking the progress of Belisarius who was advancing to its relief The Imperial fleet only just failed to succour the city, which was plundered by Totila Its walls and other fortifications, however, were soon restored, and Totila again marching against it was defeated by Belisarius, who, however, did not follow up his advantage Several cities were taken by the Goths, while Belisarius remained inactive and then left Italy, and in 549 Totila advanced a third time against Rome, which he captured through the treachery of some of its defenders. His next exploit was the conquest of Sicily, after which he subdued Corsica and Sardinia and sent a fleet against the coasts of Greece. Justinian, thereupon entrusted the conduct of a new campaign to the eunuch Narses, Totila marched against him and was defeated and killed at the battle of Tagina in July 552.

See E. Gibbon, *Decline and Fall*, ed. by J. B. Bury (1898), vol iv, T. Hodgkin, *Italy and her Invaders* (1896), vol iv and Kampfner, *Totila, Konig der Ostgoten* (1889)

TOTNES, GEORGE CAREW, or Carey, Earl of (1555–1629), English politician and writer, son of Dr George Carew, dean of Windsor, and Anne, daughter of Sir Nicholas Harvey, was born on May 29 1555, and was educated at Broadgates Hall, Oxford, where he took the degree of M A in 1588. After holding various military and diplomatic appointments he accompanied Essex in the expedition to Cadiz in 1596 and to the Azores in 1597. In 1598 he attended Sir Robert Cecil, the ambassador, to France. He was appointed treasurer at war to Essex in Ireland in March 1599, and on the latter's sudden departure in September of the same year, Carew became first a lord justice, and in 1600, president of Munster, where his vigorous measures enabled the new lord deputy, Lord Mountjoy, to suppress the rebellion. He returned to England in 1603 and was well received by James I., who gave him many honours. In 1610 he revisited Ireland to report on the state of the country; and in 1618 pleaded in vain for his friend Sir Walter Raleigh. He received his earldom in 1626. He died on March 27, 1629, leaving no issue. Besides his fame as president of Munster Carew had a considerable reputation as an antiquary.

Carew made large collections of materials relating to Irish history and pedigrees, which he left to his secretary, Sir Thomas Stafford, reputed on scanty evidence to be his natural son, while some portion has disappeared, 39 volumes after coming into Laud's possession are now at Lambeth, and 4 volumes in the Bodleian library A calendar of the former is included in the State Papers series edited by J. S Brewer and W. Bullen His correspondence from Munster with Sir Robert Cecil was edited in 1864 by Sir John Maclean, for the Camden Society, and his letters to Sir Thomas Roe (1615–17) in 1860 Other letters or papers are in the Record Office, among the mss at the British Museum and calendared in the *Hist MSS. Com Series*, *Marquess of Salisbury's MSS.*

TOTNES, a market town and municipal borough in the Totnes parliamentary division of Devon, England, on the Dart, 29 m S.S.W. of Exeter, by the G.W railway Pop. (1921) 3,983. It stands on the west bank of the river, and is joined by a bridge to the suburb of Bridgetown It was formerly a walled town, and two of the four gates remain Many old houses are also preserved, and in High street their overhanging upper stories, supported on pillars, form a covered way for foot-passengers The castle, founded by the Breton Juhel, lord of the manor after the Conquest, was already dismantled under Henry VIII; but its ivy-clad keep and upper walls remain The grounds form a public garden Close by are the remains of St Mary's priory, which comprise a large Perpendicular gatehouse, refectory, precinct wall, abbot's gate and still-house, also the Perpendicular church of St Mary. The guildhall is formed from part of the priory Vessels of 200 tons can lie at the wharves near the bridge The industries include brewing, flour milling, and the export of agricultural produce, chiefly corn and cider. Trout and salmon are plentiful in the river

Totnes (*Toteneis, Totton*) was a place of considerable importance in Saxon times; it possessed a mint in the reign of Aethelred, and was governed by a portreeve In the Domesday Survey it appears as a mesne borough under Juhel of Totnes. Its earliest charter dates from 1215.

TOTONICAPAN, the capital of the department of Totonicapan, Guatemala, on the same high plateau as Quezaltenango, from which it is 12 m E N E. Pop (1925) 30,888 Totonicapan is inhabited mainly by Quiché Indians, employed in the making of cloth, furniture, pottery and wooden musical instruments. There are hot mineral springs in the neighbourhood. In 1838 Totonicapan was declared an independent republic, in which the adjoining departments of Sololá and Quezaltenango were included. This State existed for two years, and was then again merged in the republic of Guatemala. The city suffered greatly in the earthquake of April 18, 1902

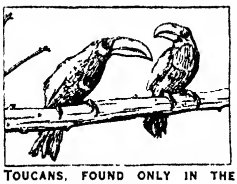
TOTTENHAM, an urban district of Middlesex, England, and suburb of London, 6½ m N of London Bridge, and adjoining Edmonton on the south. Pop. (1921) 146,711. Its full name, not now in use, was Tottenham High Cross, from the cross near the centre of the district. The present structure was erected *c.* 1600. Formerly Tottenham was noted for its "greens," in the centre of one of which stood the famous old elm trees called the "Seven Sisters"; these were removed in 1840, but the name is preserved in the Seven Sisters road. Bruce castle, on the site of the old mansion of the Bruces, but built probably by Sir William Compton in the beginning of the 16th century, was occupied by a boarding-school founded by Mr. (afterwards Sir) Rowland Hill in 1827 on the system he instituted at Hazlewood. Birmingham. It became public property in 1892; the grounds are now used as a public park. All Hallows church, Tottenham, was given by David, king of Scotland (*c.* 1126) to the canons of the church of Holy Trinity, London, and parts of the old building still remain.

In the reign of Edward the Confessor the manor of Tottenham was held by Earl Waltheof, and passed later, by marriage, to

the royal family of Scotland, and so to Robert Bruce and his co-heirs. The parliamentary borough of Tottenham returns two members to parliament.

William Bedwell, the Arabic scholar, was vicar of Tottenham, and published in 1632 a *Briefe Description of the Towne of Tottenham*, in which he printed for the first time the burlesque poem, the *Turnament of Tottenham*.

TOTTENVILLE, a former village of Richmond county, New York, U S.A , and since 1898 a part of New York city It is on the southern shore of Staten Island in New York bay and on Staten Island sound, about 20 m S.W of the south extremity of Manhattan Island The "Billopp House" here (still standing) was the scene of the conference, on Sept 11, 1776, between Lord Howe, representing Lord North, and Benjamin Franklin, John Adams and Edward Rutledge, representing the Continental Congress, with regard to Lord North's offer of conciliation This house, originally called the "Manor of Bentley," was built by Capt. Christopher Billopp (1638–1726), who sailed from England in an armed vessel, the "Bentley," in 1667, and, by circumnavigating Staten Island in 24 hours, made it, under the ruling of the duke of York, a part of New York From the duke of York he received 1,163 ac of land, including the present site of Tottenville The village was long known as Bentley, but in 1869 was incorporated (under a faulty charter, revised in 1894) as Tottenville, apparently in honour of Gilbert Totten, a soldier in the Revolution



TOUCANS, FOUND ONLY IN THE WESTERN HEMISPHERE

TOUCAN, the Brazilian name for a bird of the family *Ramphastidae*, characterized by their huge but light beaks

The type of the family is *Rhamphastes toco*, of Guiana and Brazil. The beak, 8in long and 3in high at the base, is deep orange with a large black spot near the tip The eye is surrounded by a bare orange space, the plumage is black except for the white throat, edged beneath with red The tail is nearly square In many allied species, the bill is parti-coloured *R vitellinus* inhabits Trinidad, but all the remaining members of the family are confined to the mainland, where they do not extend north of Mexico. In the Andes, they reach an elevation of 10,000ft.

TOUCH, SENSE OF. In the environment of every animal, the solid, impenetrable objects with which it may collide play an important part Sensitiveness to touch, comparable to our own, is, therefore, generally developed. The manner in which an animal reacts to contact stimuli depends, principally, on the force of the contact All such stimuli which exceed a certain degree act as repellants, and feeble, defenceless animals seek to escape from them This is evident already in the simplest animals, such as the amoeba. It is sufficient to touch one of the protruded pseudopodia of an amoeba with a pointed, glass needle to bring about its immediate retraction. Already in many infusorians there are extraordinarily developed tactile cilia; if another animal comes into contact with them, it causes the infusorian to swim hastily away (fig. 1)

FIG. 1.—DIOPHRYS HYSTRIX, AN INFUSORIAN WITH PARTICULARLY LONG TACTILE CILIA (AFTER VON BUDDENBROCK)

In multicellular animals the reaction to mechanical impulses differs very much, in accordance with the defensive powers of the individual. This is sufficiently well known in the higher animals. Defenceless animals, such as earthworms, or gasteropods, flee, or withdraw into their protective shells; on the other hand, those capable of defending themselves, such as the large Crustacea, cuttlefishes or sea-urchins meet the assault by active defensive movements. The example last mentioned is, perhaps, of sufficient interest for it to be discussed more particularly

If we touch a sea-urchin on any part of its surface, one of three things happens In the first case, all the spines which are situated in the neighbourhood of the part stimulated bend towards it. If some animal were the cause of the contact it would, thus, be grievously stung by the sharp spines, and put to flight. In the second case the pedicellariae come into action (fig 2) These are pincers consisting of three small snapping blades on a pliant stalk They turn towards the place whence the contact stimuli proceed, and wave their gaping jaws rapidly to and fro They bite firmly into the skin of the enemy, or into its hairs, and assist, either in putting it to flight, or in holding it fast and bringing it into contact with the tube-feet round the mouth, where it is consumed Lastly, in a third case, the whole sea-urchin moves in a direction calculated, if possible, to take it out of the sphere of the stimulus

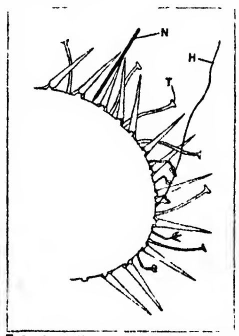


FIG 2—SURFACE OF SEA-URCHIN UNDER MECHANICAL STIMULATION BY NEEDLE N AND HAIR H. T IS A TUBE FOOT

The common crab, particularly the male, reacts to strong contact stimuli by assuming its very characteristic defensive attitude It turns towards its opponent and presents its widely-opened pincers If the enemy still continues to approach, it strikes at it with great force.

Some animals are able to assume an appearance of death when attacked The most pregnant examples of this are furnished by insects The death-feigning reflex usually consists in the animal drawing in its legs, and remaining perfectly motionless, continuing thus even if maltreated in the most violent manner In such a case, the assailant, a bird for example, thinks it is dealing with a dead thing instead of a food animal, and gives up the attack Insects such as these, which feign death, usually resemble very closely some inanimate object, such as a piece of wood or a twig The stick-insects provide the best known examples of this

As was mentioned at the beginning, the sense of touch often serves to prevent an animal dashing itself against hard objects when moving from place to place The whirligig beetle, *Gyrinus*, which we see skimming rapidly to and fro over the surface of the water in summer, bears eloquent witness to the degree of sensitiveness attained The careful observer will soon perceive that these lively little creatures never collide with any object which may be floating on the surface of the water; they also do not run against one another, although, often, many may be skimming about in a restricted space The sense organs which render this possible are situated in the feelers, as Eggers has proved. The antennary flagella are borne free in the air; their amputation does not cause alterations in the animal's conduct. On the other hand, the second basal joint rests on the water like a float (fig. 3). It contains numerous sensory cells, bearing stylets, which are

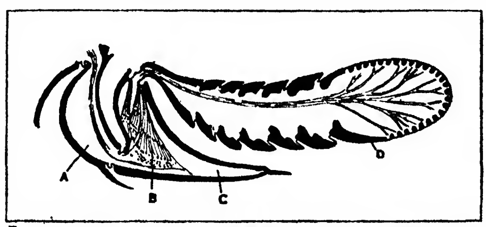


FIG 3.—ANTENNA OF WHIRLIGIG BEETLE. (A AND C) BASAL JOINTS OF ANTENNA, (B) JOHNSTON'S ORGAN, (D) ANTENNARY FLAGELLUM

grouped together in "Johnston's organ" With the assistance of these the animal perceives in some way the proximity of solid objects; it may, perhaps, react to the waves of water reflected to it by these objects.

Among vertebrates, bats are able to perform a, perhaps, even greater feat. As was known already to the naturalists of the 18th century, even blind bats are able to avoid all obstacles which may be placed in their path

An opposite condition to that discussed hitherto prevails in not a few cases in which the animal seeks to establish contact with a solid object, and is uneasy if it cannot do so This phenomenon has been given a special name, and is known as "thigmotropism." In most animals the soles of the feet are usually placed in constant contact with solid bodies The vigorous attempts at "righting" which are made by almost every animal if it falls upon its back, until it regains its feet once more, are due, in many cases, to the effort to bring the feet again into contact with solid bodies This may be seen particularly well in insects If we put a caterpillar upon its back it immediately rights itself If, however, we place between its feet a twig to which it can adhere, it remains peacefully upon its back, and even eats in this position. The following experiment is easily carried out, and shows this every clearly. A thread is gummed firmly on to the back of a fly, and is then attached to a stand, the feet of the insect being allowed to hang down free. If, now, a small ball of paper is placed between them, the fly begins at once to run about upon it.

The normal running movement, therefore, follows contact of the feet with the solid object. In leeches, contact stimuli are of particular importance in locomotion Uexkuell showed that in these animals a quite definite co-ordination exists between the action of the suckers and the contraction of the muscles of the body When the leech is adhering by means of its posterior sucker, it stretches out its body at full length, searching thus for a suitable surface on which to fasten its anterior sucker When the anterior sucker is attached, the posterior sucker relaxes its hold, and immediately a reflex contraction of the longitudinal muscles of the body takes place Both phases, taken together, give rise to the characteristic looping motion of the leech (*See* fig. 4) If, however, we throw the leech into water without giving

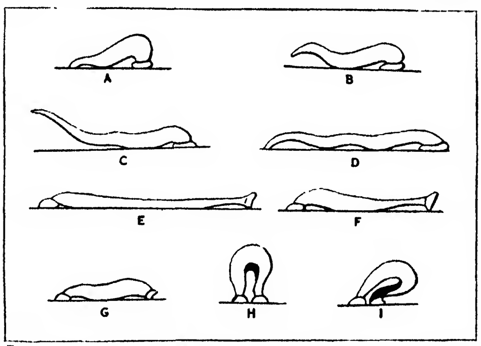


FIG. 4—CRAWLING MOVEMENT OF A LEECH. (A–D) POSTERIOR SUCKER IS ATTACHED, AND THE WORM EXTENDED; (E–G) ANTERIOR SUCKER IS ATTACHED, POSTERIOR IS FREE, ANIMAL IS CONTRACTED, (H–I) RE-ATTACHMENT OF THE POSTERIOR SUCKER

it an opportunity of attaching itself by one of its two suckers, swimming movements at once take place

Thigmotropism, however, appears also in quite another form. It was thought at first that many animals which are in the habit of dwelling in narrow tubes (such as many worms), or in crevices in wood, or under bark are led to seek out their hiding places through an aversion to light The truth of the matter is that such an animal feels comfortable only if its body is in contact, as much as possible, on all sides, with solid surfaces. Thigmotropic worms will also creep into glass tubes, and some insects hide between glass slides, in spite of being fully exposed to daylight when in these retreats. Under natural conditions, the thigmotropic animal thus avoids the covetous eyes of its enemies, since in nature there are no transparent solid objects.

Sensitiveness to mechanical stimuli has a very important use in the sense which in higher animals makes them aware of the relative position of the parts of the body. To the majority of human beings it certainly appears quite as a matter of course that they are able to take hold of their noses with their hands Science teaches, however, that this is possible only through stimulation of numerous sensory cells in the skin, which are pulled or pressed when the arm or the hand is moved If the skin is narcotized, the power of touching any particular part of the body is lost

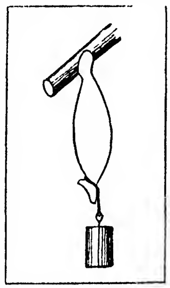


FIG 5—LEECH SUPPORTING WEIGHT (AFTER CAHNHEIM AND UERKÜLL)

It is of interest that some of the lower animals, particularly arthropods, possess a similar sense Insects and Crustacea show this in the very vigorous way in which they clean the limbs and the body, making use of legs specialized for this purpose The precision with which the decapod Crustacea, after moulting, place fresh statoliths in their statocysts is astonishing (*See* also HEARING) They seize grains of sand, or similar material in their delicate pincers, and are able to introduce them into the statocyst through its minute opening.

As regards the lower animals, we do not yet know anything for certain about the localization of the sensory cells which function in these movements In Crustacea, this faculty is distributed apparently among sensory hairs in the region of the joints, in insects we know that there are free nerve endings in the skin of the joints

To the mechanical sense belongs also the sense of "strength" When a man lifts a weight, he notices exactly if it is heavy or light, and, according to this sensation, he regulates the amount of energy to be expended The leech shows that a similar sense is present also in the lower animals. It has been mentioned already that this animal contracts when the anterior sucker is attached and the posterior sucker is free When the animal is in this position we can force it to lift fairly heavy weights, which, under certain circumstances, it will support for hours together (*See* fig 5) If we cautiously hold up the weight with one hand, the worm experiences a sensation of considerable relief, and alters the impulse it sends to its muscles This is clearly proved by the fact that, as soon as we withdraw our hand again, the worm is drawn out by the weight which it formerly had supported

Stimulation of the Nervous System by Mechanical Influences.—Every organism, in order to be able to move vigorously, requires constant stimulation from without. To man this statement does not appear very credible, but it can occasionally be proved quite clearly in the lower animals. In the article on HEARING, we have described the statocysts of the lower organisms, which usually act as balancing organs It has been generally proved by experience, that the animals fall into an enduring state of debility after these statocysts have been removed by an operation. They are no longer able to make powerful movements; we can express mathematically the amount of diminution in the gripping power of the chelae of a crustacean caused by the removal of the statocyst It is not yet determined for certain how this connection between the statocysts and the muscular strength is to be explained Apparently, the mechanical stimulation of the sensory cells of the statocyst by the statoliths affects the central nervous system of the animal, thus, as we may say, rousing it into activity in a somewhat similar manner to that in which coffee stimulates a tired man.

Flies furnish a particularly remarkable instance of this. In these insects, the posterior wings are transformed into oscillating clubs or "halteres," which, during flight, move simultaneously with the wings, with great rapidity (figs. 6a, 6b). If these

clubs are removed or stuck down firmly, the insect is no longer capable of flight. It can neither rise from the ground nor maintain itself in the air. It appears from this that the active movement of the halteres is essential. Formerly, it was thought that the halteres were a kind of balancing organs, and it was believed that the fly lost its power of balance after they had been removed. This, however, is excluded by the extremely minute size of the halteres. Now, however, numerous sensory cells affected by mechanical stimuli have been found on the basis of the halteres. These are so arranged that they must be vigorously stimulated by the movement of the halteres, which, apparently, has this stimulation as its object. We may assume that this affects the nervous system of the fly in a similar way as stimulation of the statocyst affects crustaceans. The fly is able to send the necessary impulses to the muscles of flight only if this constant stimulation is present.

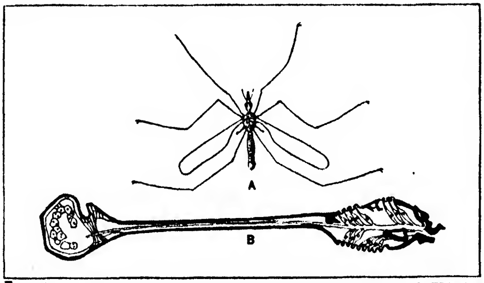


FIG. 6.—(A) TEPULA, A FLY (DADDY-LONG-LEGS) SHOWING HALTERES; (B) LONGITUDINAL SECTION THROUGH A HALTERE, SHOWING SENSE ORGAN AT THE BASE (AFTER PFLUGSTEDT)

Wille has recently discovered a similar, and, considered as a whole, certainly still very problematical contrivance in the Brazilian locust, *Rhipipterix chopardi*. This insect bears sense organs on the under side of its hind legs; if these are put out of action by being stuck down, the insect is prevented from springing and flying.

Structure of Tactile Organs.—There is not very much to be said on the subject of the anatomy of the sensory cells which serve for the transmission of mechanical stimuli. It has been mentioned already that, even among unicellular animals (infusoria) tactile cilia are occasionally to be found. (*See* fig. 1.) In multicellular animals there are frequently found, projecting from the surface of the body, groups of cells bearing small hairs like cilia, which are usually considered to be tactile organs (fig. 7 and 8). Several of these organs from the skin of different kinds of Echinoderms are shown in fig. 7. In fig. 8 is represented a "sensilla" from the skin of the leech. In yet other cases we find what are called free nerve-endings (fig. 9), the nerve cells, which are deeply situated beneath the skin, sending one or many fine processes up to the outer surface. Unfortunately, in no case can it be proved definitely that the groups of sensory cells mentioned really serve for the perception of mechanical stimuli. The only way in which this might be determined, namely by removing the organs by an operation and experimenting with the animals thus treated, is not practicable, owing to the large number of the organs, which usually are distributed over the whole surface of the skin. This difficulty of proof occurs also when dealing with arthropods, in which the tactile organs exhibit an astonishing diversity. The rule that the cuticle is particularly thin where the sensory cells are situated (*see* fig. 10) applies to all these creatures (insects, crustaceans, spiders). When a sensory cell is quite separated from the exterior by a layer of chitin, it is impossible that it can perceive chemical stimuli, and we may assume, with some degree of probability, that it is an organ for the perception of mechanical stimuli.

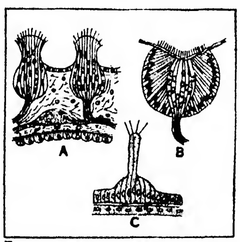


FIG. 7.—EPITHELIAL SENSE-ORGANS OF ECHINODERMS

(A) Ophuroid, transverse section through the wall of an ambulacral foot; (B) Sea-cucumber, epithelial sense-organ from a tentacle; (C) Sensory papilla from an ambulacral foot of a feather-star

Among Crustacea the most general form in which these occur is the sensory hair; in insects we find in addition sensory cones (fig. 10 B), sensory pits (10 C), cup-shaped sense organs (fig. 10 D), and so forth. In insects only there is found also a particular kind of sense organ, the chordotonal organs. In form they are like a cord stretched between two flat surfaces of the body wall, and, doubtless, function when these surfaces are displaced in any way. The following parts may be distinguished in them:—the sensory cell with the proximal enveloping cell, the distal enveloping cell (cap cell) which connects the peculiar stylet (scolopala) with the hypodermis, and, lastly, the ligament which spans the whole apparatus. Such organs are found singly or in groups on the body and extremities of insects. The organs which most resemble them are "Johnston's organs" in the feelers. (*See* fig. 4.)

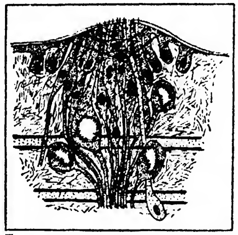


FIG. 8.—SENSILLA FROM THE SKIN OF A LEECH WITH OPTIC CELLS, AND APPARENTLY TACTILE CELLS (AFTER HACHLOFF)

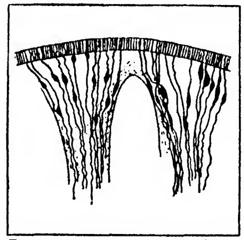


FIG. 9.—ANTERIOR END OF A SHORT HORN OF A SLUG (ARION), SHOWING FREE NERVE ENDINGS (AFTER RETZIUS)

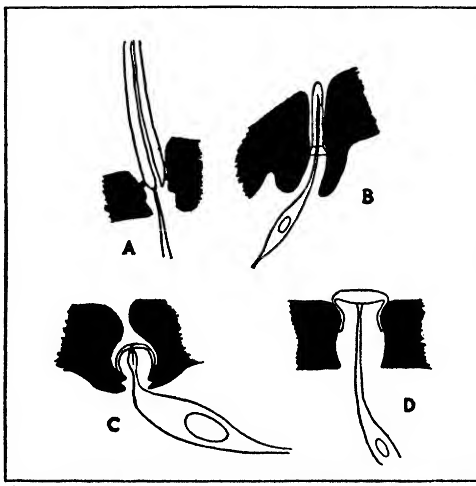


FIG. 10.—FOUR DIFFERENT KINDS OF TACTILE ORGANS FROM THE WATER-BEETLE (AFTER HOCHREUTHER)

In the auditory organs of insects the chordotonal organs certainly receive the sound waves; what purpose they serve in Johnston's organ, or in the simpler organs, is not yet known.

The Sense of Temperature.—Since heat, as is well known, consists in a mechanical vibration of molecules, the sense of tem-

perature, also, must be included in the mechanical sense It goes without saying that the higher animals possess a sense of temperature which is very similar to that of human beings. It is of greater interest to prove its presence in the lower animals. The simplest method of deciding whether an animal reacts to heat stimuli is by the use of the temperature organ. This consists of a narrow box, about a meter in length, the bottom of which is

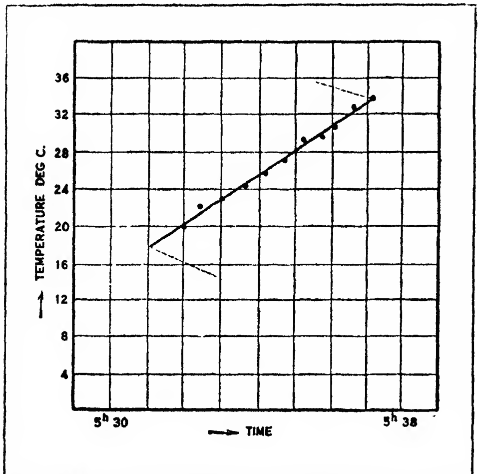


FIG 11.—RISING OF THE TEMPERATURE OF THE BODY OF A MOTH DURING VIBRATORY MOVEMENTS OF THE WINGS (AFTER DOTTERWEICH)

heated at one end, and, at the other, is cooled with ice. If a number of small animals, such as ants, are placed in the box, they avoid both the hot and the cold ends, and seek for a part in which a temperature prevails which suits them best.

Bees furnish a very fine example of an extraordinarily developed temperature sense. During the time when the eggs are hatching, they keep the interior of the hive at a very constant temperature of 35° (Hess, Himmer). The observed variations often lie within half a degree, that is to say, bees regulate the warmth of the hive just as exactly as mammals regulate the temperature of the blood

It goes without saying that they must possess sensory cells by means of which they perceive heat They raise the temperature of the hive apparently by muscular movements, over-heating they counteract by carrying in water and allowing it to evaporate

Nocturnal Lepidoptera regulate the temperature of the body before flying. As a result of the heat produced by muscular activity, they attain, during flight, a temperature of about 36–40° Before they fly off, they make very rapid, vibratory movements with their wings, buzzing or whirring This, as Dotterweich has recently proved, is simply to raise the temperature of the body As soon as the flight temperature is reached, they fly off. Fig. 11 represents, graphically, the raising of the body temperature during this vibration.

Very little is known, up to the present time, of heat perception in the rest of the Invertebrata. (W. v. BUD)

For the sensory function of touch in man *see* SKIN, SENSORY FUNCTIONS OF

TOUCH-ME-NOT (*Impatiens Noli-tangere*), a plant so called from the fact that the fruits are extremely explosive, the valves rolling up inwards and scattering the seeds when touched. The genus *Impatiens* (family Balsaminaceae) includes about 340 species, found in tropical and north temperate regions, and especially abundant in the mountains of India and Ceylon. Many are cultivated ornamental flowers. (*See* IMPATIENS.)

TOUL, a garrison town of north-eastern France, in the department of Meurthe-et-Moselle, 21 m. W. of Nancy on the Eastern railway. Pop. (1926) 10,113. Toul (*Tullum*) was originally capital of the Leuci, in the Belgic Confederation, and acquired great importance under the Romans. It was evangelized by St. Mansuy in the 4th century, and became one of the leading sees of north-east Gaul. After being sacked successively by Goths, Burgundians, Vandals and Huns, Toul was conquered by the Franks in 450 Under the Merovingians it was governed by counts, assisted by elective officers. The bishops became sovereign counts in the 10th century, holding only of the emperor, and for 300 years (13th to 16th centuries) the citizens maintained a long struggle against them. Together with Verdun and Metz, the town and its domain formed the territory of the Trois-Evêchés Toul was forced to yield for a time to the count of Vaudémont in the 12th century, and twice to the duke of Lorraine in the 15th Charles V. made a solemn entry into the town in 1544, but in 1545 it placed itself under the perpetual protection of the kings of France. Henry II. took possession of the Trois-Evêchés in 1552, but the territory was not officially incorporated with France till 1648 Henry IV was received in state in 1603, and in 1637 the parlement of Metz was transferred to Toul In 1700 Vauban rebuilt the fortifications of the town. In 1790 the bishopric was suppressed and the diocese united to that of Nancy. Toul capitulated in 1870.

The church of St. Étienne, which was formerly a cathedral, has a choir and transept of the 13th century; the nave and aisles are of the 14th, and the fine façade of the last half of the 15th There are two western towers. The two large lateral chapels of the nave are in the Renaissance style. South of the church there is a fine cloister of the end of the 13th century which was much damaged at the Revolution. The church of St. Gengoult, chiefly late 13th or early 14th century, has a façade of the 15th century and a 16th century cloister in Flamboyant Gothic. The *hôtel-de-ville* occupies a building of the 18th century, once the episcopal palace Toul is the seat of a sub-prefect The industries include the manufacture of porcelain, trade is in wine and brandy.

TOULON, a seaport and first-class fortress and naval station of France, department of Var, capital of the arrondissement of Toulon, on the Mediterranean, 42 m. E.S E. of Marseilles. Pop. (1926) 92,759. The Roman Telo Martius is supposed to have stood near the *lazaretto*. The town was successively sacked by Goths, Burgundians, Franks and Saracens. Until conquered by Charles of Anjou in 1259, it was under lords of its own, and entered into alliance with the republics of Marseilles and Arles. St Louis, and especially Louis XII and Francis I. strengthened its fortifications It was seized by the emperor Charles V. in 1524 and 1536. Henry IV. founded there a naval arsenal which was further strengthened by Richelieu, and Vauban made the new dock, a new enceinte, and several forts and batteries. In 1792 the royalists of the town sought the support of the English and Spanish fleets cruising in the neighbourhood. The Convention having replied by putting the town *hors la loi*, the inhabitants opened their harbour to the English. The army of the republic now (1793) laid siege to the town, and on this occasion Napoleon Bonaparte first made his name as a soldier. The forts commanding the town having been taken, the English ships retired after setting fire to the arsenal. Under the Directory Toulon became the most important French military fort on the Mediterranean; here Napoleon organized the Egyptian campaign.

The bay, which opens to the east, has two divisions, the Grande Rade and the Petite Rade; it is sheltered on the north and west by high hills, closed on the south by the peninsula of capes Sicié and Cépet, and protected on the east by a huge breakwater. The forts of St Marguerite, of Cap Brun, of Lamalgue and of St Louis to the north, and the battery of the signal station to the south, the battery of Le Salut to the east, and the forts of Balaguier and L'Aiguillette to the west protect the entrance. The bay of La Seyne lies west of the Petite Rade, and is defended by the forts of Six-Fours, Napoléon (formerly Ft. Caire), and Malbousquet, and the batteries of Les Arènes and Les Gaus. To the north of Toulon rise the defensive works of Mt. Faron and Ft. Rouge, to the east the forts of Artigues and St. Catherine, to the north-east the formidable fort of Coudon, and to the south-east that of Colle Noire, respectively dominating the highway into Italy and

the valley of Hyères with the Bay of Carqueiranne. The modern quarter lies to the north of the old town. The chief buildings are the former cathedral of St. Marie Majeure (from the 5th century Toulon was a bishop's see till 1801, when it was annexed to that of Fréjus), the church of St. Louis, the naval and military hospital, a naval school of medicine, a school of hydrography, and large barracks The imports are corn, wood, coal, hemp and salt provisions; the exports are salt, figs, raisins, almonds, oranges, cloth, bauxite ore, cork, soap and oils The principal industries, apart from the arsenal, are shipbuilding, fishing and wine-growing The interesting buildings and gardens of the hospital of St Mandrier stand on the peninsula of Cape Cépet, and near them is the *lazaretto*. Toulon is the seat of a sub-prefect, of a chamber of commerce, a board of trade-arbitrators and of a permanent maritime tribunal

Toulon is the most important of the French dockyards, and is the headquarters of the Mediterranean fleet The arsenal, which was created by Louis XIV.—Vauban being the engineer of the works—lies on the north side of the Petite Rade This is approached from the Grande Rade by passages at the north and south ends of a long breakwater which extends from the direction of Le Mourillon towards the Cépet peninsula Outside in the Petite Rade is a splendid protected anchorage for a great fleet, the whole being commanded by many forts and batteries There are four great basins (*darses*) approached from the Petite Rade—the Vieille Darse, to the east, on the side of Le Mourillon; the Darse Vauban, next to it; and the Darse de Castigneau and the Darse Missiessy, farther to the west Shipbuilding and its accessory trades are carried on at Toulon (H J F)

The Battle of Toulon.—This battle was fought off the port from which it takes its name on February 11, 1744 An allied Franco-Spanish fleet of 28 ships was in harbour, commanded by M de Court, and was being watched by a British fleet of similar size under Admiral Mathews England and Spain had been at war since 1739, but England and France, though on opposite sides, had not yet actually declared war on one another Spain was employed at this time in sending troops to North Italy for an attack on Austria's Italian possessions, and France was helping her by placing Toulon at her disposal as a base from which to operate, and also by providing about two-thirds of this fleet which was to convoy them In these circumstances, as it was his business to prevent the despatch of these troops, Mathews felt he would be justified in attacking the French as well as the Spaniards, should the former's proffered assistance with their Mediterranean fleet materialize. The combined fleet put out of Toulon on February 9, and to Mathews' surprise, made off on a southerly course If he were to follow them, he would uncover Toulon and the transports would slip out, on the other hand, if he waited for the transports, the enemy's fleet would not be brought to action. The English admiral decided in these circumstances to go after the fleet and bring it to action quickly, at any cost, and by any means, and then to double back and intercept the escaping transports. Consequently he dashed after the enemy. He himself was commanding the centre Lestock, the second-in-command, the rear, and Rowley the van.

Misunderstood Plan.—According to the fighting instructions of the day, it was Mathews' duty first, if possible, to obtain the windward position. This he did. Then, before he bore down on the enemy to what distance he considered suitable, he was so to arrange his line that the ends would be conterminous with those of the enemy, so that, when parallel battle was finally joined, each ship would be opposed to the corresponding ship in the enemy's line Clearly, however, Mathews' plan was hardly compatible with such instructions. If he was to wait until his whole line was covering the allies before attacking, he was the less likely to be back off Toulon in time to deal with the transports. Consequently, when Rowley's squadron was opposite the allied centre, and his own opposite the allied rear, Mathews signalled the attack. He was further influenced to this course by the fact that the British rear was far behind and to the east, owing, so its commander said, to variable breezes and adverse currents; in this connection, however, it must be noted that there was bad blood between Lestock and Mathews, the former was sullen, and the latter not without grave defects of temper—he was "Il Furibundo" to the Italians. Previously to the attack, Mathews had been flying the signal for the line—obviously applicable to Lestock—but when the commander-in-chief flew also the signal for battle, clearly meaning that Lestock should come up and take on the unengaged allied van before it should get about to assist the centre and rear, the second-in-command hove to and did nothing, on the grounds that Mathews was already filling his place opposite the enemy's rear and that consequently there was nothing for him to do His action can scarcely be justified except on technical grounds

Confusion of Signals.—The remainder of the British fleet was also puzzled at being ordered to attack before the whole enemy line was covered, and in this connection it must be remembered that Mathews had at his disposal no signals other than those ordering the movements laid down in the fighting instructions, and no means of conveying to his subordinates his decision that, on this occasion, these instructions did not apply. The centre bore down on the enemy eventually, but in considerable confusion Some of Rowley's squadron also attacked, but they were nervous of being doubled by the unoccupied allied van, and the leading ships correctly beat to windward to prevent this Eventually M de Court, realizing that the Spaniards who formed his rear were hard pressed, ordered his whole fleet about, and as the fresh ships came into action, Mathews broke off the battle The only prize was the *Poder*, taken by Captain Hawke

Verdicts of Courts-martial.—A record number of courts-martial followed, and it is impossible to deal with them all here Lestock was acquitted on the technical grounds indicated above, but Mathews was sentenced to dismissal from the service He had, with such ships as supported him properly, fought energetically; he had dispersed the Spanish squadron of the allied fleet, he had forced the enemy into Barcelona, and even resumed his work off Toulon He was dismissed because, in trying to force a decision in difficult circumstances, he had trespassed against the fighting instructions of his day

Bibliography.—J. S. Corbett, *Fighting Instructions*, Navy Records Society (1905), H W. Richmond, *The Navy in the War of 1739–48* (1920) (G. A. R. C.; J. G. B)

TOULOUSE, a city of south-western France, capital of the department of Haute-Garonne, 443 m S by W. of Paris by the Orléans railway, and 159 m S E of Bordeaux by the Southern railway Pop (1926), 152,580 Toulouse stands on the right bank of the Garonne, which here describes a curve round which the city extends in the form of a crescent On the left bank is the low-lying suburb of St Cyprien The river is spanned by three bridges—that of St Pierre to the north, that of St. Michel to the south, and the Pont Neuf in the centre; the last, a fine structure of seven arches. East and north of the city runs the Canal du Midi, which here joins the lateral canal of the Garonne

The church of St. Sernin or Saturnin, whom legend represents as the first preacher of the gospel in Toulouse, where he was perhaps martyred about the middle of the 3rd century, has an 11th century choir, and is the largest Romanesque basilica in existence, being 375 ft from east to west and 210 ft in extreme breadth The nave (12th and 13th centuries) has double aisles The choir (11th and 12th centuries) ends in an apse, or rather chevet, surrounded by a range of columns, marking off an aisle, which in its turn opens into five chapels Against the northern wall is an ancient *table d'autel,* which an 11th century inscription declares to have belonged to St Sernin. In the crypts are many relics, which, however, were robbed of their gold and silver shrines during the Revolution On the south there is a fine outer porch in the Renaissance style. The church was restored in the 19th century. The cathedral, dedicated to St. Stephen, has an 11th century nave and a 13th century choir, restored, the axis of which is not in a line with that of the nave. It is surrounded by 17 chapels. The western gate is flanked by a huge square tower. Over this gate there is a beautiful 13th century rose-window. The city contains other interesting old churches

The principal secular buildings are the capitole, with a long

Ionic façade built 1750–60, and the museum. The law courts stand on the site of the old Château Narbonais, once the residence of the counts of Toulouse and later the seat of the parlement of Toulouse Toulouse is singularly rich in mansions of the 16th and 17th centuries, notably the Hôtel Bernuy, a fine Renaissance building and the Hôtel d'Assézat of the same period. The Maison de Pierre has an elaborate stone façade of 1612

Toulouse is the seat of an archbishopric, of a court of appeal, a court of assizes and of a prefect. It is also the headquarters of the XVII army corps and centre of an educational division (*académie*) There are tribunals of first instance and of commerce, a board of trade-arbitrators and a chamber of commerce The educational institutions include faculties of law, medicine and pharmacy, science and letters, a Catholic institute with faculties of theology and letters, schools of veterinary science, fine arts and industrial sciences and music, and an agricultural institute Toulouse, the principal commercial and industrial centre of Languedoc, has important markets for horses, wine, grain, flowers, leather, oil and farm produce Its numerous industrial establishments include the national tobacco factory.

History.—Tolosa does not seem to have been a place of great importance during the early centuries of the Roman rule in Gaul, though in 106 B C the pillage of its temple by Q S Cepio, afterwards routed by the Cimbri, gave rise to the famous Latin proverb *habet aurum Tolosanum,* in allusion to ill-gotten gains It possessed a circus and an amphitheatre, but its most remarkable remains are to be found on the heights of Old Toulouse (*vetus Tolosa*) some 6 or 7 m to the east, where huge accumulations of broken pottery and fragments of an old earthen wall mark the site of an ancient settlement The numerous coins that have been discovered on the same spot do not date back farther than the 2nd century B C, and seem to indicate the position of a Roman trading centre then beginning to occupy the Gallic hill-fortress that, in earlier days, had been the stronghold of the native tribes dwelling on the river bank Tolosa does not seem to have been a Roman colony; but its importance must have increased greatly towards the middle of the 4th century It is entered in more than one itinerary dating from about this time, and Ausonius alludes to it in terms implying that it then had a large population. In 419 it was made the capital of his kingdom by Wallia, king of the Visigoths, and under his successors it was the centre of the great Visigothic kingdom On the defeat of Alaric II. (507) Toulouse fell into the hands of Clovis, who carried away the royal treasures Under the rule of the Merovingian kings Toulouse seems to have remained the greatest city of southern Gaul It figures prominently in the pages of Gregory of Tours and Sidonius Apollinaris About 628 Dagobert erected South Aquitaine into a kingdom for his brother Charibert, who chose Toulouse as his capital For the next 80 years its history is obscure, till we reach the days of Charles Martel, when it was besieged by Sema the leader of the Saracens from Spain (*c* 715–720), but delivered by Eudes, "princeps Aquitaniae" Its real history recommences in 780 or 781, when Charlemagne appointed his little son Louis king of Aquitaine, with Toulouse for his chief city

During the minority of the young king his tutor Chorson ruled at Toulouse with the title of duke or count. Being deposed at the Council of Worms (790), he was succeeded by William Courtnez, the traditional hero of southern France, who in 806 retired to his newly founded monastery at Gellone, where he died in 812 In the troubles of the century Toulouse suffered in common with the rest of western Europe It was besieged by Charles the Bald in 844, and taken four years later by the Normans, who in 848 had sailed up the Garonne as far as its walls About 852 Raymond I., count of Quercy, succeeded his brother Fridolo as count of Rouergue and Toulouse, it is from this noble that all the later counts of Toulouse trace their descent

Dating from the 11th century the counts of Toulouse were the greatest lords in southern France. Raymond IV, the crusader, assumed the formal titles of marquis of Provence, duke of Narbonne and count of Toulouse While Raymond was away in the Holy Land, Toulouse was seized by William IX., duke of Aquitaine, who claimed the city in right of his wife Philippa, the daughter of William IV., but was unable to hold it long (1098–1100). The rule of Raymond's son and successor Bertrand, also a crusader, was disturbed by the ambition of William IX and his grand-daughter Eleanor, who prevailed upon her husband Louis VII to support her claims to Toulouse by war. On her divorce from Louis and her marriage with Henry II, Eleanor's claims passed on to this monarch, who at last forced Raymond V to do him homage for Toulouse Raymond V., the patron of the troubadours, died in 1194, and was succeeded by his son Raymond VI, under whose rule Languedoc was desolated by the crusaders of Simon de Montfort, who occupied Toulouse in 1215, but lost his life in besieging the city in 1218 Raymond VII, the son of Raymond VI and Joan of England, succeeded his father in 1222, and died in 1249, leaving an only daughter Joan, married to Alfonso the brother of Louis IX On the death of Alfonso and Joan in 1271 the vast inheritance of the counts of Toulouse lapsed to the Crown From the middle of the 12th century the people of Toulouse seem to have begun to free themselves from the most oppressive feudal dues An act of Alphonse Jourdain (1141) exempts them from the tax on salt and wine; and in 1152 we have traces of a "commune consilium Tolosae" making police ordinances in its own name "with the advice of Lord Raymond, count of Toulouse, duke of Narbonne, and marquis of Provence"

The parlement of Toulouse was established in 1443 and was for Languedoc and southern France what the parlement of Paris was for the north During the religious wars of the 16th century the Protestants of the town made two unsuccessful attempts to hand it over to the prince de Condé After St Bartholomew's Day (1572) 300 of the party were massacred Towards the end of the 16th century, during the wars of the League, the parlement was split up into three different sections, sitting respectively at Carcassonne or Béziers, at Castle Sarrasin and at Toulouse The three were reunited in 1596. Under Francis I it began to persecute heretics, and in 1619 rendered itself notorious by burning the philosopher Vanini. The University of Toulouse owes its origin to the action of Gregory IX, who in 1229 bound Raymond VII to maintain four masters to teach theology and eight others for canon law, grammar and the liberal arts Civil law and medicine were taught only a few years later The famous "Floral Games" of Toulouse, in which the poets of Languedoc contended (May 1–3) for the prize of the golden amaranth and other gold or silver flowers, given at the expense of the city, were instituted in 1323–24 The *Académie des Jeux Floraux* still awards these prizes for compositions in poetry and prose

See L Ariste and L Brand, *Histoire populaire de Toulouse depuis les origines jusqu'à ce jour* (Toulouse, 1898). (X.)

Battle of Toulouse, 1814.—Marshal Soult, retreating eastwards after a series of defeats (*see* PENINSULAR WAR), took shelter within the defences of Toulouse The town lies on the right (east) bank of the Garonne, with a suburb, St. Cyprien, in the re-entrant angle on the left bank In 1814 it was surrounded by fortified walls, St. Cyprien having also an outer line of earthworks On the right bank the defences were (1) the walls; (2) the Languedoc canal, which covers the north and east sides, (3) the ridge of Calvinet, east of the canal; (4) the river Hers, east of Calvinet and about two miles distant from the town Wellington's plan was for Beresford's corps to attack the southern end of Calvinet ridge by way of the Caraman and Lavaur roads, while Freire's Spaniards advanced down the Albi road, captured the outlying Pujade hill, and attacked the Great Redoubt at the northern end of the ridge; to keep the defenders fully employed Hill was to demonstrate against St. Cyprien on the left bank, and Picton and Alten's Light Division against the northern defences of the town Soult's dispositions were as follows: Maransin's division held St. Cyprien; Travot's division occupied the ramparts and the eastern stretch of the canal; Darricau's division was along its northern stretch from the Albi road to the Garonne On the Calvinet ridge, Taupin was responsible for the southern end, including the La Sypière redoubts, Harpisse for Mas des Augustins, Villatte for the Great Redoubt, while Darmagnac covered the Albi road Each army numbered something under 40,000; but it must be remembered that the French *moral* at this

time was at a very low ebb. At 9 A.M. on April 10, 1814, Hill attacked St. Cyprien and during the course of the morning occupied the outer line of defences; the 3rd and Light Divisions closed up to the northern stretch of the canal and Freire gained the Pujade hill with little opposition. Wellington's plan necessitated Beresford's marching southwards three miles up the valley of the Hers, straight across the enemy's front and under direct fire of his guns The going was so heavy that it was noon before he reached the Caraman road, his men nearly exhausted and his guns stuck in the mud miles behind In spite of this he formed his corps for the attack, 6th Division on the right, 4th on the left, each in three lines. Meanwhile Freire, impatient for glory, launched a premature attack down the Albi road. After some initial success he was counter-attacked by Darmagnac and driven back with severe losses Beresford now began his advance and quickly drove Taupin's division from La Sypière, but reinforcements from the town enabled the French to form a new line in front of the canal, connecting with Mas des Augustins. Beresford paused to rest his men and wait for his guns, whereupon Picton, contrary to orders, hurled his division against the fortified canal bridges near the Garonne, and was repulsed with heavy loss Wellington now ordered Beresford and Freire to renew their attacks upon the Calvinet redoubts Freire was again repulsed, but the 6th Division, after heavy and fluctuating fighting, won possession of Mas des Augustins and the neighbouring works Upon this Soult withdrew from the remainder of the ridge and when night fell the French were behind the canal, except for two bridgeheads at its southern end Wellington spent the 11th bringing up ammunition supplies, but during that night Soult, fearful of being shut up in Toulouse, evacuated the town and took the road for Carcasonne The Allies lost 4,400 men, 1,800 being Spaniards, the French little more than 2,000 Vain losses, for Napoleon had abdicated a week previously (H L A -F.)

TOUNGOO or TAUNG-NGU, a town and district in the Tenasserim division of Burma The town is situated on the right bank of the river Sittang, 166 m N of Rangoon by rail Pop (1921) 19,332. From the 14th to the 16th century Toungoo was the capital of an independent kingdom The district has an area of 6,135 sq m., pop (1921), 381,883 The main Rangoon-Mandalay railway is the chief means of communication The rainfall is between 60 and 90 inches. Rice is the staple crop; there are some plantations of rubber Forests cover more than 5,000 sq m, of which large areas have been reserved, yielding a large revenue

TOURACOU, the name of certain birds belonging to the plantain eaters (*Musophagidae*) The term is often extended to cover the whole family, which is exclusively African.

The plantain-eaters proper comprise the genus *Musophaga* They are birds the size of a crow, with the horny base of the bill prolonged backwards over the forehead The plumage is purple, with the top of the head and primaries deep crimson and, in *M. violaca*, a white eye-streak

The Touracous number some 15 species The white-crested Touracou (*Turacus albicristatus*) inhabits Cape Colony and Natal *T persa*, from Guinea, is distinguished from the last by the purple, instead of green, wing coverts and tail The slate-brown grey Touracou (*Schizorrhis concolor*) inhabits Natal.

TOURAINE, a French province, bounded on the north by Orléanais, west by Anjou and Maine, south by Poitou and east by Berry, and corresponding approximately to the modern department of Indre-et-Loire. Touraine took its name from the *Turones,* the tribe by which it was inhabited at the time of Caesar's conquest of Gaul The capital city, Caesarodunum, was made by Valentinian the metropolis of the 3rd Lyonnaise, which included roughly the later provinces of Touraine, Brittany, Maine and Anjou The ecclesiastical province of Tours was apparently created during the episcopate of St. Martin (*fl.* 375–400), who founded the abbey of Marmoutier, near Tours, and whose tomb in the city became a celebrated shrine. Tours was included in the territory of the Visigoths, but the Tourangeans refused to adopt the Arian heresy of their conquerors, and easily accepted the conquest of the province by Clovis (*c.* 507). The possession of Touraine was constantly in dispute between different Merovingian princes, and the province enjoyed no settled peace until the reign of Charlemagne. He established Alcuin as abbot of St Martin of Tours, under whom the school of Tours became one of the chief seats of learning in Gaul From Merovingian times, the administration of Touraine was entrusted to counts appointed by the Crown. The office became hereditary in 940 or 941 with Theobald the Old. His son Odo I was attacked by Fulk the Black, count of Anjou, and despoiled of part of his territory. His grandson Theobald III, who refused homage to Henry I, king of France, in 1044, was entirely dispossessed by Geoffrey Martel of Anjou (d. 1060) and the county of Touraine remained under the domination of the counts of Anjou (*q v*) until 1204 Philip Augustus appointed William des Roches hereditary seneschal in 1204, but the dignity was ceded to the Crown in 1312 Touraine was granted from time to time to princes of the blood as an appanage of the Crown of France In 1328 it was held by Jeanne of Burgundy, queen of France, by Philip, duke of Orleans, in 1344, and in 1360 it was made a peerage duchy on behalf of Philip the Bold, afterwards duke of Burgundy Charles VII. bestowed the duchy successively on his wife Mary of Anjou, on Archibald Douglas and on Louis III of Anjou It was the dower of Mary Stuart as the widow of Francis II The last duke of Touraine was Francis, duke of Alençon (d 1584) Plessis-les-Tours had been the favourite residence of Louis XI, who granted many privileges to the town of Tours, and increased its prosperity by the establishment of the silk-weaving industry The reformed religion numbered many adherents in Touraine, who suffered in the massacres following on the conspiracy of Amboise Many Huguenots emigrated after the massacre of St. Bartholomew, and after the revocation of the Edict of Nantes the silk industry, which had been mainly in the hands of the Huguenots, was almost destroyed This migration was one of the prime causes of the extreme poverty of the province in the next century

See the quarterly publication of the *Mémoires* of the *Société archéologique de Touraine* (1842, etc) which include a *Dictionnaire géographique, historique et biographique* (6 vols, 1878–84), by J X Carre de Busserolle There are histories of Touraine and its monuments by Chalmel (4 vols 1828), by S Bellanger (1845), by Bourrasse (1858) *See* also Dupin de Saint Andre, *Hist du protestantisme en Touraine* (1885), T. A. Cook, *Old Touraine* (1892)

TOURCOING (tōōr-kwăn), a town of northern France in the department of Nord, less than a mile from the Belgian frontier, and 8 m N N E. of Lille on the railway to Ghent Pop (1926) 79,491 Famed since the 12th century for its woollen manufactures, Tourcoing was fortified by the Flemings in 1477, when Louis XI of France disputed the inheritance of Charles the Bold with Mary of Burgundy but in the same year was taken and pillaged by the French In 1794 the Republican army, under Moreau and Souham, gained a decisive victory there over the Austrians Tourcoing is practically one with Roubaix to the south, being united thereto by a tramway and a branch of the Canal de Roubaix The public institutions comprise a tribunal of commerce, a board of trade arbitrators, a chamber of commerce, an exchange and a conditioning house for textiles Together with Roubaix, Tourcoing ranks as one of the chief textile centres of France. Its chief industry is the combing, spinning and twisting of wool, spinning of cotton and the manufacture of all kinds of woollen, cotton and silk goods, notably carpets. To these industries must be added those of dyeing, the manufacture of hosiery, of textile machinery and of soap

TOURING CAR. A term widely used to describe an automobile of open body type with a folding top, removable side curtains and two fixed seats In the United States (1929), the word "phaeton" seems to be preferred to describe such a body, leaving the name touring car for any automobile used for touring. (*See* PHAETON.)

TOURMALINE, a mineral of interest from several points of view, but of no commercial value, except occasionally when used as a gem-stone. The name is from the Cingalese *toramalli,* brown gem-stones having come from Ceylon early in the 18th century. The mineral is of interest chemically on account of its complex composition, containing, perhaps, a greater variety of chemical elements than any other mineral, and these are present

in very variable proportions. Many attempts have been made to arrive at a general formula to express the composition. The one now generally accepted is that of S L Penfield and H W. Foote (1899), who regarded the several varieties of tourmaline as salts of a hypothetical alumino-borosilicic acid $H_9Al_3(BOH)_2Si_4O_{19}$. Here hydrogen is partly, but not wholly, replaced by aluminium, ferric and ferrous iron, chromium, manganese, magnesium, calcium, sodium, potassium, lithium, etc , and fluorine is usually also present in small amounts Rather than a single species, tourmaline thus represents an extensive series of isomorphous minerals, but the sub-division into species is not practicable According to the predominance of certain elements, a chemical distinction has been made between iron-tourmaline, magnesium-tourmaline and alkali-tourmaline

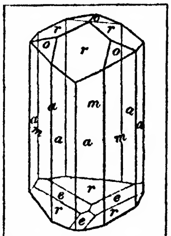


FIG. 1.—CRYSTAL OF TOURMALINE SHOWING HEMIMORPHIC DEVELOPMENT

All crystals of tourmaline belong to the ditrigonal pyramidal (hemimorphic-hemihedral) class of the rhombohedral system, and no variation can be detected in the interfacial angles corresponding with the wide range in chemical composition. The crystals are of interest in showing a different development of faces at the two ends, the vertical trigonal axis, or principal axis, being uniterminal or polar. At the upper end in fig 1 are two trigonal pyramids *r* and *o*, and at the lower end the trigonal pyramids *r* and *e*. The crystals are usually prismatic in habit with one hexagonal prism *a* and a trigonal prism *m*, and between the two there may be several ditrigonal prisms each of six faces All these prism faces are deeply striated or furrowed parallel to the vertical axis, so much so that the cross-section is usually triangular with curving convex sides This characteristic feature enables the mineral to be readily distinguished from others of similar appearance.

Another interesting feature of tourmaline is shown in the pyro-electrical properties, which are intimately related to the hemimorphic or polar development of the crystals mentioned above. When a crystal is slightly warmed, one end becomes charged with positive electricity and the other end acquires a negative charge. On cooling these charges are reversed This is well shown by dusting a cooling crystal over with a mixture of red-lead and sulphur, when the yellow sulphur is attracted to the positively charged end and the red lead to the negatively charged end A faceted gem-stone of tourmaline may be tested in this way. Tourmaline also shows the related phenomenon of piezoelectricity When a plate cut perpendicular to the principal axis is subjected to variations of pressure it develops positive and negative charges on the two surfaces This property can be made use of for detecting small variations in pressure, as in depth-sounding apparatus.

The optical properties are also of exceptional interest. A ray of light entering a crystal of tourmaline is split up into two rays, one, the ordinary ray, vibrating perpendicular to the principal axis, and the other, the extraordinary ray, vibrating parallel to this axis Coloured crystals are very strongly dichroic, the ordinary ray being almost completely absorbed. Plates cut parallel to the principal axis of the crystal, therefore, allow only the extraordinary ray to pass through, and if two such plates are placed in crossed position the light is entirely cut out. A pair of such plates form a very simple polarizing apparatus known as tourmaline tongs. The crystals are optically uniaxial and negative, and the refractive indices vary with the chemical composition, for the ordinary ray $\omega = 1{\cdot}6315$–$1{\cdot}6854$, and for the extraordinary ray $\epsilon = 1{\cdot}6123$–$1{\cdot}6515$ for sodium-light The specific gravity shows a corresponding range from 3·0 to 3·2 The hardness is 7·5.

In general appearance, tourmaline is extremely variable. It may be quite colourless and water-clear, black and opaque, or various shades of red, yellow, brown, green or blue. Some crystals show very strikingly bands of different colours. The coloured varieties when clear and of good quality are cut as gem-stones under the names rubellite or "Siberian ruby," "Brazilian emerald," indicolite, etc. In addition to well-formed crystals, the mineral may take the form of rounded triangular rods or fine needles, which are often aggregated in bundles or radiating groups, or it may form compact granular masses. A common form, especially in the Cornish tin mines, is as bundles of black needles, this form being known as *schorl* (German, *Schörl*).

Tourmaline generally occurs in connection with granitic rocks, and it is often an indication of the presence of tin-ore It would appear to have originated in most cases by the interaction of boron-bearing emanations from the granite magma on the surrounding rocks and minerals The best crystals are found in pegmatite veins and in metamorphic limestones in contact with granite masses Being resistant to weathering processes the mineral accumulates in detrital deposits and in sedimentary rocks. Gem tourmaline comes from the gem-gravels of Ceylon and is quarried in pegmatite veins in the Ural mountains, California and Madagascar. (L J S.)

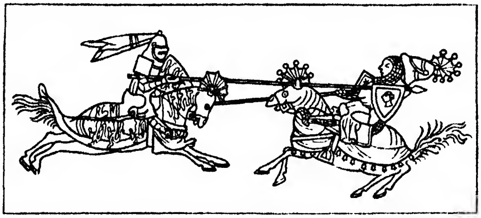
TOURNAI (Flemish *Doornik*), city, province of Hainaut, Belgium, on the Scheldt. Pop. (1925) 36,266 The cathedral of Notre-Dame dates from 1030, the nave is Romanesque of the middle of the 12th century, with much pointed work. The transept was added in the 13th century. The first choir was burned down in 1213, but was rebuilt in 1242 at the same time as the transept, and is a superb specimen of pointed Gothic There are five towers with spires. There are several old pictures of merit, and the shrine of St. Eleuthère, the first bishop of Tournai in the 6th century, is a remarkable product of the silversmith's art The belfry on the Grand Place, the oldest in Belgium, was built in 1187, partly reconstructed in 1391 and finally restored and endowed with a steeple in 1852. The church of St Quentin in the same square as the belfry is almost as ancient as Notre-Dame In the church of St Brice is the tomb of Childeric discovered in 1655 Among the relics were three hundred small golden models of bees These were removed to Paris, and when Napoleon was crowned emperor a century and a half later he chose Childeric's bees for the decoration of his coronation mantle In this manner the bee became associated with the Napoleonic legend just as the lilies were with the Bourbons. The Pont des Tours over the Scheldt, with towers at each end, was built in 1290, and some old houses still in occupation date back to the 13th century On the Grand Place is the fine statue of Christine de Lalaing, princess d'Epinoy, who defended Tournai against Parma in 1581. Tournai carries on a large trade in carpets (called Brussels), bonnet shapes, corsets and fancy goods generally

The actual site was occupied under Julius Caesar and called *civitas Nerviorum* or *castrum Turnacum*. In the reign of Augustus, Agrippa fixed the newly mixed colony of Suevi and Menapii at Tournai In the 5th century the Franks seized Tournai, and Merovaeus made it the capital of his dynasty. This it remained until the subdivision of the Frank monarchy among the sons of Clovis. When feudal possessions, instead of being purely personal, were vested in the families of the holder after the death of Charlemagne, Tournai was specially assigned to Baldwin of the Iron Arm by Charles the Bald, whose daughter Judith he had abducted, on receiving the hereditary title of count of Flanders During the Burgundian period it was the residence of Margaret of York, widow of Charles the Bold, and the pretender Perkin Warbeck, whom she championed, if not born there, was the reputed son of a Jew of Tournai. In the early 16th century Tournai was an English possession for a few years and Henry VIII. sold it to Francis I It did not long remain French, for in 1521 the count of Nassau, Charles V.'s general, took it and added it to the Spanish provinces

TOURNAMENT or **TOURNEY.** Of the mediaeval definitions of the tournament given by Du Cange (*Glossarium, s.v.* "Tourneamentum"), the best is that of Roger of Hoveden, who described tournaments as "military exercises carried out, not in the spirit of hostility (*nullo interveniente odio*), but solely for practice and the display of prowess (*pro solo exercitio, atque ostentatione virium*)." It apparently originated in France, and more than one chronicler records the violent death, in 1066, of a French baron, Geoffroi de Preulli, who, according to the testimony of his contemporaries, "invented tournaments." In England, at least, the

tournament was counted a French fashion, Matthew Paris calling it *conflictus gallicus*.

By the 12th century the tournament notwithstanding the condemnation of the Council of the Lateran, had grown so popular in England that Henry II. found it necessary to forbid the sport which gathered in one place so many barons and knights in arms In that age we have the famous description by William FitzStephen of the martial games of the Londoners in Smithfield He



ENGLISH KNIGHTS TILTING WITH LANCES IN A TOURNAMENT FROM THE LOUTERELL PSALTER, AN ILLUSTRATED MANUSCRIPT OF THE 14TH CENTURY

tells how on Sundays in Lent a noble train of young men would take the field well mounted, rushing out of the city with spear and shield to ape the feats of war. Divided into parties, one body would retreat, while another pursued striving to unhorse them The younger lads, he says, bore javelins disarmed of their steel, by which we may know that the weapon of the elders was the headed lance William of Newbury tells us how the young knights, balked of their favourite sport by the royal mandate, would pass over sea to win glory in foreign lists Richard I relaxed his father's order, granting licences for tournaments, and Jocelin of Brakelond has a long story of the great company of cavaliers who held a tournament between Thetford and Bury St Edmund's in defiance of the abbot From that time onward unlicensed tourneying was treated as an offence against the Crown, which exacted heavy fees from all taking part in them even when a licence had been obtained

In 1299 life and limb were declared to be forfeit in the case of those who should arrange a tourney without royal licence, and offenders were to be seized with horse and harness As the tournament became an occasion for pageantry and feasting, new reason was given for restraint, a simple knight might beggar himself over a sport which risked costly horses and carried him far afield Jousters travelled from land to land, offering and accepting challenges Thus Edward I, before coming to the throne, led 80 knights to a tournament on the Continent Before the jousts at Windsor on St George's day in 1344 heralds published in France, Scotland, Burgundy, Hainault, Flanders, Brabant and the domains of the emperor the king's offer of safe conduct for competitors At the weddings of princes and magnates and at the crowning of kings the knights gathered to the joustings, which had become as much a part of such high ceremonies as the banquet and the minstrelsy

Regulations.—About 1292 a "Statute of Arms for Tournaments" enacted new laws Swords with points were not to be used, nor pointed daggers, nor club nor mace. None was to raise up a fallen knight but his own appointed squires, clad in his device The squire who offended was to lose horse and arms and lie three years in gaol Disputes were to be settled by a court of honour of princes and earls. That such rules were needful had been shown at Rochester in 1251, where foreign knights were beaten by the English and so despitefully treated that they fled to the city for refuge On their way the strangers were faced by another company of knights who handled them roughly and spoiled them, thrashing them with staves in revenge for the doings at a Brackley tournament. Even as early as the 13th century some of these tournaments were mere pageants of horsemen For the Jousts of Peace held at Windsor Park in 1278 the sword-blades were of whalebone and parchment, silvered: the helms were of boiled leather and the shields of light timber. But the game could make rough sport Many a tournament had its tale of killed and wounded in the chronicle books. We read how Roger of Lemburn struck Arnold de Montigny dead with a lance thrust under the helm. The first of the Montagu earls of Salisbury died of hurts taken at a Windsor jousting, and in those same lists at Windsor the earl's grandson Sir William Montagu was killed by his own father. William Longéspee in 1256 was so bruised that he never recovered his strength, and he is among many of whom the like is written, injuries were often caused when dismounted adversaries continued the combat on foot Blunted or "rebated" lance-points came early into use, and by the 14th century the coronall or cronell head was often fitted in place of the point After 1400 the armourers began to devise harness with defences specially wrought for service in the lists But the joust lost its chief perils with the invention of the tilt, which, as its name imports, was at first a cloth stretched along the length of the lists The cloth became a stout barrier of timber, and in the early 16th century the knight ran his course at little risk. Locked up in steel harness, reinforced with the grand-guard and the other jousting pieces, he charged along one side of this barrier, seeing little more through the pierced sight-holes of the helm than the head and shoulders of his adversary His bridle arm was on the tilt-side, and thus the blunted lance struck at an angle upon the polished plates Mishaps might befall At the close of the famous tournament which formed part of the rejoicings for the peace of Cateau-Cambresis in 1559 Henry II of France died from the stroke of Gabriel de Montgomeri, who failed to cast up in time the truncheon of his splintered lance The result of this tragedy was a considerable diminution in the popularity of the tournament But the 16th century tournament was, in the main, a bloodless meeting, as befitted a spectacle arranged as much for the delectation of women as of men Prizes, usually consisting of arms and armour, rich robes and great silver vessels were at the close presented to the victors by the Lady of the Tournament

Pageantry.—In the 15th century the tournament had the aspect of a pageant. The great meeting at Bruges, when the jousting of the Knights of the Fleece was part of the pageant of the Golden Tree, the Giant and the Dwarf, may stand as a magnificent example of many such gay gatherings When Henry VIII. was scattering his father's treasure the pageant had become an elaborate masque For two days after the crowning of the king at Westminster Henry and his queen viewed from the galleries of a fantastic palace set up beside the tilt-yard a play in which deer were pulled down by greyhounds in a paled park, in which the Lady Diana and the Lady Pallas came forward, embowered in moving castles, to present the champions Such costly shows fell out of fashion after the death of Henry VIII ; and in England the tournament remained, until the end, a martial sport. In France it degenerated to the carrousel, which became an unmartial display

The tournament was, from the first, held to be a sport for men of noble birth, and on the Continent, where nobility was more exactly defined than in England, the lists were jealously closed to all combatants but those of the privileged class In the German lands, questions as to the purity of the strain of a candidate for admission to a noble chapter were often settled by appeal to the fact that this or that ancestor had taken part in a tournament. Konrad Grunenberg's famous heraldic manuscript shows us the *Helmschau* that came before the German tournament of the 15th century—the squires carrying each his master's crested helm, and a little scutcheon of arms hanging from it, to the hall where the king of arms stands among the ladies and judges each blazon

The Eglinton Tournament.—An attempt to revive the tourney was made at Eglinton castle Ayrshire, in 1839 The inception of the idea was due to Archibald, 13th Earl of Eglinton, who found an ideal setting for his tournament in the grounds of Eglinton castle On Aug 28, 1839, the lists were dressed in the park Each knight, with his esquires and attendants, had a separate pavilion The lists were splendidly decorated and richly hung, and temporary adornments of Westminster Abbey at the then recent coronation were again used At Lord Eglinton's request many of the ladies wore the costume of the 14th and 15th centuries The marquess of Londonderry was "King of the Tournament" and Lady Seymour, afterwards duchess of Somerset, was "Queen of Love and Beauty." The official list contained the names of 15 knights:—The earl of Eglinton, the marquess of Waterford, the

earl of Craven, the earl of Cassilis, Viscount Alford, Viscount Glenlyon, the hon Capt Gage, the hon. Mr Jerningham, Capt. Fairlie, Sir Frederick Johnstone, Sir Francis Hopkins, Capt Beresford, Charles Lamb, C Boothby and Mr. Lechmere. They were in armour and carried lances. The crown of victory was bestowed upon Lord Eglinton. The second day there was a series of mimic tilts on foot and under cover between Prince Louis Napoleon, afterwards Napoleon III, and Charles Lamb, both of whom were in armour On the third day there was a series of "tourneys" in which eight knights, armed with swords, were engaged A good description of the Eglinton tournament will be found in Chapters 59 and 60 of Disraeli's famous novel, *Endymion*.

When Prince Humbert, afterwards Humbert I, King of Italy, was married at Turin in 1868 to Princess Margherita of Savoy, the festivities included a tournament. The Royal Naval and Military Tournament which has been held annually in London since 1880 consists of a series of displays of skill in arms, in the largest sense of the phrase, but differs widely from the mediaeval tourney

TOURNEUR, CYRIL (*c* 1575–1626), English dramatist, was perhaps the son of Captain Richard Turnor, water-bailiff and subsequently lieutenant-governor of Brill in the Netherlands Cyril Tourneur also served in the Low Countries, for in 1613 there is a record made of payment to him for carrying letters to Brussels. He enjoyed a pension from the government of the United Provinces, possibly by way of compensation for a post held before Brill was handed over to the Dutch in 1616 In 1625 he was appointed by Sir Edward Cecil, whose father had been a former governor of Brill, to be secretary to the council of war. This appointment was cancelled by Buckingham, but Tourneur sailed in Cecil's company to Cadiz On the return voyage from the disastrous expedition he was put ashore at Kinsale with other sick men, and died in Ireland on Feb 28, 1626

Tourneur's fame rests on two plays, *The Revenger's Tragedy* (pr. 1607) and *The Atheist's Tragedy* (pr 1611) Of these Swinburne, in an article contributed to the 9th ed of the *Encyclopædia Britannica,* wrote as follows

"The singular power, the singular originality and the singular limitation of his genius are all equally obvious in *The Atheist's Tragedy*, a dramatic poem no less crude and puerile and violent in action and evolution than simple and noble and natural in expression and in style. The executive faculty of the author is in the metrical parts of his first play so imperfect as to suggest either incompetence or perversity in the workman; in *The Revenger's Tragedy* it is so magnificent, so simple, impeccable and sublime that the finest passages of this play can be compared only with the noblest examples of tragic dialogue or monologue now extant in English or in Greek There is no trace of imitation or derivation from an alien source in the genius of this poet. . . . As a playwright, his method was almost crude and rude in the headlong straightforwardness of its energetic simplicity; as an artist in character, his interest was intense but narrow, his power magnificent but confined; as a dramatic poet, the force of his genius is great enough to ensure him an enduring place among the foremost of the followers of Shakespeare"

BIBLIOGRAPHY—The complete list of his extant works runs: *The Atheists Tragedie; or, The Honest Man's Revenge* (1611), *A Funerall Poeme Upon the Death of the Most Worthie and True Soldier, Sir Francis Vere, Knight* . . (1609), "A Griefe on the Death of Prince Henrie, Expressed in a Broken Elegie . .," printed with two other poems by John Webster and Thomas Heywood as *Three Elegies on the most lamented Death of Prince Henry* (1613); *The Revengers Tragaedie* (1607 and 1608), and an obscure satire, *The Transformed Metamorphosis* (1600)

The Revenger's Tragedy was printed in Dodsley's *Old Plays* (vol iv, 1744, 1780 and 1825), and in *Ancient British Drama* (1810, vol ii) The best edition of Tourneur's works is *The Plays and Poems of Cyril Tourneur, edited with Critical Introduction and Notes*, by J. Churton Collins (1878). *See* also the two plays printed with the masterpieces of Webster, with an introduction by J A. Symonds, in the "Mermaid Series" (1888 and 1903) No particulars of Tourneur's life were available until the facts given above were abstracted by Mr Gordon Goodwin from the *Calendar of State Papers* ("Domestic Series," 1628–1629, 1629–1631, 1631–1633) and printed in the *Academy* (May 9, 1891) A critical study of the relation of *The Atheist's Tragedy* to *Hamlet* and other revenge-plays is given in Professor A. H. Thorndike's "Hamlet and Contemporary Revenge Plays" (*Publ. of the Mod Lang Assoc*, Baltimore, 1902). For the influence of Marston on Tourneur *see* E E Stoll, *John Webster* . . . (1905, Boston, Massachusetts), pp. 105–116.

TOURNON, a town of south-western France, capital of an arrondissement in the department of Ardèche, on the right bank of the Rhône, 58 m. S. of Lyons by rail Pop (1926) 3,740 Tournon preserves a gateway of the 15th century and other remains of fortifications and an old castle used as town hall, court-house and containing a Gothic chapel. The church of St Julian dates chiefly from the 14th century. Tournon had its own counts as early as the reign of Louis I

TOURS, a town of France, capital of the department of Indre-et-Loire, 145 m S W. of Paris by rail Pop (1926) 73,109

Tours (*see* TOURAINE), under the Gauls the capital of the Turones or Turons, originally stood on the right bank of the Loire, a little above the village of St Symphorien At first called *Altionos*, the town was afterwards known as *Caesarodunum* The Romans removed the town from the hill where it originally stood to the left bank of the river

Tours became Christian about 250 through the preaching of Gatien, who founded the bishopric The first cathedral was built 100 years later by St Litorius The bishopric became an archbishopric when Gratian made Tours the capital of Lugdunensis Tertia, though the bishops did not adopt the title of archbishop till the 9th century. In the 5th century the official name of Caesarodunum was changed to *Civitas Turonorum* St Martin, the apostle of the Gauls, was bishop of Tours in the 4th century

Affiliated to the Armorican confederation in 435, the town fell to the Visigoths in 473 It became part of the Frankish dominions under Clovis At the end of the 6th century the bishopric was held by St Gregory of Tours Tours grew rapidly in prosperity under the Merovingians, but abuse of the right of sanctuary led to great disorder Charlemagne re-established discipline in the disorganized monastery and set over it the learned Alcuin, who established one of the oldest public schools of philosophy and theology. The arts flourished at Tours in the middle ages and the town was the centre of the Poitevin Romanesque school of architecture. The abbey was made into a collegiate church in the 11th century, and was for a time affiliated to Cluny, but soon came under the direct rule of Rome, and for long had bishops of its own The suburb in which the monastery was situated became important under the name of Martinopolis The Normans pillaged it in 853 and 903. Walls were erected from 906 to 910, and the name was changed to that of Châteauneuf.

In the 14th century Tours was united to Châteauneuf within a common wall, of which a round tower, the Tour de Guise, remains, and both towns were put under the same administration The numerous and long-continued visits of Charles VII, Louis XI, who established the silk-industry, and Charles VIII during the 15th century favoured commerce and industry In 1562 Tours suffered from the violence of both Protestants and Catholics

In the 17th and 18th centuries it was the capital of the government of Touraine Its manufactures, of which silk weaving was the chief, suffered from the revocation of the Edict of Nantes (1685) In 1772 its mint, whence were issued the "livres" of Tours, was suppressed During the Revolution the town formed a base of operations of the Republicans against the Vendeans

Tours lies on a flat tongue of land between Loire and Cher just above their junction. The right bank of the Loire is bordered by hills at the foot of which lie St Cyr and St. Symphorien. The river is crossed by two suspension bridges.

St. Gatien, the cathedral of Tours, dates from the 12th to the 16th centuries The lower portions of the west towers belong to the 12th century, the choir to the 13th century; the transept and east bays of the nave to the 14th; the remaining bays, a cloister on the north, and the façade, decorated in the Flamboyant style, to the 15th and 16th centuries, the upper part of the towers being in the Renaissance style of the 16th century. In the choir there is fine 13th century stained glass. The 16th century tomb of the children of Charles VIII, is attributed to the brothers Juste. The square tower of the church of St. Julien is Romanesque, the rest being in the early Gothic style of the 13th century, with

the exception of two apses added in the 16th century. Two towers and a Renaissance cloister are the chief remains of the celebrated basilica of St Martin. Two other churches are Notre-Dame la Riche, originally built in the 13th century, rebuilt in the 16th, and magnificently restored in the 19th century; and St. Saturnin of the 15th century. Of the old houses of Tours the hôtel Gouin and that wrongly known as the house of Tristan l'Hermite (both of the 15th century) are the best known. Tours has a valuable library, including among its mss. a gospel of the 8th century on which the kings of France took oath as honorary canons of the church of St. Martin. Balzac was a native of Tours. Tours is the seat of an archbishop, a prefect, and a court of assizes, and headquarters of the IX. Army Corps, and has tribunals of first instance and of commerce, a board of trade-arbitrators and a chamber of commerce.

There are silk factories and important printing works, steel works, iron and tin foundries and factories for automobiles, machinery, oil, cement, stained glass, boots and shoes, porcelain and other goods. A considerable trade is carried on in the wine of the district and in brandy, dried fruits and confectionery.

BATTLE OF TOURS

The battle of Tours (A.D. 732), sometimes called the battle of Poitiers, marks the turning point in the northern advance of the Moors; the victory of the Franks checked once and for all the expansion of Islam in western Europe. In 711 the Arabs had crossed the Straits of Gibraltar and conquered the weak Visigothic kingdom of Spain, a few years later they crossed the Pyrenees, and in 720 captured Narbonne, which became the base for their further progress into Gaul, where the wealth of the churches and monasteries offered a powerful inducement. The plan of extending their power to the north was rendered more possible by the political rivalry which subsisted betweeen the dukes of Aquitaine and the Merovingian Mayors of the Palace. However, in 720, the year in which the Arab attacks began in earnest, Eudo, duke of Aquitaine, had made his peace with Charles Martel, and was therefore free to deal with the impending danger. In 721 he relieved Toulouse, which was being besieged, and won a decisive victory over the Arabs. But after a short respite the attack was renewed in 725. A strong army crossed the eastern Pyrenees, captured Carcassonne and Nîmes, and occupied the greater part of the province of Septimania. In the same year they made a raid into Burgundy and destroyed the city of Autun. Internal dissensions among the Arabs themselves, the incessant hostility between the Ma'ddites and the Yemenites, prevented them, however, from following up these successes, and it was not until the appointment in 731 of the popular and energetic governor of the Yemenite party, 'Abd-ar-Raḥmān, that the offensive was resumed. The situation in Gaul was favourable for the enterprise, for war had once more broken out between Eudo and Charles. With a large army 'Abd-ar-Rahmān crossed the Pyrenees and captured and burnt Bordeaux. Eudo, who hastened to check his advance, was defeated, with the loss of the greater part of his army, between the Garonne and the Dordogne. The Arabs pressed forward, plundering as they went, along the line of the Roman road which ran northward from Bordeaux through Poitiers to Orleans. At Poitiers they destroyed the basilica of St Hilary; their next objective was Tours, whither they were attracted by the immense riches of the famous church of St. Martin. But before they reached it they were met by Charles, to whom Eudo, despite his previous hostility, had fled for assistance after his defeat.

Charles, at the head of a large army, engaged with the enemy south of Tours, perhaps at the little town of Cenon, near the junction of the Clain and the Vienne, and not far north of Old Poitiers (*see* the inset map in Spruner-Menke, *Hand-Atlas*, Plate 29). For seven days the two armies stood facing each other. Then on a Saturday in October the serious fighting began. Charles had taken up a defensive position in close formation. It was the moral and physical superiority of the Teutonic race over the Muslims that won the day. The light Arab cavalry broke before the "immovable wall" of Frankish soldiers who stood, we are told, firm "as a rock of ice" (Isidorus Pacensis). They were hurled back with heavy loss; 'Abd-ar-Rahmān himself was killed on the field. Fighting continued till nightfall; and when, on the next morning, the Franks prepared to resume the battle, they found the Arab tents deserted. The Arab losses were very severe.

The battle of Tours is commonly regarded as one of the decisive battles of the world's history. In a sense this is true. It dealt a decisive check to the advance of the Arabs into Gaul. It removed an imminent peril, a constant menace. But there were causes other than Charles's victory which in part account for the cessation of the Arab advance. The revolt of the Berbers in North Africa was as decisive a factor as the battle of Tours in putting an end to the advance of the Arabs into western Europe.

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TOURVILLE, ANNE-HILARION DE COTENTIN

(or COSTANTIN), COMTE DE (1642–1701), French admiral and marshal of France, was the son of César de Cotentin, or Costantin, who held offices in the household of the king and of the prince of Condé. Destined by his family to enter the Order of Malta, he served for eleven years with the galleys of the Order against the Barbary pirates. In 1667 he was incorporated in the corps of officers of the French Royal navy and in 1689 he left the Order. In the French navy he served in the Mediterranean for some years. In 1670, Tourville commanded the "Page" (50), in the squadron of the comte d'Estrées (1624–1707) sent to co-operate with the duke of York against the Dutch. He was present at the battle of Solebay (June 7, 1672), and in the action on the coast of Holland in the following year, when Prince Rupert commanded the English fleet. When England withdrew from the alliance, the scene of the naval war was transferred to the Mediterranean, where Holland was co-operating with the Spaniards. Tourville served under Abraham Duquesne in his battles with De Ruyter. By this time he was known as one of the best officers in the service of King Louis XIV. By 1689 he had been promoted lieutenant-général des armées navales, and was named vice-admiral du Levant or of the East. In June of that year he became commander-in-chief of the French naval forces in the war against England and her continental allies.

From this time till the failure of his resources compelled King Louis XIV. to withdraw his fleets from the sea, Tourville continued to command the naval war in the Channel and the Atlantic. His conduct and example during this period were the source of the system of manoeuvring to gain an advantage by some method other than plain fighting. In 1690 he had an opportunity which might well have tempted the most cautious, and he missed it out of sheer care to keep his fleet safe against all conceivable chances, aided perhaps by a pedantic taste for formal, orderly movement. He was opposed in the channel by the allies, who had only fifty-six ships, while his own force was from seventy to eighty sail strong. He was feebly attacked by Admiral Arthur Herbert, earl of Torrington, off Beachy Head on July 10. The Dutch ships in the van were surrounded. The allies retreated in disorder, and Tourville followed in "line of battle" which limited his speed of pursuit to that of his slowest ship. In 1692 the Mediterranean fleet having failed to join him, he was faced by a vastly superior force of the allies. The French king had prepared a military force to invade England, and Tourville was expected to prepare the way. He made a resolute attack on the centre of the allies on May 29, off Cape Barfleur, and drew off before he was surrounded. This action, with the pursuit of the following days, made up what is called "the battle of La Hogue." His flagship the "Soleil Royale" and fifteen other ships were cut off and destroyed. In 1693 he was again at sea with a great fleet, and had a chance to capture the Smyrna convoy off Gibraltar. Again he kept his fleet in battle order, and a large part of the convoy escaped. Tourville was made Marshal of France in 1693. He died in Paris in 1701.

TOUSSAINT L'OUVERTURE (or LOUVERTURE), **PIERRE-DOMINIQUE** (*c.* 1746–1803), one of the liberators of Haiti, claimed to be descended from an African chief. His first surname Breda was afterwards changed to L'Ouverture in token of his valour in causing a gap in the ranks of the enemy. He obtained his master's confidence and was made superintendent of the other negroes on the plantation After the insurrection of 1791 he joined the insurgents and acted as physician to the forces. His rapid rise aroused the jealousy of Jean François, who caused his arrest on the ground of his partiality to the whites. He was liberated by the rival insurgent chief Baisson, and a partisan war ensued, but after the death of Baisson he placed himself under the orders of Jean François Subsequently he joined the Spaniards, but, when the French government ratified the act declaring the freedom of the slaves, he came to the aid of the French In 1796 he was named commander-in-chief of the armies of St Domingo, but, having raised and disciplined a powerful army of negroes, he made himself master of the whole country, renounced the authority of France, and announced himself "the Buonaparte of St. Domingo." He was captured by the French and died in the prison of Joux, near Besançon, on April 27, 1803

See Toussaint l'Ouverture's own *Mémoires*, with a life by Saint Remy; (1850), Gragnon-Laconte, *Toussaint Louverture* (1887); Scholcher, *Vie de Toussaint Louverture* (1889), and J. R. Beard, *Life of Toussaint Louverture* (1853).

TOUT, THOMAS FREDERICK (1855–), British historian, was born in London on Sept. 28, 1855, and educated at St. Olave's school, Southwark, and at Balliol college, Oxford. In 1881 he was appointed professor of history at St. David's college, Lampeter, and from 1890 to 1925, held a similar appointment at Manchester university. He was a fellow of Pembroke college, Oxford, from 1883 to 1890. He has taken a prominent part in the work of various historical societies and educational committees, and in 1911 was elected fellow of the British Academy. In 1925 he was elected president of the Royal Historical Society, and from 1927 to 1928 was messenger lecturer at Cornell university

His works include *History of England for Schools* (with Prof. York Powell), vol iii. (1890); vol. ii. (1898); *The Empire and the Papacy* (1898). He was first editor with H. Johnstone of *Select Trials of the Judges and Ministers, 1289–92* (Camden Series, *Royal Hist. Soc*, 1906); and has written *Chapters in the Administrative History of Mediaeval England* (vols i. and ii, 1920); *France and England, their Relations in the Middle Age and Now* (1922); and many school text books and articles in historical reviews.

TOVEY, DONALD FRANCIS (1875–), English pianist, composer and writer on music, was born on July 17, 1875, at Eton, where his father, the Rev. Duncan Charles Tovey, was a master. He was trained as a pianist by Sophie Weiss In 1900 he definitely took up music as a career and began to give recitals, in which his own compositions were included, in London and on the Continent Since 1914 he has been Reid professor of music at Edinburgh university. The Reid orchestral concerts, which he conducts, owe their existence to his initiative. He has contributed a large number of articles to the present edition of the *Encyclopædia Britannica*.

The orchestral compositions include a symphony in D, performed at Aix-la-Chapelle in 1913, a pianoforte concerto in A, prelude and entr'actes for Maeterlinck's *Aglavaine et Sélysette* (for string orchestra), and an opera, *The Bride of Dionysus* to R. C. Trevelyan's text In chamber music he has written two sonatas for violin alone; a sonata for two violoncellos; a pianoforte trio and a quintet; a trio in C minor for pianoforte, clarinet and horn; two string quartets; variations on a theme by Gluck for flute and strings He has also written three anthems and 25 rounds for equal voices.

TOWER, the term given to a lofty building originally designed for defence, hence, any structure whose height is its most important dimension, whether isolated or forming part of another building. The two earliest uses of lofty buildings were military and religious; in the one case constructed to give a raised platform from which a defending force could advantageously discharge missiles upon an attacking force, at the same time remaining protected from it; in the other case, always in connect with sun, moon or star worship, apparently in the effort to r the worshipper or the priest as near heaven as possible.

Military.—The Mesopotamian peoples seem to have built first highly developed masonry towered fortifications. Thus o tablet in the lap of the famous statue of Gudea, the king Lagash (*c.* 2700 B.C), now in the Louvre, there is a represer tion of a fort with towers and gates. The Egyptians used tow less frequently, but certain remains exist in which the Asian t appears and the palace pavilion of Amenhotep at Medinet has projecting towers of Assyrian type. The Greek world m a less definite use of towers. In Roman times, however, tow formed an integral part of every developed fortification, and w especially important on the city walls, as can be seen in m examples, especially at Pompeii and in the wall of Aurelian Rome. In Constantinople successive emperors merely follo Roman tradition and the existing ruins of the walls origin built by Theodosius reveal many analogies to similar Ron work, with their boldly projecting, square, battlemented tow Towers with curved fronts are also occasionally found, especi in connection with gates (*q v*).

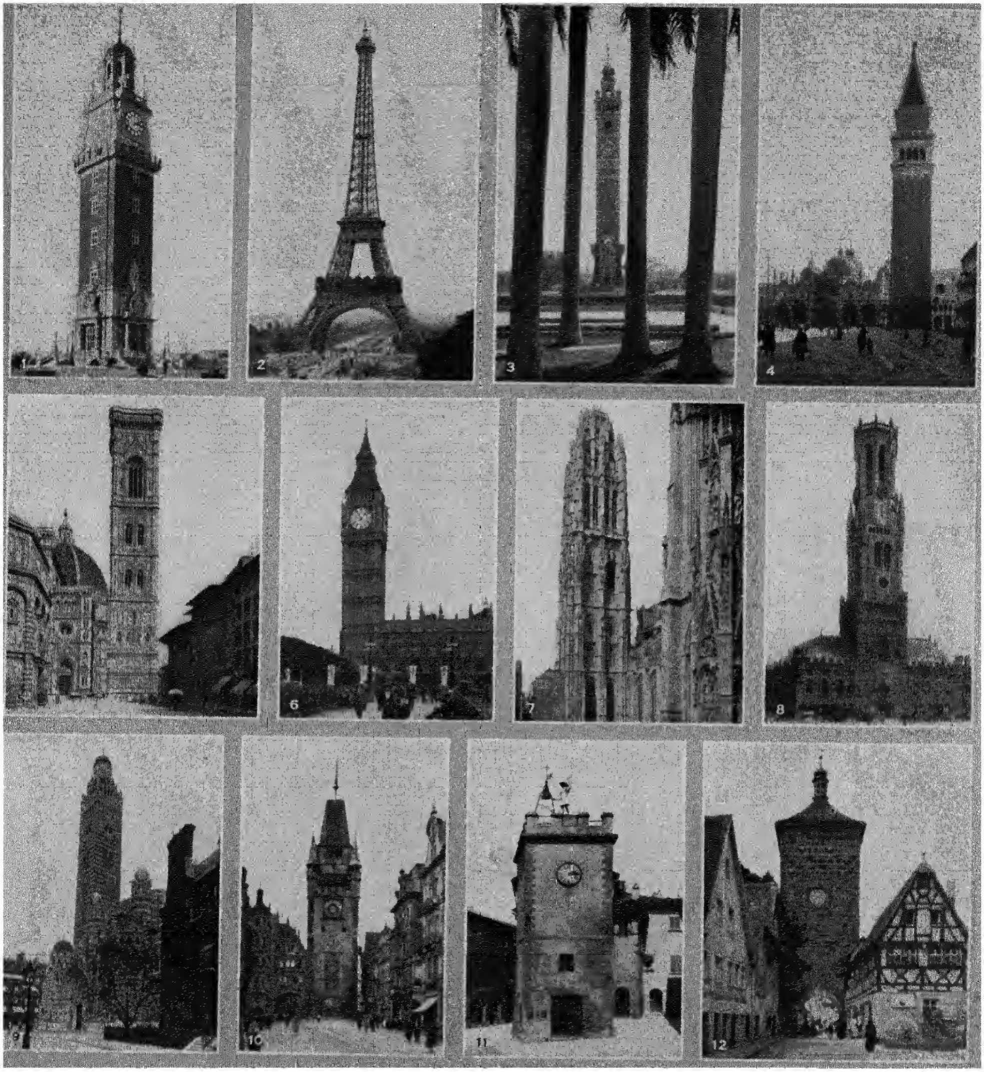
In the mediaeval period, from the 13th century on, the milit tower received its greatest development, which found express in such city walls as those of Aigues Mortes and Carcassor both dating largely from the latter part of the 13th century, in such châteaux as Coucy (13th century) or Pierrefonds (1 century) The greatest development of the defensive tower through its use as the keep (*q.v*) or donjon (*q.v.*), such as mediaeval White Tower of the Tower of London (11th centu or the famous round tower of Coucy It is probably from use of the tower as a keep that the word occurs often in ho names in England, such as Houghton Tower Meanwhile, many important towns in mediaeval Italy noble families e tried to have its own tower as a place of refuge in time of f tional strife These towers were extremely high and often isolat with only a small entrance and a few small openings.

In the Near East, the great towers of the fortifications b on either side of the Bosporus at Rumeli Hissar and An Hissar, during the siege of the city (middle 15th century) still landmarks In China great masonry towers crown each g of a city wall, topped with garrison buildings that give much ac tional height; towers of a simpler and strangely European t form the most conspicuous features of the famous Great Wall China.

With the appearance of firearms, and particularly of la cannon, the use of towers as fortifications practically vanish (*See* FORTIFICATION AND SIEGECRAFT.)

Religious.—Towers built for religious purposes appear in early developed form in the Chaldean ziggurats (*q.v.*)—the gr stepped pyramids, with stairs or inclined planes connecting levels, and an open terrace with an altar or a shrine at the t which were attached to nearly every Chaldean and Assyrian te ple. Similar high buildings, the so-called pyramids, were f quently associated with temples in ancient Mexico and Cent America. The early Persians seem also to have used raised p forms on small towers in connection with their fire worship. the classic world towers do not appear as important religi buildings, and it was not until the 8th century, and probably w the wide introduction of bells that they came to be associa with churches. (*See* CAMPANILE.)

By the end of the 11th century the use of church towers almost universal. In France the earliest examples are placed the crossing of nave and transepts, often taking the form o lantern in several stages or levels, with a pyramidal top. England, on the other hand, a position at the west end of the n had become common during the Saxon period, as at Earl's Bar and Barnack. In the Norman period central towers became us as well as towers flanking the main entrance. Particularly p turesque were the grouped towers common in the Rhineland in the 12th century churches of Mainz and Speyer. Romanes tower design was generally simple. Shallow corner buttres were occasionally found, but the main effect was gained by



PHOTOGRAPHS, (1, 2, 3, 5, 6, 8, 10, 12) EWING GALLOWAY, (4) PUBLISHERS PHOTO SERVICE, (7) COLLECTION ARCHIVES PHOTOGRAPHIQUES, (9) UNDERWOOD PRESS SERVICE, (11) BURTON HOLMES FROM EWING GALLOWAY

CLOCK AND OTHER TOWERS

1. The English Clock Tower in Buenos Aires. That city has many towers and monuments honouring the countries represented in its population
2. Eiffel Tower, Paris, France, built in 1889 and now used as a wireless station. It is one thousand feet in height
3. The Husainabad Clock Tower in Lucknow, India, viewed through stately palms. The Hindu tank of the original Royal Palace is near its base
4. Plaza of St. Mark, Venice, Italy, with the Cathedral and Campanile
5. The Campanile, or Giotto's Tower, at Florence, Italy
6. "Big Ben," London's most famous clock, on the Clock Tower of the Houses of Parliament
7. Tour de Beurre at Rouen Cathedral, so named because funds for its building were given in return for permission to eat butter in Lent
8. The Belfry, Bruges, Belgium
9. Tower of Westminster Cathedral
10. Martinsthor Gate at the end of the Kaiserstrasse in Freiburg-im-Breisgau, Germany
11. Ancient clock tower at Montepulciano, Italy, showing the bell and the figure which strikes the hour
12. The Siebers Tower, one of the numerous picturesque gate towers in Rothenburg, Bavaria, and one of the most interesting pieces of mediaeval architecture in the town. An old wine house is shown at the right of the tower

succession of storeys of arcaded windows; arcaded cornices or corbelled (bracketed) cornices were much used. Interesting examples of Romanesque towers are: S. Front, Périgueux; Loches; S. Pierre, Vienne; S. Paul, Issoire; the cathedral at Le Puy en Velay; and S. Germain des Prés, Paris, all of the 12th century, in France. In England, the west towers of Durham cathedral (lower part 1128, upper part 1220); the central tower at Tewkesbury (*c.* 1125) and the 12th century church at Castor are noteworthy.

The Gothic period produced profound changes in tower design. Windows and arcades were much lengthened; buttresses increased in size and complexity; corner buttresses were much emphasized and frequently crowned with pinnacles and offsets were arranged to vary the silhouette. Although many Gothic towers were designed to carry spires a large number have flat roofs with rich battlemented or traceried parapets and many pinnacles and finials. Sometimes octagonal turrets rose continuously from the ground to the top at one or more corners of the tower. The number of towers contemplated for great churches increased with their complexity. Thus in Rheims, seven towers with crocketed spires were originally planned, and at Chartres, eight; Tournai cathedral (the only scheme of the three completed) in Belgium has seven. Of flat topped towers the Tour S. Jacques, Paris (1508–1522) is a graceful example. The most beautiful of English Gothic towers are Canterbury cathedral (central tower 1495); Lincoln (western towers *c.* 1250, completed *c.* 1400), central tower (lower portion 1240–50, upper portion 1307–1311); Gloucester (central tower middle 15th century); and York (central tower 1400–1423, south-west tower begun 1432, north-west tower finished 1474) Of the smaller towers, those of Wrexham church (1506) and the famous Magdalen tower at Oxford (1492–1505) are both beautiful examples of Perpendicular richness.

Secular.—Towers are not limited to either military or religious uses Many were built in connection with town halls, others to carry clocks. Isolated belfrys are also found as at Amiens (present building 1748, on a mediaeval base), and Darnétal (1512–14); and those containing clocks at Evreux (1490); Rouen (1389, altered 1527); Bordeaux (13th and 15th centuries). The greater number of the hôtels de ville of France, Germany and the Netherlands had towers, serving as belfrys. Examples exist at S. Antonin, France (12th century), Ypres (early 14th century, now, 1928, destroyed) and Arras in Belgium (1554), while the fantastic tower of the Rathaus at Rothenburg (13th century) is characteristic of the German examples.

Oriental.—The Muslim architects rank with the greatest mediaeval tower designers, but except for a few examples in palaces, such as the 14th century Comares tower in the Alhambra at Granada, Spain, the greater number were purely religious and served for places from which the call to prayer was given The greatest of them all is the Giralda tower at Seville, originally a mosque minaret (1195), but in its present form it is crowned with a Renaissance top, built in the 17th century by the architect Hernan Ruiz. The Kutub Minar at Delhi, (early 13th century) is the most important Indian example. (*See* MINARET.)

Tower-like structures play an important part in the Brahmin temples of India and in other religious architecture of the Far East. Thus many of the temples are entered through gateways under enormous piles of masonry which take the form of oblong pyramids, lavishly covered with tier on tier of sculptured figures, carved mouldings, little projecting shrines and the like. Characteristic examples are those at Madura (17th century) and Conjeeveran. Sometimes a square, pyramidal tower is placed over the Holy of Holies of a temple, as at Madura.

In China the tower is chiefly developed as the pagoda (*q v.*), whose characteristic, repeated roofs and galleries form an interesting silhouette, typically Chinese. Japanese pagodas are similar in everything but small details.

Renaissance.—The best Renaissance towers are those of comparatively late date, for it required the imaginative freedom of the Baroque spirit to combine classic detail with the non-classic verticality a rich tower requires. Of these Baroque towers the best were those of south Germany, Austria and England, in all of which comparatively simple bases were crowned with several stages of rich, colonnaded detail, the whole topped with some sort of fantastic, curved roof. The Spanish Baroque towers differ from those already mentioned in being crowned by a lantern, usually smaller than the tower below, with frequently a low dome at the top of the entire composition; sometimes two or more stages occur, each smaller than the one below. Such towers were common, not only in Spain itself, but also in the Spanish colonies in America, existing in rich and highly developed examples in Mexico, as in the cathedral at Mexico City, and in much simplified form in the mission churches of California, as in S. Luis Rey, completed 1802.

The greater number of modern church towers follow the precedent of earlier styles, but a few of marked individuality exist. Westminster cathedral tower, London (1895–1903), by J. F. Bentley, 283 ft high, is especially interesting, also the tower of the church of Nôtre Dame at La Raincy (1924), built of reinforced concrete, by Perret Frères Other modern examples include the Eiffel tower, Paris (1889), by Gustave Eiffel, 984 ft high; in Germany, the Einstein tower, Potsdam, an observatory, (1921), by E. Mendelsohn and Stuttgart railway station (1927), by Bonatz and Scholer, in America, the Cleveland Memorial tower, Princeton university (1913), by Cram and Fergusson; the Harkness Memorial tower at Yale university (1921), by J. G Rogers; the tower of the Holder group, Princeton (1909), by Day and Klauder; and in Sweden, the tower of the city hall, Stockholm (1924), by Ragnar Ostberg. A characteristic modern use of the word tower is for high office buildings. (*See* ARCHITECTURE; INDUSTRIAL ARCHITECTURE) Office towers are also sometimes incorporated into modern governmental buildings. (*See* GOVERNMENTAL ARCHITECTURE). (T. F. H.)

TOWER OF LONDON, THE, an ancient fortress on the east side of the City of London, England, on the north bank of the river Thames. On a slight elevation now called the Tower Hill, well protected by the river and its marshes, and by woods to the north, there was a British stronghold Tradition, however, pointed to Julius Caesar as the founder of the Tower (Shakespeare, *Richard III.*, III., i. and elsewhere), and remains of Roman fortifications have been found beneath the present site. The Tower contains barracks, and is the repository of the regalia. It covers an irregular hexagonal area, and is surrounded by a ditch, formerly fed by the Thames, but now dry Gardens surround it on the north and west, and an embankment borders the river on the south. Two lines of fortifications enclose the inner bail, in which is the magnificent White Tower or Keep, flanked by four turrets. This was built by Gundulf, bishop of Rochester, *c.* 1078. Its exterior was restored by Sir Christopher Wren, but within the Norman work is little altered. Here may be seen a collection of old armour and instruments of torture, the rooms said to have been Sir Walter Raleigh's prison, and the magnificent Norman chapel of St. John. Among the surrounding buildings are the modern barracks (1845), and the chapel of St Peter ad Vincula, dating from the early part of the 12th century, but rebuilt in the early 14th and much altered in Tudor times. The Ballium Wall, the inner of the two lines of fortification, is coeval with the keep. Thirteen towers rise from it at intervals, in a chamber of one of which, the Wakefield Tower, the regalia or crown jewels (*see* JEWELS, CROWN) are kept, this room was formerly the oratory, and it is said that it was here that Henry VI. met his death (1471) while at prayers.

The chief entry to the fortress is through the Middle Tower on the west (near which was a menagerie from Norman times until 1834), across the bridge over the moat, and through the Byward Tower. On the south, giving entry from the river through St Thomas's Tower and the Bloody Tower, is the famous Traitors' Gate, by which prisoners of high rank were admitted. The chief historical interest of the Tower lies in its association with such prisoners. The Beauchamp Tower was for long the principal place of confinement for captives of rank, but dungeons and other chambers in various parts of the buildings also have similar associations; as, for instance, the Bell Tower with Queen Elizabeth when princess, Bishop Fisher, and Sir Thomas More; the Bowyer Tower

with the duke of Clarence of the butt of Malmsey legend, the Salt Tower and Broad Arrow Tower with Roman Catholic prisoners of Elizabeth's time and the Martin Tower with Colonel Blood who, in 1671, nearly succeeded in carrying off the crown and regalia, which were then kept there

Executions took place both within the Tower and on Tower Hill. Many of those executed were buried in the chapel of St. Peter ad Vincula, such as Sir Thomas More, Henry VIII's queens, Anne Boleyn and Katharine Howard, Lady Jane Grey and her husband Dudley and the duke of Monmouth The Tower was not only a prison from Norman times until the 19th century, but was a royal residence at intervals from the reign of Stephen, if not before The royal palace was demolished by order of Cromwell The tower is under the governorship of a constable The attendant staff, called Yeomen of the Guard or familiarly "Beefeaters" still wear their picturesque Tudor costume

See W Hepworth Dixon, *Her Majesty's Tower* (1869), Lord Ronald Sutherland Gower, *The Tower of London* (1901), Sir George Younghusband, *The Tower from Within* (1918), and *The Jewel House* (1920), W. G. Bell, *The Tower of London* (1921)

TOWHEE (*Papilo erythrophthalmus*), a well-known North American bird belonging to the family of the finches (*q v*) The back and breast are black, the sides chestnut, the belly white in the male, the female being brown on the back and breast The song is loud, but not over musical In the north of its range it is migratory The allied spurred towhee (*P maculatus*) breeds in the western mountains and great plains.

TOWN, in its most general sense, is a collection or aggregation of inhabited houses larger than a village The O Eng *tun* (M Eng *toun*) meant originally a fence or enclosure, *cf* Ger *zaun*, hedge, hence an enclosed place The Scottish and Northern English use of the word for a farmhouse and its buildings, a farmstead, preserves this original meaning, and is paralleled by the Icel *tun*, homestead, dwelling-house A cognate Celtic form meaning a fastness, a strong place, appears in Gael and Irish *dun*, Welsh *din*, fortress, hill-fort (*cf* Welsh *dinas*, town) This is familiar from the many Latinized names of places, *e g*, *Lugdunum*, *Augustodunum*, etc In English law "town" is not a word defined by statute For purposes of local government there are boroughs, urban districts and rural districts, but many urban districts are rural in character and the distinction is purely an administrative one (*see* BOROUGH, CITY, COMMUNE *Mediaeval*; MUNICIPIUM; ENGLAND *Local Government*, and the sections on local administration under various country headings). The meaning attached to the term "township" in the local administration of the United States is treated under UNITED STATES *Local Government*

TOWN AND CITY PLANNING. The terms town planning and city planning are used to designate the modern movement to plan the growth of cities, towns and villages, particularly in respect to the development of land for building purposes and systems of circulation When, for purposes of planning, it is necessary or desirable to deal with an area that embraces a number of adjacent communities that have separate local governments the movement is described as regional planning

Purposes.—A city grows as the result of artificial processes which need to be controlled, truly proportioned and harmonized The main purpose of planning is to mould and co-ordinate these processes in harmony with natural conditions The city, as the most dominant factor in modern civilization, calls upon the architect to recognize its fundamental relationships as a complete being and not as an aggregation of disparate building units No conception of civic design is adequate that does not envisage the city, in its ideal form, as a work of art.

Thus the general object of planning of urban areas is to influence the orderly, healthy and efficient development of communities In particular the aim of the plan should be to secure (*a*) a wholesome and reasonably spacious lay-out of the sites and surroundings of dwellings; (*b*) a well-balanced distribution of all buildings and open spaces, and of building bulks and uses of buildings in relation to street areas; (*c*) the orderly development and architectural treatment of private and public buildings; (*d*) adequate systems of streets and highways to permit free circulation of traffic, and of efficient transit and transportation services and terminal arrangements; (*e*) ample areas for all purposes of recreation and; (*f*) suitable land and water approaches The plan should deal with these and other physical improvements comprehensively, in relation to the city as a unified whole

Types.—Much of what is called town or city planning is really re-planning of towns or parts of existing towns, or the planning of portions of the undeveloped land in the environs of such towns The most prominent example of the former is Haussman's plan of Paris, and of the latter the town-planning schemes being prepared for the open areas adjacent to English towns For an effective plan for an existing city, replanning or reconstruction of defective areas should be combined with the planning of undeveloped areas On rare occasions, opportunities arise for planning and building new cities and towns from the beginning Sometimes the plans of areas forming extensions of existing cities are so elaborate and comprehensive as to be equivalent in importance to the planning of a complete town Frequent opportunities of planning *ab initio* occur for planning villages or large estates

HISTORIC TOWN AND CITY PLANNING

References to many examples of planning town settlements and some comparatively large cities exist in histories of Egypt, Mesopotamia, Greece, Rome and China Kahun (2500 B C) and Babylon have been cited as the earliest planned cities, although Aegean and Egyptian discoveries now point to a considerably more ancient date The early Italian settlements (Terremare) present traces of system in planning as far back as the Bronze age (2000 to 1800 B C) In many of the cities of the Near East, Egypt and Greece there were the same dominant characteristics pictured by Demosthenes as the combination of splendid public edifices and noble works of art with a simple and severe private life.

Later examples include Selinus and Cyrene, probably founded in the 7th century B C, as well as the Italian city of Pompeii Hippodamus of Miletus (480 B C), is referred to by Aristotle as the first architect to combine his street system with the grouping of dwellings and the treatment of the town as a harmonious whole Aristotle, however, points out that the method of Hippodamus, although advantageous aesthetically and giving the benefits of air and sun to each dwelling, was disadvantageous in time of war when the old Greek system of closely and irregularly packed houses with winding alleys and passages would be most valuable for defence He is said to have planned Peiraeus (the port of Athens), Thurii and Rhodes. Although ancient Athens was not built from a preconceived plan, the splendour of its public buildings and the accidental or deliberate axial arrangement of its few principal streets, the grouping of its buildings in relation to its streets and the comparative meanness of its residential quarters combine to express the Greek conception of civic art In the Macedonian age (330–130 B C) there was much systematic planning of town settlements and military colonies Alexandria was a prominent example of Hellenistic city planning

Vitruvius mentioned town planning and favoured the radial rather than the rectangular pattern (Schulten, *Bonner Jahrbucher*, ciii, 23) He recognized the importance of adjusting the town plan to the site, and its influence on the placing of public buildings. The surviving street plan of Turin excellently represents the Roman military system of building The Romans carried their town planning into their provinces In England the uncovered site of Silchester and the plans of ancient York and Chester show evidences of Roman work in the first century A D In Africa Timgad affords another example of the Roman systematic arrangement Zoning regulations were not unknown in Roman law; there were restrictions on the location of cemeteries and brick-fields, and on the height of tenement houses and against fire hazards, although, as in modern times, not scientifically conceived or effectively applied. The rectangular arrangement of towns practised by the Greeks and Roman military engineers continued to be followed after the fall of the Roman empire The Chinese and, later, the Mongol system of town planning was similarly rectangular

Mediaeval.—The need of defensive walls around the cities, the laying out of main streets from the entrance gates to the civic centre and the grouping of public buildings remained dominant features of town building in mediaeval times. But systematic regularity of the city street system was replaced by picturesque irregularity. The mid-European towns of the pre-Renaissance period that remain approach nearer than modern cities to being works of art. Built by artist craftsmen, cities like mediaeval Rothenburg, Nuremberg and Carcassonne are artistic units bound together by walls and decorated by towers, spires and arched

FIG 1—MAP OF WASHINGTON, D C. SHOWING PERMANENT SYSTEM OF HIGHWAYS

approaches that still survive as monuments to their builders. University towns of this period were well proportioned and openly arranged Camillo Sitte, of Vienna, in his book *Der Stadte-bau* (1889), advocated the adoption of the picturesque as opposed to the symmetrical plan, and for a time the Sitte school in Germany influenced a great deal of town extension planning

The development of architecture and the building of towns has always depended much on the leadership of statesmen and princes In one age it has been a Pericles or an Augustus, in another a Peter the Great or a Napoleon III, and in still another a Washington or a Jefferson Edward I of England was a leader in his day He directed the planning of many towns in southern France, of which Montpazier (1284), with its central market-place and arcades is an instance He laid out Flint, Carnarvon and Winchelsea in England.

Renaissance.—The picturesque irregularity of the Gothic towns with their closed pictures and many-gabled façades was supplanted in some cities in the Renaissance period by the dignified and monumental regularity of the planned city, still encircled by walls but with streets geometrically arranged within them, with wide avenues terminated on the distant vista of a palace or a castle Michelangelo was consulted on the enlargement of the Piazza della Signoria, Florence; Scamozzi prepared a design for an ideal city; and Leonardo da Vinci proposed roads on two levels. The grand manner of planning started in Italy and spread to France. Under Louis XIV. much replanning was done in Paris The planning of Versailles by Le Nôtre has had much influence on the art of planning cities Christopher Wren did similar work in England, and left to posterity one of the finest examples of town design in his plan for the rebuilding of London (1666). It should be said, however, of Sir Christopher's plan, that the requirements of the grandiose did not overshadow the truest utilitarian concern Although to London's great misfortune the plan was not carried out, much work was done in laying out squares and in building development that greatly added to the beauty of the city. Inigo Jones did much to contribute to this result. Penn's plan of Philadelphia was made in 1682, and St. Petersburg was planned in 1703 under Peter the Great. Karlsruhe and Mannheim (1715) in Germany are among the classic examples of radial and rectangular plans, respectively, and include much notable architectural work. The Government centre of Nancy designed by Emanuel Heré in 1750–57 is another notable example of town development. A beginning was made with the plan of the new part of Edinburgh in Scotland in 1767. A young architect, Craig, won the competition for laying out the new town and then followed a long period of architectural control of building construction in the Scottish capital, with which were associated such names as the brothers Adam, Playfair and Reid Splendid work was also done at this period by the Woods in Bath, by Nash in London and Grainger in Newcastle The planning of new developments in London included the reservation of many fine open squares, most of which still remain, although constantly under threat of destruction Architectural influence in these cities waned after the coming of the railroad and civic art has remained more or less in a dormant condition since. The planning of Washington, D C (1791), by L'Enfant, under the influence of President Washington and the architect-statesman Jefferson, marked an epoch in city planning

MODERN URBAN GROWTH

People congregate in towns primarily for economic reasons The growth of industrial and marketing communities begins as the result of natural advantages and concentration of transportation facilities. Most towns grow because of the means of livelihood or the cultural opportunities that they provide Certain great cities, like London and Paris, combine all features; others, like Washington, are mainly political and cultural centres The immense urban aggregations which have grown up around the harbours and railroad terminals of New York and London are unique in history and the result of a new set of forces that are encouraging a high degree of concentration In proportion as the inventiveness of man has led to the introduction of standardized methods of production, of improved methods of communication and building construction and of sanitary equipment adaptable for crowded populations, it has been possible to expand cities to great size and yet to retain a comparatively high degree of efficiency and wholesomeness In general, however, modern cities, whatever their size, suffer from lack of intelligent planning and well-balanced distribution of buildings and open spaces

Influences.—In all civilized countries urban populations have increased rapidly during the past 100 years In newer countries like the United States the urban growth has shown no signs of slackening during the present century. There are three outstanding factors in this growth, apart from its extent, which are having a great influence on the form that it is taking The first is the coming of motor vehicles and the consequent increase in the use of highways Urban growth in the 19th century was dominated by the railroad which helped to promote concentration In the 20th century the railroad continued to expand slowly, while the use of the automobile as a supplementary means of transportation has grown enormously, particularly in the United States In the United States alone, between 1905 and 1925 the number of passenger cars registered increased from 77,400 to 17,512,638, and the number of commercial trucks from 600 to 2,441,709 In America and Great Britain and on the Continent great arterial highways and fast speedways, radiating from the surrounding cities, are being constructed to provide means of circulation for this means of transport

A second influence operating in recent decades has consisted of the great expansion of rapid transit facilities City workers have thereby been enabled to live at a distance from their places of occupation, and the result has been that the most rapid urban expansion has been taking place in the environs of cities New York and London have been growing rapidly in their outskirts and actually diminishing in population in their central areas

Powerful effects on urban concentration has been caused on the Western Hemisphere by the erection of buildings of much greater heights than has been possible in the past The results of improved transit facilities, combined with the inventions of the steel frame method of building construction and the elevator, have produced the sky-scraper with possibilities of building concentration that have only been partially realized. (*See* ARCHITECTURE.) The greatest problem of a modern city is to retain

the advantages of reasonable and proper concentration in face of the tendencies for over-concentration or congestion. This congestion is due not to lack but to wrong distribution of space. The original cause of the defects in city growth is in the lack of true purpose with which the land is laid out when urban growth first takes place.

MODERN PRACTICE

Europe.—The uncertainties caused by the arrival of railroad transportation and the diversion of energy from art to mechanical engineering that accompanied the growth of manufacture prevented much general progress being made in the development of civic art in Europe during the greater part of the 19th century. Sanitation and health conditions were likewise neglected To improve these conditions public health and town extension acts embodying some planning regulations were passed in Italy, Sweden and Germany between 1864 and 1875. Under Napoleon III. of France, Haussman directed the replanning of Paris by Deschamps in 1853 and brought near to completion the remodelling of that city. The streets, places and gardens of Paris are splendidly proportioned in relation to its building heights and masses. The remodelling of central Vienna was carried out towards the end of the 19th century. At this time, Germany and Sweden were the most active countries in Europe in the development of town extension and the architectural planning of cities Before the World War extensive town planning was done in Nuremberg, Dusseldorf, Cologne, Frankfort and Hamburg. Every great Prussian and Swedish city has its town planning department, and at the present time the degree of control of new building development is probably greater in these countries than elsewhere Immediately after the World War there was much activity in town planning in the devastated regions of France. A town planning act was passed in 1919. Other post-war work included plans for Salonika and the remodelling of Athens in Greece.

Great Britain and the Dominions.—Town planning legislation was first introduced into England in 1909. The emphasis has always been on its social features. Although still limited in its application to undeveloped land, it has inaugurated new conceptions of city building that will gradually influence all forms of civic growth. Under the amended act of 1923 all urban areas having a population of 20,000 and more must prepare a plan.

The development of town planning in England has been associated with and received much of its impetus and direction from the building of garden cities (*q v*) and suburbs. Planning of large regions comprising many adjacent urban and rural districts is being carried out extensively. Many regional schemes, including the Manchester, Tyneside, Sheffield, Doncaster, Bristol, Kent, Surrey, Sussex, Essex and other city and county districts, have been prepared or are in course of preparation. A committee has been appointed to inaugurate the preparation of a plan for the whole of metropolitan London. The development of the Aldwych-Kingsway area in central London and the fine civic centre at Cardiff are two prominent examples of architectural town planning. A movement has been started to preserve the English countryside from spoilation by unregulated building development

Of modern plans for new cities two of the most important that have been prepared in recent years are for the capital cities of New Delhi in India and Canberra in Australia. (*See* also GOVERNMENTAL ARCHITECTURE.) There are town-planning laws and much activity in preparing schemes of civic improvement in Canada, Australia and New Zealand. This legislation is largely based on the British model In some Canadian provinces it is compulsory. Several Canadian cities had comprehensive plans made during 1912–14, and the improvement of the lake waterfront of Toronto was carried out on the scale of a large town-planning operation.

Orient.—In Asia, Russian and Japanese architects and engineers have done much geometrical planning An example of the former is the plan of Dalny and of the latter the work done in recent years in the replanning of Tokyo after the earthquake. Extensive plans have been made for several cities in India in addition to New Delhi, and for Manila, Singapore, Canton, Khartoum, Jerusalem and other cities in eastern countries The Straits Settlements has a town planning department attached to its government.

United States.—In the United States the harmonious and spacious grouping of monumental buildings in the Columbian Exposition in Chicago (*see* EXPOSITION ARCHITECTURE) and in the University of California, both in 1893, gave an incentive to the promotion of what was called the "city beautiful." A few years later Daniel H. Burnham, the supervisory architect of the Chicago exposition, with the aid of Edward Bennett and others, prepared the plan of Chicago (completed in 1907), whose publication, with its inspiring pictures by Jules Guerin, was a landmark in city-planning history; much of it is being gradually realized Comprehensive plans were subsequently made for San Francisco, while Cleveland, Buffalo and other cities prepared civic centre plans in quick succession. An important town-planning event in 1901 was the creation of the Senate Park Commission for the improvement of Washington with Daniel H. Burnham, Charles F McKim, Frederick Law Olmsted, Jr., and Augustus St. Gaudens as members. They reported their findings in 1902, which included the recommendation that the L'Enfant plan be adhered to, and its principles extended to new areas, and that where mistakes had been made in altering the original plan they should be corrected. The street plan of Washington has since been constantly restored to the original conception and its architectural growth has been brought up to the standard of the finest capitals of the world

In America the most popular form in which piecemeal planning is done is known as zoning (*q.v.*) In 1926, 525 communities in the United States, as against six in 1916, had prepared zoning plans, or ordinances for the purpose of controlling uses, heights and densities of buildings (*City Planning Quarterly*, April 1928) There are also 300 planning agencies at work in America, dealing with problems other than zoning. Many cities are preparing major highway or transit plans, independently of zoning or architectural features A few small towns such as Mariemount and Palos Verdes have been completely planned, and many comprehensive replanning schemes and surveys have been made. The most hopeful form in which planning is being done is in the making of regional plans for great metropolitan areas, such as New York, Washington, D.C., Philadelphia, Buffalo and the Niagara region, and Los Angeles.

The most elaborate regional survey and plan that has so far been initiated is that prepared for the New York region, which comprises 5,528 square miles Consideration was given to architectural as well as engineering, economic, social and legal problems, and groups of leading architects and landscape architects assisted in preparing designs for specific projects Their conclusions were published in May 1929 One of the chief purposes of

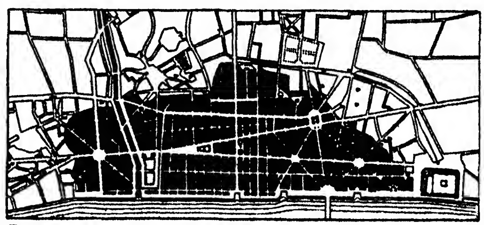
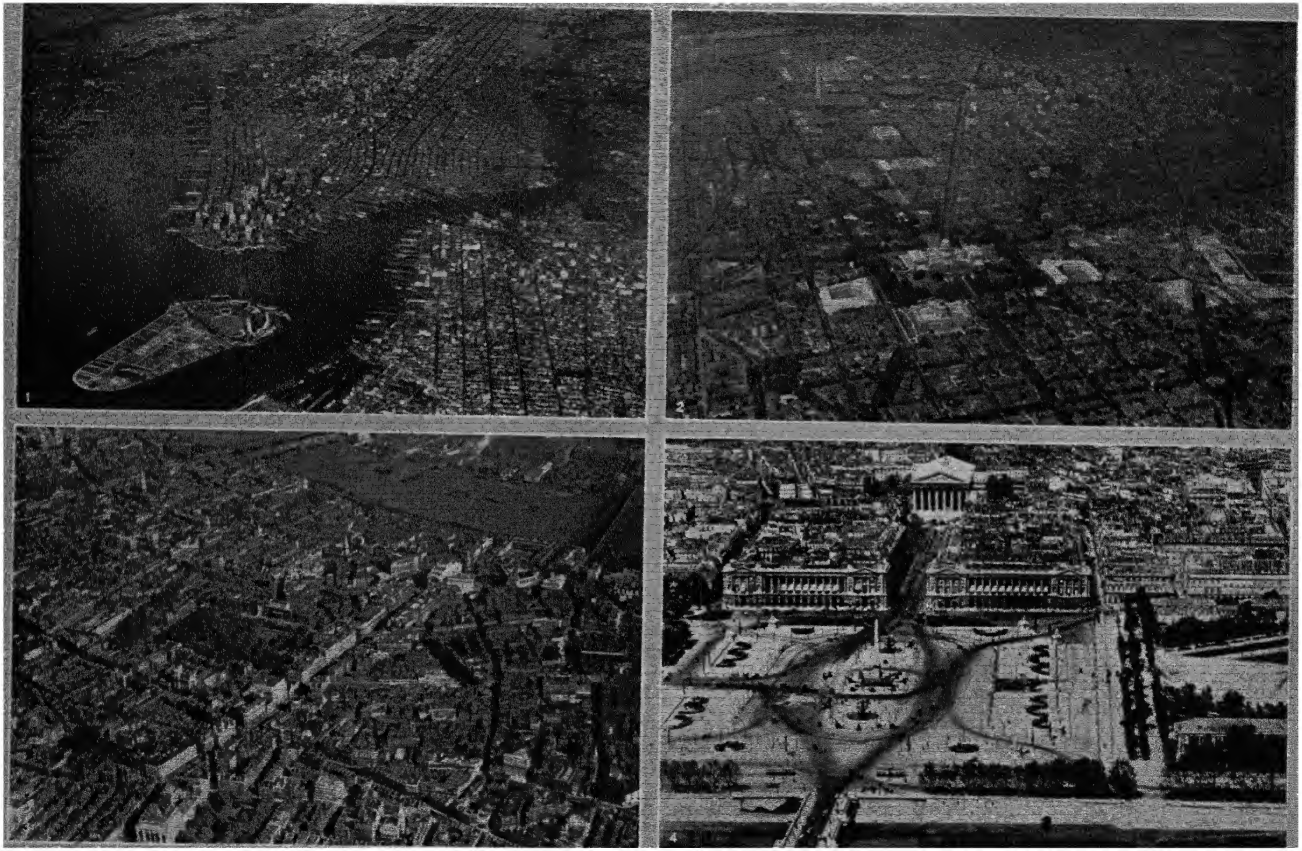


FIG. 2.—SIR CHRISTOPHER WREN'S PLAN FOR REBUILDING LONDON AFTER THE GREAT FIRE IN 1666

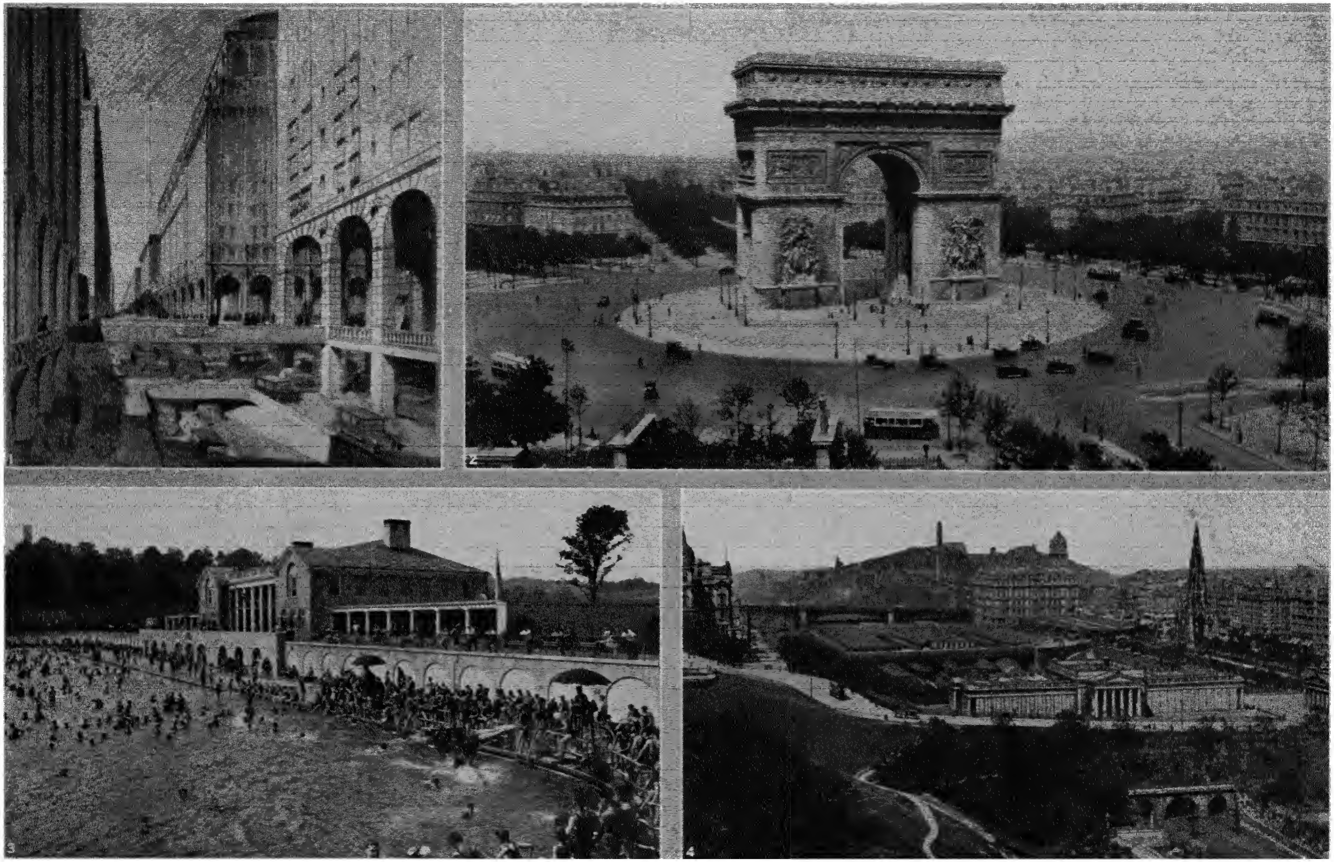
this plan is to improve the approaches to New York by water, rail and highway, and to secure a more dignified treatment of its immense waterfront.

Along with the great increase in local planning activity in the United States, the progress of the movement is indicated by the extension of State planning laws, a more favourable attitude of courts towards planning regulations, and the appointment of an advisory committee on zoning by the Department of Commerce. One of the ways in which architectural projects have been prominent in recent years has been in the improvement of railway



AEROPLANE VIEWS OF AMERICAN AND EUROPEAN CITIES

1. New York city and environs. Manhattan island, upper centre, from Battery park to beyond the north end of Central Park at 110th street. Borough of Brooklyn in right foreground, Governor's Island in immediate foreground
2. Washington, D.C. The Capitol in left centre. The Washington Monument in the upper left and Potomac River beyond
3. London, looking south to the Thames; Blackfriars bridge in upper left. Waterloo bridge in upper right. High Holborn runs diagonally from lower right corner. Kingsway runs from lower left corner. Square with trees, left centre, is Lincolns Inn Fields
4. Paris. Place de la Concorde in foreground with the Tuileries Gardens to the right. The church in the background is the Madeleine



EXAMPLES OF MODERN CITY PLANNING

1. Conjectural view showing a proposed highway plan for New York. In addition to elevated highways, this plan eliminates street intersections by having cross streets tunnelled under the avenues
2. Arc de Triomphe, Place de L'Étoile, Paris, from which radiate twelve broad boulevards
3. Architectural treatment of swimming pool and pavilion at Yonkers, N.Y., by Westchester Park System
4. Looking eastward from Castle Rock, Edinburgh, across the valley between the old town and the new. Railway submerged in right foreground; the Royal Institution which now houses the galleries of the Royal Scottish Academy is shown in the distance. The Sir Walter Scott monument can be seen at the right centre

terminals in America. New railway stations in New York, Washington, Chicago and other great centres have been built in such a way as to afford dignified entrances to these cities. (*See* INDUSTRIAL ARCHITECTURE.)

The planning and construction of parkways which was begun in Boston many years ago has now been extended to many cities. The Fairmount parkway in Philadelphia is an outstanding example of a fine central avenue linking the hub of the city with its extensive park system and including important architectural features. In the environs of New York probably the most extensive county park system in the world is being created by the Westchester park commission, and its success is largely due to the extent to which architectural design has been used for its landscape and structural features. New civic centres have been planned in many cities including Camden, Toledo, Denver and Pasadena.

MODERN TENDENCIES

The tendencies in all countries for good city planning are better to-day than they have been for the past century. The coming of the railroad destroyed interest and activity in planning cities. In recent years, electrification and improvement of steam-propelled trains, together with architectural treatment of railway stations, have been gradually destroying the convention that railway equipment and operations are essentially displeasing. The motor car has restored the highway as a principal means of travel, and the improvement of the public rights of way now absorbs the chief energies and expenditures of local governments. There is found to be need of vigilance in planning street systems, and in relating street spaces to the uses and bulks of buildings. The use of steel frame construction and of the elevator has given a new direction to building. (*See* ARCHITECTURE.) The growth of rapid transit lines is partly a cause as well as an effect of a demand on the part of the citizens for better environment in the neighbourhoods where they live Concurrent with these developments, the wealth of cities has been greatly increased and more widely distributed, and the mass of citizens has become more highly educated; consequently an increased demand for improvements in physical surroundings has been created simultaneously with a growing ability to pay for such improvements.

One of the least satisfactory features of modern town development is the disorderly growth taking place around cities that possess great architectural quality. Paris outside the ramparts, Washington outside the area planned by L'Enfant, and the modern part of Edinburgh are all suffering from lack of planning and architectural control. In the English university towns of Oxford and Cambridge the suburbs are being woefully commercialized.

The newest development in town planning in all countries arises from the need of landing places for aeroplanes. Most large cities are now developing airports, and it is important that they be attractively designed. The architectural treatment of buildings surrounding airports is of great importance too The trend of the time is towards improved living conditions and more spaciousness in city building. Unfortunately fallacies, to the effect that congestion and overcrowding are unavoidable because of lack of space, and that concentration may proceed to any limits without destroying its own advantages, still persist. Hence there are now improved standards of living, more facilities for rapid movement, better sanitation and finer buildings on the one hand, and unhealthy crowding, absence of light in buildings, congested traffic, lack of recreation spaces and uncomfortable travel on the other. The good elements in the first category give a starting point for a better conception of city building, and the very existence of the evils is, in the face of growing intelligence, a necessary stimulus to action in bringing about the realization of this conception. In the task that lies ahead, the architect, the landscape architect and the engineer must work together, for in city building, as in architecture, the best work of all three results from their cooperation.

Education.—One of the most hopeful features of the time is the development of education and research in civic problems. In several countries universities and schools now teach town planning and civic design. Although this is a development of the past 20 years, it includes not only the training of specialists in town planning, but the extension of fine art, architectural, engineering and other courses for the purposes of broadening general education. Much stimulus has been given to town planning education by the conferences and exhibitions beginning with those held in Berlin, Düsseldorf, London and Washington in 1910. Three years later a beginning was made in creating town and city-planning institutes, with architects, landscape architects, engineers and lawyers as members. Educational progress, however, has been largely in the science rather than in the actual art of town planning.

The conditions of the modern city—in size, in speed of circulation, in concentration of building masses, and in growth and standardization of industry—are unique. Whatever guidance the planner may obtain from knowledge and experience of the past, or however sound his conception of principles and traditions may be, he cannot rely upon these alone to solve the problems of the city of to-day. First hand knowledge of entirely new facts—relating to forms of aggregation and distribution of functions and of means of communication—has to be obtained. The principal contribution of the present generation of specialists in town planning seems to be that of building up knowledge of these new conditions. Most of the so-called planning that is being done is part of this process of accumulating knowledge on the basis of experiment. Considered in this light, striking progress is being made towards the time when, it is hoped, the art of building and reshaping towns will be developed on the basis of a sound scientific foundation.

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TOWNSEND, SIR CHARLES VERE FERRERS (1861–1924), English general and politician, was born on Feb. 21, 1861. He first joined the Royal Marines, but in 1886 was transferred to the Indian army. He received rapid promotion, and was one of the officers in the Kashmir contingent of the Hunza-Nagar expedition of 1891 to the Himalayas, becoming military governor of Hunza. In 1895 he went with Sir G. Robertson to Chitral, on the occasion of the revolt of Umra Khan and Sher Afzil. In 1896 he returned to Egypt with Kitchener's Egyptian army, and took part in the Dongola expedition. Townsend acted for a time as military attaché in Paris, and in 1907 received a staff appointment in India. In 1909 he commanded the Orange River Colony, with the rank of brigadier-general, and two years later was promoted major-general. For a short time he held a territorial command in England, but in 1913 returned to India. The 2nd Rawal Pindi division, which he commanded at the outbreak of the World War, was stationed by the Khyber, but in April 1915 Townsend was given command of the 6th Division in

Mesopotamia. After outmanoeuvring the Turks in the flooded country round Amarah, with a fleet of barges, Townsend was encouraged to attack Kut on Sept. 26, 1915. He captured Kut, and on Nov. 22 attacked Ctesiphon, but was obliged to fall back on Kut. For a detailed account of the siege of Kut, *see* MESOPOTAMIA, OPERATIONS IN. Townsend surrendered on April 29, 1916, and was interned at Prinkipo. In Oct. 1918, the Turks released him as an emissary to make terms with the British. He received a K.C.B. for his services in Mesopotamia, but was not again employed. He resigned in 1920, and later in the same year became M.P. for the Wrekin division in Shropshire. In 1922 he joined the Conservative Party, but retired at the next election. He died on May 18, 1924.

Sir Charles Townsend published *My Campaign in Mesopotamia* (1920).

TOWNSHEND, CHARLES (1725–1767), English politician, the second son of Charles, 3rd Viscount Townshend, was born on Aug. 29, 1725, and was educated at Leiden and Oxford. At the Dutch university, he associated with Dowdeswell, his subsequent rival in politics, Wilkes, and Alexander Carlyle He represented Great Yarmouth in parliament from 1747 to 1761, when he found a seat for the treasury borough of Harwich. Townshend was a member of the Board of Trade from 1749 to 1754, and a lord of the admiralty from 1754 until his resignation in 1755 owing to his passionate attack against the ministry In 1756 he was treasurer of the chamber, and in the following spring he was summoned to the privy council.

With the accession of George III in 1760 Townshend transferred his support from Pitt to the young king's favourite, Bute, and in 1761, at the latter's instance, was promoted to the post of secretary-at-war, which he did not throw up until Dec. 1762. In the dying days of Grenville's cabinet, and throughout Rockingham's administration he held the post of paymaster-general, refusing to identify himself more closely with its fortunes as chancellor of the exchequer He accepted the latter position from Pitt in 1766, and was admitted to the inner circle of the cabinet

The defeat of his proposal to continue the land tax at four shillings in the pound, by William Dowdeswell and the landed gentry caused Lord Chatham to meditate Townshend's removal, but before this could be accomplished Chatham's mind became impaired, and Townshend, who was the most determined and influential of his colleagues, swayed the ministry as he liked, pledging himself to find a revenue in America with which to meet the deficiency caused by the reduction in the land tax. His wife was created (August, 1767) baroness of Greenwich, and his elder brother George, the 4th viscount, was made lord-lieutenant of Ireland He himself delivered in the House of Commons many speeches unrivalled in parliamentary history for wit and recklessness; and one of them still lives in history as the "champagne speech." His last official act was to carry out his intention by passing through parliament resolutions, which even his colleagues deprecated in the cabinet, for taxing several articles, such as glass, paper and tea, on their importation into America, which he estimated would produce the insignificant sum of £40,000 for the English treasury, and which shrewder observers prophesied would lead to the loss of the American colonies. Soon after this event he died somewhat suddenly on Sept. 4, 1767

The universal tribute of Townshend's colleagues allows him the possession of boundless wit and ready eloquence, marred by an unexampled lack of judgment and discretion.

A *Memoir* by Percy Fitzgerald was published in 1866.

TOWNSHEND, CHARLES TOWNSHEND, 2ND VISCOUNT (1674–1738), English statesman, was the eldest son of Viscount Townshend of Raynham (*c.* 1630–87), of an old Norfolk family descended from Sir Roger Townshend (d. 1493) of Raynham, who acted as legal adviser to the Paston family. Charles Townshend succeeded to the peerage in Dec. 1687. and was educated at Eton and King's college, Cambridge At first a Tory, when he took his seat in the House of Lords, he afterwards went over to the Whigs. In Nov. 1708 he was appointed captain of the yeomen of the guard, having in the previous year been summoned to the privy council. As ambassador extraordinary and plenipotentiary to the states-general (1709–11) he took part in the negotiations preceding the Treaty of Utrecht. In Sept. 1714, George I. selected him as secretary of State for the northern department. Townshend's policy, after the suppression of the Jacobite rising in 1715, was one of peace at home and abroad; he promoted defensive alliances with the emperor and with France. But in 1716 he was dismissed from his position owing to the intrigues of Sunderland, who persuaded George and Townshend's colleague, Stanhope, that Townshend and Walpole were plotting to place the prince of Wales on the throne.

Early in 1720 a partial reconciliation took place between the parties of Stanhope and Townshend, who was president of the council from June, 1720 until Feb. 1721, when, after the death of Stanhope and the forced retirement of Sunderland, a result of the South Sea bubble, he was again appointed secretary of State for the northern department, with Walpole as first lord of the treasury and chancellor of the exchequer. The two remained in power during the remainder of the reign of George I. (*See* ENGLAND. *History.*) Townshend secured the dismissal of his rival, John Carteret, afterwards Earl Granville, but soon differences arose between himself and Walpole. Although disliking him, George II retained him in office, but the predominance in the ministry passed gradually from him to Walpole Failing, owing to Walpole's interference, in his efforts to procure the dismissal of a colleague and his replacement by a personal friend, Townshend retired on May 15, 1730. His remaining years were passed at Raynham, where he interested himself in agriculture. He died at Raynham on June 21, 1738.

Townshend was twice married—first to Elizabeth (d. 1711), daughter of Thomas Pelham, 1st Baron Pelham of Laughton, and to Dorothy (d. 1726), sister of Sir Robert Walpole.

TOWNSHIP, a subdivision of local government, found in most of the central and western United States It is an outgrowth of New England towns and of New York and Pennsylvania local government, which was influenced both by the New England town and the Southern county. At first townships were often called towns, showing the influence of the terms of New England. Townships are generally about 6 sq m. in size, depending upon State constitutional or statutory provision The township meeting has fallen very much into disuse, just as the town meeting has ceased to be a potent factor in many parts of New England. In some of the States the chief administrative authority of the township is the committee or board, while in the others it is the supervisor, who also serves as the member of the township on the county board of supervisors. Other township officers are the clerk, assessor, treasurer, overseer of the poor and constable. Usually officials are chosen by the voters of the township

See H. G. James, *Local Government in the United States* (1921). (S. LE)

TOWNSVILLE, a port of Queensland, Australia, situated on the west side of Cleveland Bay in the north-east of the State and 750 miles north of Brisbane. It is built upon the banks and near the mouth of Ross Creek—here spanned by an iron bridge—and rises picturesquely up the lower slopes of Castle Hill which towers, a great rock-mass 936 ft. high, behind it It is the outlet for a wide area of country of varied economic potentialities The thriving town (pop. 30,000) is built substantially and, on the whole, suitably to the climate. The estuary of Ross Creek has been straightened and deepened to allow of sea-going vessels (24 ft. draught) to berth alongside the quays, and Townsville, with a total "overseas" trade valued (1926/7) at £1,550,000, is the second port of Queensland and may be termed "the capital of the North," as Rockhampton is of the centre, and Brisbane of the whole, and of southern Queensland in particular The harbour is served by a series of regular overseas shipping lines (total tonnage 1926–27: *c.* 80,000) as well as the regular coast services (combined tonnage of all classes 1926–27, 1,050,500 tons).

TOWTON, a village of Yorkshire, England, 2½m S. of Tadcaster, the scene of a battle fought on Palm Sunday, March 29, 1461, between the armies of York and Lancaster. The party of Lancaster had lately won the battle of St. Albans, but, unable

to gain admission into London, and threatened by the approach of Edward the young duke of York from the west of England, was compelled to fall back northward. York having been proclaimed as Edward IV, followed them up into Yorkshire, and on the 27th his leading troops surprised the passage of the Aire at Ferrybridge. The Lancastrians were encamped at Towton, some miles away, covering Tadcaster and York; but a force under Lord Clifford was promptly sent out, recaptured Ferrybridge by surprise, and cut to pieces the Yorkist garrison. About the same time, however, Edward's van, under Lord Fauconberg, an experienced soldier, crossed the Aire higher up, and Clifford was compelled to retire. He was closely pressed, and at Dintingdale, within a few furlongs of his own camps, was cut off and killed with nearly all his men. Edward's main body was now close at hand, and the Lancastrians drew up on their chosen battlefield early on the 29th. This field was an elevated plateau, with steep slopes, between the present Great North Road and the river Cock, cut in two by a depression called Towton Dale. On opposite sides of this depression stood the two armies, that of York facing north, their opponents southward. Both lines of battle were very dense. On a front of little more than a thousand yards the Lancastrian party had nearly 60,000 men Edward's force (less than 50,000) was not all present, the rear "battle" under Norfolk being still distant Snow and sleet blew in the faces of the Lancastrians and covered the field of battle. The skilful Fauconberg used this advantage to the utmost Aided by the wind, his archers discharged flights of arrows against the enemy, who replied blindly and feebly, hampered by snow and wind. The Yorkists withdrew until the enemy had exhausted their quivers, and then advanced afresh. Their arrows soon stung the Lancastrians into a wild and disorderly charge Suffering severe losses the latter closed with Edward's line of battle No quarter was given by either party, and on the narrow front the numerical superiority of the Lancastrians counted for little The long, doubtful and sanguinary struggle was only decided by the arrival of Norfolk's corps, which charged the enemy in flank. Driven backwards and inwards, the Lancastrians were in a desperate position, for their only way of escape to Tadcaster crossed the swollen waters of the Cock by a single narrow and difficult ford, and when, after a stubborn struggle, they finally broke and fled, they were slaughtered in thousands as they tried to cross At the close of the day the defeated army had ceased to exist 25,000 Lancastrian and 8,000 Yorkist dead were buried in and about Towton.

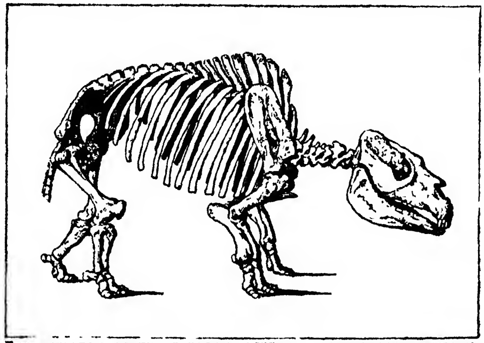
See R. Brooke, *Visits to English Battlefields* (London, 1857); C R. B. Barrett, *Battles and Battlefields of England* (London, 1896), H. B. George, *Battles of English History* (London, 1895).

TOXICOLOGY, the name of that branch of science which deals with poisons, their effects and antidotes, etc. (*See* POISONS and MEDICAL JURISPRUDENCE)

TOXIN: *see* DIPHTHERIA, SCARLET FEVER, MEDICAL RESEARCH.

TOXODONTIA. An extinct order or sub-order of South American hoofed mammals, some (toxodonts) being massively-proportioned three-toed beasts which played the part of rhinoceroses, and others (typotheres) small animals more nearly comparable to rabbits and the larger rodents in appearance and probably in habits. The order was distinguished by long-crowned, often rootless teeth of peculiar pattern, the front teeth enlarged and somewhat like those of rodents, the cheek teeth of triangular pattern above and unequal crescents below, the jaws deep and rather short, heavy zygomatic arches and the mastoid bone peculiarly inflated. The feet have from three to five digits, the arrangement of the carpals is alternating but the astragalus has a short neck and convex head, the fibula articulates with the calcaneum but the navicular does not reach the cuboid. In the Miocene of Patagonia the toxodonts are of moderate size, *Nesodon* as large as a tapir, *Adinotherium* of the size of a sheep, and the typotheres are all small creatures comparable with a wood-chuck or guinea-pig. In the Pleistocene of Argentina *Toxodon* equals the Indian rhinoceros in size, *Toxodontherium* and *Xotodon* of the Pliocene are no less gigantic, while *Typotherium*, the largest of the smaller group, may be compared to the modern capybara.

A third assemblage, the Entelonychia, is related to the toxodonts and typotheres and included with them under the order Notoungulata (also called Toxodonta). They are more primitive in teeth and foot-construction, many of them brachyodont, five toed, clawed and chiefly found in the older Tertiary formations of South America, with a few specialized survivors in the Miocene Among these last *Homalodontotherium*, with large compressed claws but with grinding teeth somewhat like the rhinoceros type, is analogous to the Chalicotheriidae of the northern world, while



THE SKELETON OF THE TOXODON, AFTER A CAST IN THE AMERICAN MUSEUM OF NATURAL HISTORY

Astrapotherium shows a remarkably close parallelism to the *Metamynodon* of the north The Litopterna (*q v*) also have some affinity to the notoungulate groups, the whole assemblage being peculiar to South America save for a couple of small and primitive entelonychians found in the Lower Eocene of Wyoming (*Arctostylops*) and the Paleocene of Mongolia (*Palaeostylops*); these may indicate that these South American Tertiary "ungulates" originally came from Holarctica about the end of the Cretaceous

The invasion of South America by northern mammal faunas at the end of the Tertiary period brought about the progressive extinction of the toxodonts and their allies, *Toxodon* and *Macrauchenia* being the last survivors Unlike the edentates, the South American hoofed animals do not seem to have made any counter-invasion into North America. (W D. M)

TOY, CRAWFORD HOWELL (1836–1919), American Hebrew scholar, was born in Norfolk, Va, on March 23, 1836 He graduated at the University of Virginia in 1856, completed in one year the three-year course at the Southern Baptist theological seminary, served in the Confederate army, studied at the University of Berlin in 1866–68 and taught in various southern educational institutions His resignation from the seminary in which he had studied was accepted in 1879 because of his sympathy with Darwin's views on evolution and his belief that in spite of their divine inspiration there were obvious human errors in the Scriptures which, however, concerned the shell, not the kernel, of religious truth. After a brief period with the *Independent* he went to Harvard as professor of Hebrew and Oriental languages and until 1903 Dexter lecturer on biblical literature. He became professor emeritus in 1909 and died in Cambridge, May 12, 1919 He was the author of *History of the Religion of Israel* (1882), *Quotations from the Old Testament in the New Testament* (1884), *Judaism and Christianity* (1890), *Introduction to the History of Religions* (1913) and of various critical and exegetical works

See sketches in the *American Journal of Semitic Languages and Literature* (vol. xxxvi., Oct. 1919) and the *Harvard Theological Review* (vol. xiii., Jan. 1920).

TOY, a child's plaything; also a trifle, a worthless, petty ornament, a gew-gaw, a bauble. Children's toys and playthings survive from the most remote periods, though many so-called diminutive objects made and used by primitive man, sometimes classified as playthings, may have been workmen's models, votive offerings or sepulchral objects. A large number of wooden, earthenware, stone or metal dolls remain with which the children of

ancient Egypt once played; thus in the British Museum collection there is a flat painted wooden doll with strings of mud-beads representing the hair, a bronze woman doll bearing a pot on her head, an earthenware doll carrying and nursing a child; some have movable jointed arms There are also many toy animals, such as a painted wooden calf, a porcelain elephant with a rider; this once had movable legs, which have disappeared. Balls are found made of leather stuffed with hair, chopped straw and other material, and also of blue porcelain or papyrus. Jointed dolls, moved by strings, were evidently favourite playthings of the Greek and Roman children, and small models of furniture, chairs, tables, sets of jugs painted with scenes of children's life survive from both Greek and Roman times. Balls, tops, rattles and the implements of numerous games, still favourites in all countries and every age, remain to show how little the amusements of children have changed. (*See* also DOLL; TOP)

TOYNBEE, ARNOLD (1852–1883), English social reformer and economist, second son of Joseph Toynbee (1815–1866), a distinguished surgeon, was born in London on Aug. 23, 1852 He had originally intended to enter the army, but ill health and a growing love of books changed his plans, and he settled down to read for the bar. Here again the same causes produced a change of purpose, and he entered as a student at Pembroke College, Oxford Two years later he removed to Balliol college, where, after taking his degree, he was appointed lecturer and tutor to students preparing for the Indian civil service. He devoted himself to the study of economics and economic history. He was a practical social reformer, taking part in much public work and delivering lectures in the large industrial centres on economic problems. He overtaxed his strength, and after lecturing in London in January 1883 he had a complete break-down, and died of inflammation of the brain at Wimbledon on March 9.

Toynbee had a striking influence on his contemporaries, not merely through his intellectual powers, but by his strength of character, love of truth and ardent and active zeal for the public good. He was the author of some fragmentary pieces, published under the title of *The Industrial Revolution* (1884).

Toynbee's interest in the poor and his anxiety to be personally acquainted with them led to his close association with the district of Whitechapel in London, where Canon Barnett (*q.v.*) was at that time vicar—an association which was commemorated after his death by the social settlement of Toynbee Hall, the first of many institutions for social betterment. (*See* SETTLEMENTS.)

See F. C. Montague's *Arnold Toynbee* (Johns Hopkins University Studies, 1889); Lord Milner's *Arnold Toynbee: a Reminiscence* (1901); and L. L. Price's *Short History of Political Economy in England* for a criticism of Toynbee as an economist; also a new edition of his *Lectures on the Industrial Revolution* (1919), with preface by Lord Milner.

TOYNBEE, PAGET (1855–), English philologist and critic, was born at Wimbledon on Jan. 20, 1855, and educated at Haileybury and at Balliol college, Oxford. From 1878 he acted for 14 years as private tutor, afterwards making a name for himself as a Dante scholar. He has also published and edited a number of works relating to Horace Walpole.

His publications include *Specimens of Old French, with Notes and Glossary* (1892); *Life of Dante* (1900; 4th enlarged ed., 1910); *Dante Studies and Researches* (1902); *Chronological List of English Translations from Dante, from Chaucer to the Present Day* (1906); *Dante in English Literature from Chaucer to Cary* (2 vols., 1909); *Critical Texts of Letters of Dante* (1915–19, amended text and translation, 1920); *Dante Studies* (1921); *Horace Walpole's Journal of the Printing Office at Strawberry Hill* (1923); *Horace Walpole's Reminiscences* (1924), etc.

TOYNBEE HALL. Founded in London by Canon Barnett, then rector of St. Jude's Whitechapel in 1884, and named after Arnold Toynbee, a brilliant economist and co-worker whose death shortly before had been hastened by his zeal for social reform, Toynbee Hall, the pioneer university settlement, inaugurated an important movement (*see* SOCIAL SETTLEMENTS). In the earlier years of his ministrations at St. Jude's, Barnett had succeeded in creating interest at Oxford and Cambridge in the problems of East London and had brought to Whitechapel a considerable number of undergraduates to spend their holidays with him and learn about social conditions. The connection which was established in this way prepared the universities for the suggestion of a closer union between them and the East End and Barnett's plan to found a settlement: that is, a house of residence for university undergraduates who might wish to live in an industrial area, was at once warmly supported. With money collected mainly at Oxford he was able to purchase and reconstruct premises next door to St. Jude's which had been used for the purposes of an industrial school and with the help of a band of "settlers" to commence activities which left an enduring mark on the social history of the period. Mainly these activities were concerned with the collection of social data, with social experimentation, and with the amelioration of social and industrial conditions; but Barnett's underlying aim was to bring the generosity and learning of the young and the universities into effective relation with the industrial population so that both communities might come in time to serve ideals of citizenship and neighbourliness.

The War involved the closing of the hostels (Balliol house and Wadham house) which Barnett had founded for working men students at Toynbee Hall and in other ways suspended the operations of the settlement. Since 1919 however most of its customary activities have been resumed and its work as a "popular university" has been extended. An important feature of its annual programme is now a large "American Summer School" which is attended by about 100 preachers, educationalists and social workers from the United States, selected because of their interest in the international aspect of social and economic problems.

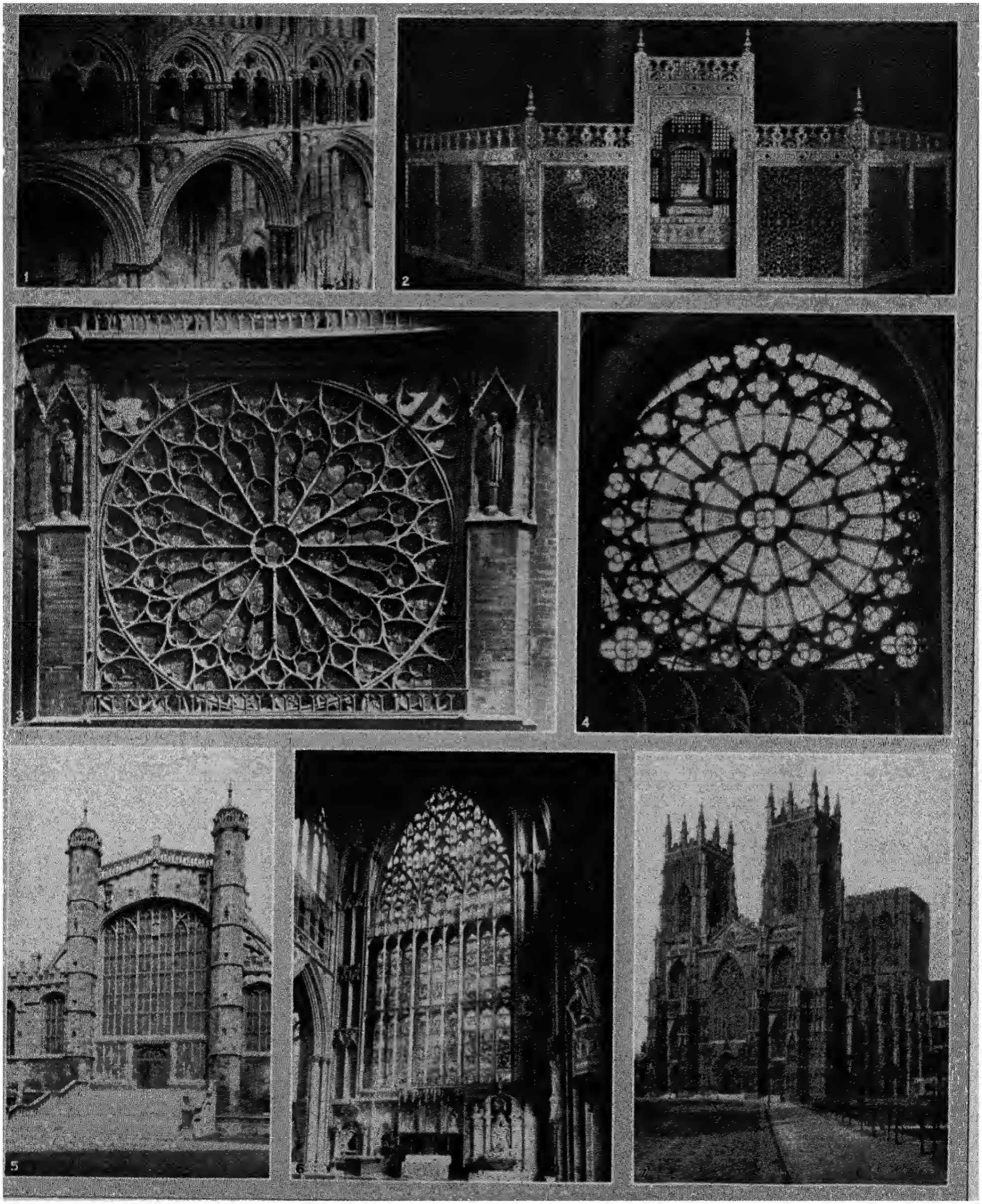
(J. J. M.)

TOZZI, FEDERIGO (1883–1920), Italian novelist, was born at Siena on Jan. 1, 1883, the son of an innkeeper. His childhood and early youth are described in *Con gli ochi chiusi* (1919). His father died in 1908, and Tozzi married the same year, and *Il Podere* (1921) is a record of his experiences at this time. He learnt Latin and studied old Tuscan, his first book being an *Antologia d'antichi scrittori senesi* (1913). *Tre Croci* (1920) translated into English as *Three Crosses* (1921), the only one of his novels which is not autobiographical, is considered his finest work. He died in Rome on March 21, 1920, before he was able to reap the fame which the success of his latest work brought him.

TRACERY, the term given in architecture to the upright curving or intersecting bars or ribs, used in a window or other opening to give beauty and variety to its silhouette. The term is also applied to similar forms used in relief, as wall decoration (sometimes called wall-tracery), and hence, figuratively, of any intricate line pattern. The word is often restricted to the elaborate system of window decoration, with its derivative forms, developed in Europe during the Gothic period, but it may, with equal validity, be applied to the pierced marble screens common in the Mogul work of India, or to the pierced plaster windows of Persia, Turkey, Syria and Egypt.

The origin of European tracery is confused. Pierced marble screens, with the openings glazed, were used occasionally in Byzantine work. The Byzantines also used, commonly, groups of two, three or even more narrow, arched windows, placed close together, under a single, large, relieving arch above. In this they were followed by most of the Romanesque styles. In such groups, the supports between the adjacent openings of each group usually consisted of single colonnettes, hence the arches over them were thin and shallow; and the tympanum, or section of wall supported by them and filling the space between them and the great enclosing or relieving arch over the whole group, was necessarily thin also. Such windows are found in the greater number of Italian campaniles and Romanesque towers, as well as in many Romanesque triforium arcades. To decorate the tympanum, piercing was an obvious and simple method. The result was the germ of tracery.

Plate Tracery is found in early Gothic work both in France and England. In its simplest forms the tympanum is pierced with a single opening, usually circular, but occasionally taking a four-lobed or quatrefoil form. The points between the lobes, known as cusps (*q.v.*), later became an important element in



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EXAMPLES OF TRACERY

1. Geometric decorated English Gothic tracery; Angel Choir, Lincoln Cathedral, 1250–80. 2. Mogul pierced marble tracery; screen in the Taj Mahal, Agra, India, 1632. 3. Rayonnant French Gothic tracery; transept rose window, Notre Dame Cathedral, Paris, *c.* 1270. 4. Rayonnant French Gothic tracery; rose window from St. Nazaire, Carcassonne, France, beginning of the 14th century. 5. Perpendicular English Gothic tracery; west front, St. George's Chapel, Windsor, begun 1474. 6. Early Perpendicular English Gothic tracery; east window, York Cathedral, 1408. 7. Curvilinear Decorated English Gothic tracery; west front, York Cathedral, 1338

much Gothic ornament. In time, greater elaboration was sought by increasing the number and complexity of the piercings, and thus both the size and beauty of the entire unit. The climax of plate tracery appears in France in the group of magnificent windows of Chartres cathedral (1194–1212); and in England in the rose window at Lincoln cathedral (1220), known as the Dean's eye.

Bar Tracery.—As skill in stone cutting and desire for complexity increased, the area of the tympanum wall left solid grew continually smaller, finally leaving only thin bars of stone separating the adjacent openings. Moreover, in Notre Dame cathedral, Paris, certain small, interior, round windows constituting a sort of upper triforium in the original design, carried decorations of little inverted arches built of stone—a sort of rudimentary tracery. About 1220 the next inevitable step in the development was taken, and a window was considered not as a group of lights carrying a little piece of pierced tympanum wall, but as a group of lights where arches are formed of a bar of stone similar in section to that of the mullion or support between them, with the space between these arches and the enclosing arch—the old tympanum—occupied by a pattern of similar stone bars. In early work this pattern usually consists of a circle, sometimes cusped, tangent both to the enclosing arch and to the small arches of the lights below it. The cusps are usually of the type known as "soffit cusping," cut on separate pieces of stone set into grooves in the inner faces of the circle.

French Rayonnant Tracery.—In France, bar tracery occurs in the rebuilt clerestorey of Notre Dame (between 1220 and 1230) in its simplest possible form, and in a more developed type, with cusps, in the apse chapels of Reims cathedral (prior to 1230). From about 1240 on it becomes common, rapidly increasing in lightness and complexity In general, the pattern types are restricted. There are two, three or four lights. In two-light windows, a single cusped circle is the crowning feature. In three-light windows, three smaller cusped circles fill the space above. Four-light windows are formed of two two-light windows, with an additional cusped circle above. In France the spring of the arches of the lower lights is kept far below that of the enclosing arch, so that the crowning circle is large. During the late 13th century, curved-sided triangles, and trefoil and quatrefoil forms, without enclosing circles, are occasionally used. In four-light windows, the central mullion is often made heavier than the side mullions, both in depth and width, and this additional size carried around the enclosing arches of the side pairs. This heavier bar will have a section or profile, part of which is a duplicate of the smaller bars' mullions. Thus tracery of two planes and two moulding types is developed—one, that of the smaller bars, and the other, that of the larger. Each moulding type plane is known as an "order," and such a window is said to have tracery of two orders. The climax of French Rayonnant tracery can be seen in S. Urbain at Troyes (1270), S. Chapelle in Paris (1246–48) and S. Nazaire at Carcassonne (early 14th century). The rose windows (*q.v.*) of the style, such as those of Notre Dame at Paris (*c.* 1270), decorated with radiating patterns using similar combinations of forms—arches, circles, cuspings, etc.—are perhaps the most remarkable traceried windows of the style. During the later Rayonnant period, tracery forms came to be used decoratively, for wall surfaces, pinnacles, gables, etc. Especially noteworthy is the filling of gables of porches, above the door arches, with tracery forms. At first this was done simply, with little piercing; later, as in the Portail des Libraires, at Rouen cathedral (*c.* 1280), the gable became a mere decorative screen of lace-like open tracery. French Rayonnant tracery was the controlling influence in all continental tracery outside Italy.

English Geometric Tracery.—Based on the same simple arch, circle and cusp forms as the French tracery, the English geometric tracery is infinitely richer and more varied. The great east end and west windows of the cathedrals allowed the development of four-, six- or eight-light windows, designed in two or three orders, carefully systematized, like the east window of Lincoln cathedral (*c.* 1280), in eight lights, with three orders. But the greatest change is in single order windows of smaller size. In these the use of cusps without circles became common, and all sorts of star-shaped, triangular and other geometric forms occur.

English Curvilinear Tracery.—In the early years of the 14th century the English architects discovered that by the use of the ogee (*q.v.*) curve, or curve of double curvature, the occasional harsh angularities of the geometric style could be avoided, and wavy-lined tracery of great beauty produced. This gave rise to the so-called curvilinear tracery. Its simplest form is the reticulated, or network window in which the entire upper part is filled with a regular all-over pattern of waving bars, rhythmically tangent and then separating. But the introduction of the reverse curve set free the imagination of the designer, and an infinite number of varying types resulted, such as the rose window at Lincoln cathedral (1350), or the great west window at York (*c.* 1338).

Perpendicular Tracery.—By the end of the 3rd quarter of the 14th century a reaction had set in against this flowing curvature, and the 15th century saw the new style—the so-called perpendicular—triumphant. It was based on one controlling idea—verticality. Mullions were run through unbroken from bottom to top. At intervals they were connected by horizontal bars running across the window, supported on little arches between the mullions, thus dividing the whole window into tiers of little arch-headed lights. At the top there is great variety of treatment, but almost always the upper lights are smaller than those below; and there was frequent use of curved bars intersecting the verticals, and to some extent recalling the arched forms of the earlier styles. This new feeling appears in the transept window of Gloucester cathedral as early as 1335, and in a more developed form in the east window of the choir, which fills the entire east end, about 1350. During the 15th century the lines become more and more rectangular and the window heads have flatter and flatter arches. The climax of this development is reached in such enormous end windows as those of the King's College chapel, Cambridge, and St. George's chapel, Windsor (*c.* 1525).

Wall tracery of perpendicular character was widely used both for exterior and interior work during the 15th and early 16th centuries. Great areas are sometimes filled with tiers of traceried panels, as in the Henry VII. chapel, Westminster Abbey (begun 1502). In some cases, where flint was common, a tracery of cut stone, filled in with dark flints, decorates church exteriors, as in Long Melford church and St. Laurence at Ipswich. Traceried forms are also the basis of much screen, stall and tomb design of the 15th century; rood screens are particularly rich. Tracery is also the basis of the decorative rib treatments of fan vaulting (*See* FAN VAULT; VAULT.)

French Flamboyant Tracery.—In the last years of the 14th century the reverse curve came into use in French tracery, probably as the direct result of English curvilinear models. The French, however, soon gave tracery of this kind an individual spirit. In the best Flamboyant work, such as the tracery of S Maclou, Rouen (begun 1432), and the west front of Rouen cathedral (begun 1481), all of the forms are slimmer and more flame-like than is usual in English work. Particularly interesting is the application of Flamboyant tracery to rose windows, like that of the south transept of Beauvais cathedral (1500–48), in which the radiating character of the earlier types is maintained, although combined with the reverse curve. Flamboyant tracery forms the chief decoration of many gorgeous choir stalls and screens. The screen at Albi (*c.* 1500) has tracery of unbelievable lace-like delicacy in its canopies, as well as larger patterns covering wall surfaces; the wood choir stalls of Amiens (1508–19) are even more delicate and the tracery is of the utmost richness and intricacy. Noteworthy, also, is the application of Flamboyant tracery forms to exterior detail, as in the porch of S. Maclou, Rouen, and the west front of S. Wulfran at Abbeville (1480).

Italian Tracery.—Due to the Italian lack of understanding of Gothic structural principles, tracery never achieved in Italy the logical development of the north. The nearest approach to this is in the bands of tracery of Venetian palace windows, such as those of the Ca d'Oro (1430), by G. and B. Bon. Elsewhere, tracery was only understood as beautiful pattern, and much of it,

even when copying the forms of bar tracery, is pierced from large sheets of marble, as in the triforium of the cathedral at Lucca (*c.* 1400) and the cloister of S. Maria della Verita, at Viterbo.

Tracery in the Orient.—The Mohammedan designers not only followed Byzantine precedent in using pierced marble screens for windows but also, by the development of a new technique, invented a characteristic type of tracery, which combined the functions played by both leading and stone tracery in western work. This technique consisted in filling the window area with a pierced sheet of cement, each piercing being filled with a piece of coloured glass. Results of jewel-like intensity and brilliance were thus obtained, and being made of a plastic material, tracery of this type could have unlimited variety of pattern The usual types found were basically floral, with the leaf shapes in glass, carefully arranged to give a sense of flow and growth. Such cement tracery is found particularly in the later work of Cairo, such as the mosque of Barkouk (*c.* 1384) and in the imperial Turkish work, such as the brilliantly jewelled windows in the 17th century mosque of Suleiman, Constantinople In India, where ventilation is required, rather than floods of light, a different type was developed, without glass, and in a richer material—carved and pierced marble Thus, in almost all of the great Mogul palaces, and in many of the tombs, large, pointed arch openings are filled with sheets of white marble, pierced in the most elaborate patterns, of the finest scale. The most delicate example of this pierced, marble tracery is that of the screen around the sarcophagi in the Taj Mahal (*q v.*), at Agra (1632–47).

Modern Types.—Church architects of the 20th century, working, frequently, in a modernized Gothic style, have found in tracery a congenial means of free expression Both geometric and curvilinear forms have furnished inspiration, but patterns have been developed of a freshness and individuality frequently quite different from the mediaeval custom In these, foliated ornament is frequently added to the tracery basis. Noteworthy examples occur in Liverpool cathedral (Sir G G Scott, architect, still, 1928, uncompleted) and in the west front of the church of the Heavenly Rest and the Beloved Disciple, New York (1928), by Mayers, Brust and Philip, the Goodhue associates An entirely modern development is seen in the use of pre-cast cement tiles, pierced in geometric patterns and glazed, built up into large windows, as in the church of Notre Dame at Raincy, France (1924) by Perret Frères (*See* GOTHIC ARCHITECTURE; INDIAN ARCHITECTURE) (T F H)

TRACHEA, in zoology (1) the windpipe of air-breathing vertebrates, extending from the pharynx towards the lung It ultimately bifurcates into two bronchi, one to each lung The larynx, or voice-box, is a modified part of the trachea (2) The breathing tubes of insects (*q.v.*). The ramifications of the insect tracheae are called *tracheoles*

TRACHELIUM, in architecture the neck of the capital of the Doric and Ionic orders. In the Greek Doric capital it is the space between the annulets of the echinus and the grooves which marked the junction of the shaft and capital In the Roman Doric and the Ionic orders the term is given to the interval between the lowest moulding of the capital and the top of the astragal and fillet. (*See* also HYPOTRACHELIUM)

TRACHEOTOMY, the operation of opening the trachea or windpipe (*see* RESPIRATORY SYSTEM) and inserting a tube to provide a means of breathing when the natural air-passage is obstructed. The operation is by no means easy when performed on a small child, for the wind-pipe is deeply placed amongst important structures The chief anxiety is in connection with haemorrhage, for the vessels are large and generally overfull on account of the impairment of the respiration The higher the opening is made in the trachea the easier and safer is the operation. Formerly, it was frequently performed in diphtheria (*q.v.*) but since the introduction of diphtheria antitoxin it has rarely become necessary In adults tracheotomy is usually done for laryngeal obstruction by disease or foreign bodies

TRACHIS, a city of ancient Greece, at the head of the Malian Gulf in a small plain between the rivers Asopus and Melas, enclosed by Mt. Oeta which here descends close to the sea and at the Trachinian Cliffs commanded the main road from Thessaly The position was well adapted as an advanced post against invaders from the north, and furthermore guarded the road up the Asopus gorge into the Cephissus valley. Its citadel, Heracleia, was a subject of dispute between the Spartans and the Thebans at the end of the fifth century B.C. In Strabo's time the citadel alone was inhabited.

See Strabo p. 428; Herodotus vii. 198–203; Thucydides iii. 92, v. 51–52, Diodorus xiv. 38, 82; Livy xxxvi. 22–24. W. Leake, *Travels in Northern Greece*, iii. 24–31 (London, 1835); G. B. Grundy, *Great Persian War*, pp. 261–264 (London, 1901).

TRACHOMA, the name given to a chronic destructive inflammation of the conjunctiva (*see* EYE: *Diseases*), or "granular conjunctivitis" (Egyptian ophthalmia) It is contagious, associated with dirty conditions, and common in Egypt, Arabia and in some congested districts of south-eastern Europe Hence it has become important, in connection with alien immigration into the United Kingdom and America, and the rejection of those who are afflicted with it. It is important that all cases should be isolated, and that spread of the infection should be prevented.

TRACHYTE (Gr. τραχύς, rough), in petrology, a group of volcanic rocks which consist mainly of sanidine (or glassy orthoclase) felspar Very often they have minute irregular steam cavities which make the broken surfaces of specimens of these rocks rough and irregular; whence comes their name, which was first given by Hauy to certain rocks of this class from Auvergne, and long included quartz-trachytes (now known as liparites and rhyolites) and oligoclase-trachytes, which are now more properly assigned to andesites.

Mineral Composition.—The trachytes are often described as being the volcanic equivalents of the plutonic syenites. Their dominant mineral, sanidine felspar, very commonly occurs in two generations, *i.e.* both as large well-shaped porphyritic crystals and in smaller imperfect rods or laths forming a finely crystalline ground mass. With this there is practically always a smaller amount of plagioclase, usually oligoclase; but the potash felspar (sanidine) often contains a considerable proportion of the soda felspar, and has rather the characteristics of anorthoclase or cryptoperthite than of pure sanidine

Quartz is typically absent from the trachytes, but tridymite (which likewise consists of silica) is by no means uncommon in them It is rarely in crystals large enough to be visible without the aid of the microscope, but in thin slides it may appear as small hexagonal plates, which overlap and form dense aggregates; they often cover the surfaces of the larger felspars or line the steam cavities of the rock, where they may be mingled with amorphous opal or fibrous chalcedony. In the older trachytes secondary quartz is not rare, and probably sometimes results from the recrystallization of tridymite.

Of the ferromagnesian minerals present augite is the most common. It is usually pale green, and its small crystals are often very perfect in form. Brown hornblende and biotite occur also, and are usually surrounded by black corrosion borders composed of magnetite and pyroxene. Sometimes the replacement is complete and no hornblende or biotite is left, though the outlines of the cluster of magnetite and augite may clearly indicate from which of these minerals it was derived. Olivine is unusual, though found in some trachytes, like those of the Arso in Ischia Basic varieties of plagioclase, such as labradorite, are known also as phenocrysts in some Italian trachytes. Dark brown varieties of augite and rhombic pyroxene (hypersthene or bronzite) have been observed but are not common Apatite, zircon and magnetite are practically always present as unimportant accessory minerals.

The trachytes being very rich in potash felspar, necessarily contain considerable amounts of alkalis; in this character they approach the phonolites. Occasionally minerals of the felspathoid group, such as nepheline, sodalite and leucite, occur, and rocks of this kind are known as phonolitic trachytes. The soda-bearing amphiboles and pyroxenes so characteristic of the phonolites may also be found in some trachytes; thus aegirine or aegirine-augite forms outgrowths on diopside crystals, and riebeckite may be present in spongy growths among the felspars of the ground mass

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O
Riebeckite trachyte, Hohenberg, Berkum, Rhenish Prussia	66·06	16 46	2 25	1·10	0·19	0·70	6·81	5·52	0·62
Keratophyre, Hamilton Hill, Peebles, Scotland	64 38	16·98	4 04	.	0·28	1·08	7·57	4·30	1·64
Trachyte (Orthophyre), Garleton Hill, Haddington, Scotland	61·35	16·88	0·41	5·01	0·44	2·39	5 26	6 12	1·70
Trachyte, Monte Nuovo, Phlegraean Fields, near Naples, Italy	60·33	18·74	2·84	1 29	0 38	1·15	7·15	7 30	0·56
Trachyte, Algersdorf, Bohemia	64·69	18·39		3·44	0·49	1·72	4·61	6 46	0 24

(as in the trachyte of Berkum on the Rhine) Trachytic rocks are typically porphyritic, and some of the best-known examples, such as the trachyte of Drachenfels, show this character excellently, having large sanidine crystals of tabular form 1–2 in. in length scattered through their fine-grained ground mass

Two types of ground mass are generally recognized. the trachytic, composed mainly of long, narrow, sub-parallel rods of sanidine, and the orthophyric, consisting of small, squarish or rectangular prisms of the same mineral. Sometimes granular augite or spongy riebeckite occurs in the ground mass, but as a rule this part of the rock is highly felspathic Glassy forms of trachyte (obsidians) occur, as in Iceland, and pumiceous varieties are known (in Teneriffe and elsewhere), but as contrasted with the rhyolites, trachytes have a strong tendency to crystallize, and are rarely vitreous.

Distribution.—Trachytes are well represented among the Tertiary and Recent volcanic rocks of Europe. In Britain they occur in Skye as lava flows and as dikes or intrusions, but they are much more common on the Continent, as in the Rhine district and the Eifel, also in Auvergne, Bohemia and the Euganean Hills In the neighbourhood of Rome, Naples and the island of Ischia trachytic lavas and tuffs are of common occurrence In America trachytes are less frequent, but occur in S. Dakota (Black Hills). In Iceland, the Azores, Teneriffe and Ascension there are Recent trachytic lavas, and rocks of this kind occur also in New South Wales (Cambewarra range), East Africa, Madagascar, Aden, etc

In England there are Permian trachytes in the Exeter district, and Carboniferous trachytes in many parts of the central valley of Scotland The latter differ in no essential respect from their modern representatives in Italy and the Rhine valley, but their augite and biotite are often replaced by chlorite and other secondary products Permian trachytes occur also in Thuringia and the Saar district.

Closely allied to the trachytes are the *Keratophyres*, which occur mainly in Palaeozoic strata in the Harz (Germany), in the Southern Uplands of Scotland, in Cornwall, etc. They are usually porphyritic and fluidal; and consist mainly of alkali felspar (anorthoclase principally, but also albite and orthoclase), with a small quantity of chlorite and iron oxides Many of them are lavas, but others are probably dikes or thin intrusions. As the analyses given above will show. they differ from trachytes mainly in being richer in soda. (J S F)

TRACK AND FIELD SPORTS, a term used in the United States for those sports called *athletic sports* in England. For a full description of these athletic events in England and further description of the national athletic bodies in the United States *see* ATHLETIC SPORTS and also the separate articles on each sport The article below covers only the track and field sports in the United States. They include foot-racing upon the flat and over obstacles such as hurdles, hedges and water-jumps; jumping for distance and height either with or without the aid of pole or weights, and the propulsion through the air by the use of the arms and body of objects and weights (the weight being sometimes called a shot) for distance or height such as the discus, javelin and hammer. The first national athletic body formed in America was the Intercollegiate Association of Amateur Athletics of America. Founded in 1875 it had as its original members Amherst, Columbia, Cornell, Harvard, Princeton, Trinity, Union, Williams, Wesleyan and Yale A month later these were joined by Dartmouth, Pennsylvania, College of the City of New York, Brown and Bowdoin Forty-one colleges and universities were members in 1928. The association holds two great annual championship meetings, the May outdoor meeting, instituted in 1876, and the March indoor meeting, inaugurated in 1922. In 1917, owing to the World War, no meeting was held. At the first meet, held at Saratoga in 1876, the following events were contested· 100-yd. dash, quarter-, half-, one-, and three-mile runs, one- and three-mile walk, 120-yd hurdles, shot put, baseball throw, high jump, and long jump Ten colleges were represented by 28 individual athletes At the fifty-first annual track and field championship meeting, held at Franklin field, University of Pennsylvania, in 1927, the events were the 100- and 220-yd. dashes, the 440-, 880-, one-, and two-mile runs, the 100-yd. and the 220-yd hurdles, shot put, javelin throw, running high jump, pole vault, discus throw, running broad jump and hammer throw. A total of 707 athletes represented 31 colleges and universities. In the sixth annual indoor meeting (1927), held at New York city, 289 athletes from 23 universities and colleges contested in the 70-yd dash, 70-yd. hurdles, one-mile and two-mile runs, one-mile, two-mile, and freshman medley relays, and broad jump, pole vault, high jump, shot put, and 35-lb weight event. The heavier men, outclassed on the flat and in the jumps, were given another event on the introduction of the 35-lb. weight throw in 1922. The addition of the javelin and discus events to the programmes since 1922 is ascribable to their inclusion in the schedules of the Olympic games

Among record-holders S W Carr (Yale) broke the world's record in the pole vault by vaulting 14 ft at the outdoor meeting of 1927. Clarence W. Houser (University of Southern California), holder of the world's discus record and Olympic champion in the same event, established the I.C A A.A A record for 151 ft. 3⅝ in in 1926. John Paul Jones (Cornell) in 1913 established the American college record for the mile run, 4 min. 14⅖ sec A large proportion of the winners of points for the United States in the Olympic games have previously competed in the meetings of the I C.A A A A

The Amateur Athletic Union (1888) assumes jurisdiction over track and field sports in the United States (*see* ATHLETIC SPORTS *United States*) Its amateur definition, the competitor's qualification requirement (*see* AMATEUR), while rigid, is substantially the same as that of the I C.A A A A The A A U holds annual national championship meets the schedules of which have been extended to include the javelin, discus and all-round events as affording opportunity for preparation for the Olympic games

Certain college conferences and organizations also administer track and field competitions The National Collegiate Association, which was originally organized primarily as an advisory body, has held (1928) seven annual outdoor meetings Its programme is practically identical with that of the I C.A A A A. as regards the nature of the events The N C.A A meeting at Chicago in 1927 was entered by 183 athletes from 64 colleges and universities The association affords to colleges, particularly those of the middle West and South, an opportunity for track and field competition that would otherwise be lacking. Its meetings are open to all and occasionally a few of the athletes who have competed in the I C.A A A.A. championships compete also in the meet of the N C A A. The Intercollegiate Conference ("Western Conference" or "Big Ten") has conducted some 28 annual outdoor championship track and field meetings at the last of which the programme was composed of the same events as the I C.A A A A. outdoor and the N.C.A.A schedules. Its record-holders have included such college athletes as C R. Brookline (Iowa), De Hart Hubbard (Michigan), and others. All of these conferences and associations have followed the I C.A A.A A in definition, purposes and schedules of events.

American Schoolboy Track and Field Sports.—Many college athletes have taken lively interest in the schoolboy sports of their local residential communities. Through this interest have grown up numerous organizations of public spirited citizens who co-operate with municipal authorities to provide playing space,

equipment, training and competition in track and field sports for schoolboys and thus contribute to the national welfare. The pioneer in this field is the Public School Athletic League of the City of New York, founded in 1903. In the greater city of New York, each year half a million boys are provided with some form of athletic competition, the majority being engaged in track and field sports. Over 5 million have been trained since the league's organization.

The experiences of the I.C.A.A.A.A. with college youths and of the P.S.A.L. of New York city with elementary and high schoolboys have provided a stimulus to the widespread development of track and field sports in America. Cities and villages, the nation over, are organizing schoolboys for track and field sports along the lines of the P.S.A.L. of New York city. The principal features of the work of the P.S.A.L. have been the insignificant requirements of its equipment, the adjustment of some track and field sport to almost every boy's capacity, the absence of public hysteria surrounding the competition, and the lessons of discipline and democratic associations that have resulted.

See ATHLETIC SPORTS, separate articles on the branches of track and field sports, and various team games.

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TRACTORS. The petrol (gasolene) tractor for agricultural and kindred purposes is a development of the steam traction engine, widely used for operating grain threshers and to a small extent for ploughing. Steam ploughs were used toward the end of the 19th century on the large ranches of the north-western section of the United States, in Canada and other regions involving such large scale production. Their usefulness was limited, however, owing to their great weight, which resulted in the packing of the soil and in rather inefficient operation. When the weight of the petrol engine was greatly reduced by motor-car engineers about 1900, the idea of substituting that type for the heavy steam plant naturally suggested itself. Early technical development was chiefly toward large tractors designed to operate from 6 to 12 plough bottoms, because at that time only owners of large ranches in western America showed an interest in power farming.

The large petrol tractors of that period were crude in design and very heavy; their frames were built of heavy rolled channels, and they had driving wheels of very large diameter. Their great weight naturally rendered them inefficient, for a large proportion of the engine power was consumed in moving the tractor itself.

AGRICULTURAL TRACTORS

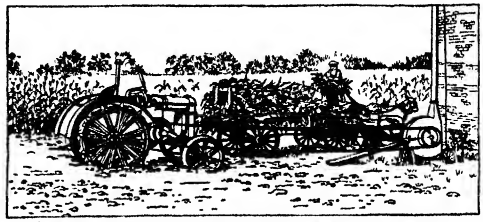
Tractors were usually rated according to the number of 14 in. plough bottoms they would pull. In 1927, of 77 models on the American market pulling two or more bottoms, 9 were two-plough tractors; 28, three-plough; 22, four-plough, and the remainder or 18, were capable of pulling five or more ploughs, up to ten. However, the tractors in the two-plough class were produced on the largest scale. Of the total of 178,074 wheeled tractors produced in the United States in 1926, 94,467 were one-plough and two-plough, while 45,523 had a rating of three-ploughs or two-to-three-ploughs. Table I shows the production of tractors in the United States.

TABLE I. *Tractor Production in the United States*

1910	4,500	1920	203,300
1912	11,400	1922	99,692
1914	10,400	1924	116,838
1916	29,670	1925	167,553
1918	132,697	1926	178,074

In 1912 the large tractors of 6 to 12 plough capacities reached their zenith, and thereafter declined rapidly. The first popular small tractor was produced the following year and in 1914 3,000 tractors of this small design were sold. Although smaller, it was still of the same crude design as the larger machines, with exposed gears, plain bearings and similar features. About 1916 a number of engineers with motor-car experience entered the tractor field, and as a result of their efforts tractor design was greatly improved.

Typical Design.—For the sake of economical manufacture many of the earlier small tractors were made with only three wheels, but the buying public did not approve of this feature of construction, and the typical 1928 wheeled tractor had four wheels, two in front for steering and two in the rear for driving. The Twin City 12–20 h.p. tractor shown in Plate I., fig. 1 is a good example of the lighter tractors based on motor-car practice.



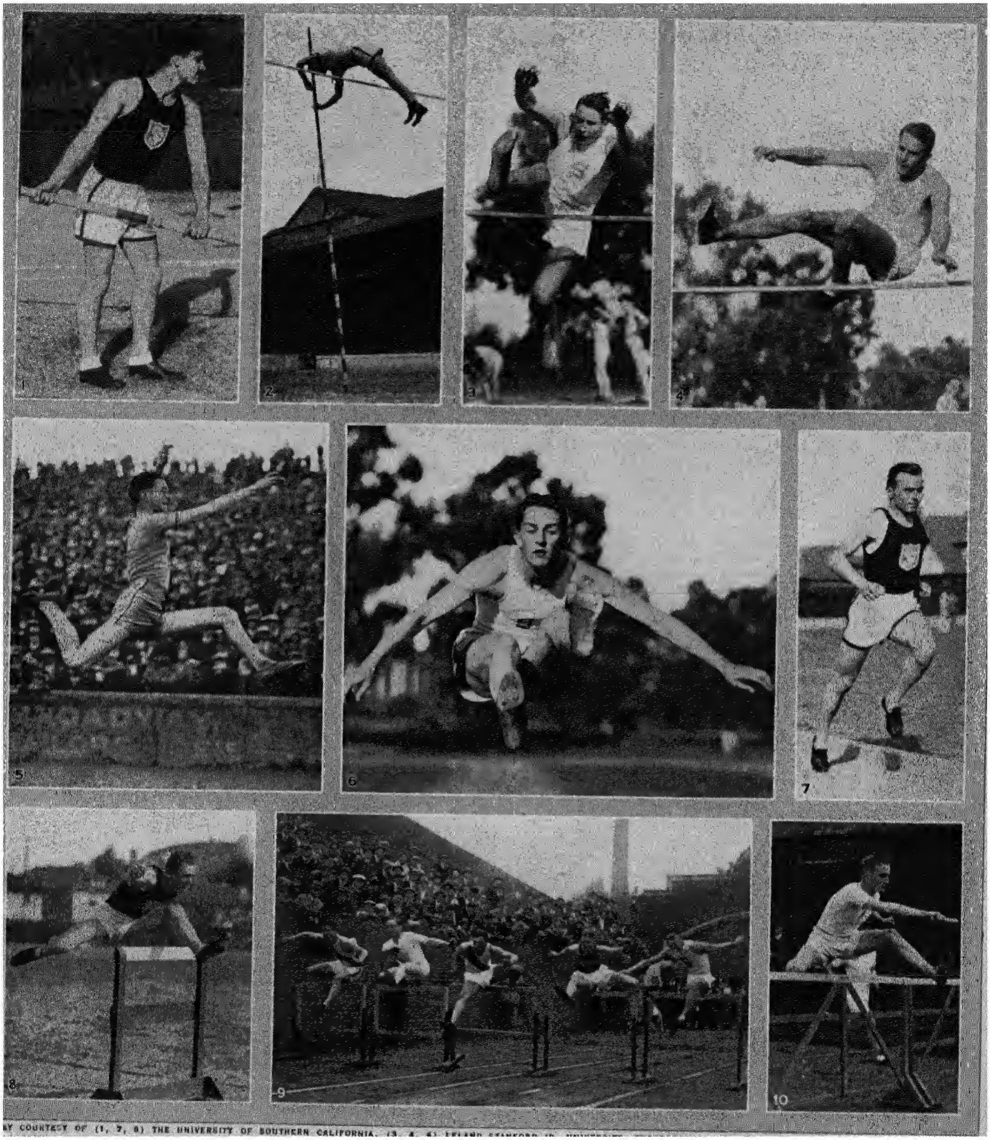
A SILAGE CUTTER AND FILLER OPERATED BY TRACTOR POWER

The tractor industry was hard hit by the heavy slump in the prices of agricultural products late in 1920. Prices of tractors and other agricultural machinery did not drop nearly as rapidly nor as much as those of farm products, and the result was a "buyers' strike," the effect of which is clearly reflected in the production figure for 1922. A very keen price competition set in, and many tractor manufacturers went out of business during the next two years. With the improvement in the economic position of the American farmer the demand for tractors increased again, but the production record set in 1920 had not been equalled up to the end of 1926. During that year the exports of tractors from the United States amounted to 27% of the total production on a numerical basis and to nearly 25% on a value basis, the actual value of exports amounting to $29,561,023. A survey made by the U.S. department of agriculture in 1927 showed that there were then 29 concerns in the country manufacturing wheeled agricultural tractors and five manufacturing the crawler type.

The Fordson Tractor.—A tractor which was manufactured in very large numbers and distributed all over the world was the Fordson, manufactured by the Ford Motor Company, Detroit, Michigan. A central longitudinal section of this machine is shown in Plate I., fig. 2. It was of the frameless or backbone type, the crankcase of the engine and the cases of the change-speed gear and rear axle forming the supporting structure. The engine had four vertical cylinders of 4 in. bore and 5 in. stroke, which were cast in a single piece with the upper half of the crankcase, the lower half of this case being a separate casting. To the rear of the crankcase was bolted a housing which enclosed the flywheel, the friction clutch and the change gearing, and also formed the rear axle housing. There was no direct "through" drive, the power being always transmitted from the upper to the lower of two parallel shafts in the gearset, and an extension of the lower shaft carried the worm which meshed with the worm wheel on the rear axle differential gear.

Changing of gear was effected not by meshing the gears, which remained in mesh continuously, but by securing one or another of the gears to the shaft by positive clutches. The rear wheels were 42 in. in diameter and the tractor was geared to give a ploughing speed of 2¾ m.p.h. with an engine speed of 1,000 r.p.m. In addition to the ploughing speed there were provided two other forward speeds and a reverse motion. Over the engine was mounted a double-compartment fuel tank holding 1 gal. of petrol and 16 gal. of kerosene, the petrol serving to start and run the engine until the carburetter was hot enough to vaporize the kerosene. Air was taken in through an air washer and the carburetter in which the kerosene, after having been sprayed into a stream of air to form a very rich mixture, was vaporised by being passed between two stampings of sheet steel, the outer faces of which were in contact with the hot exhaust gases. Additional air was mixed with this rich mixture close to the inlet valves. Ignition was by a flywheel magneto, engine lubrication by the circulating splash system, and circulation of the cooling water by the gravity or thermo-siphon

TRACK AND FIELD SPORTS



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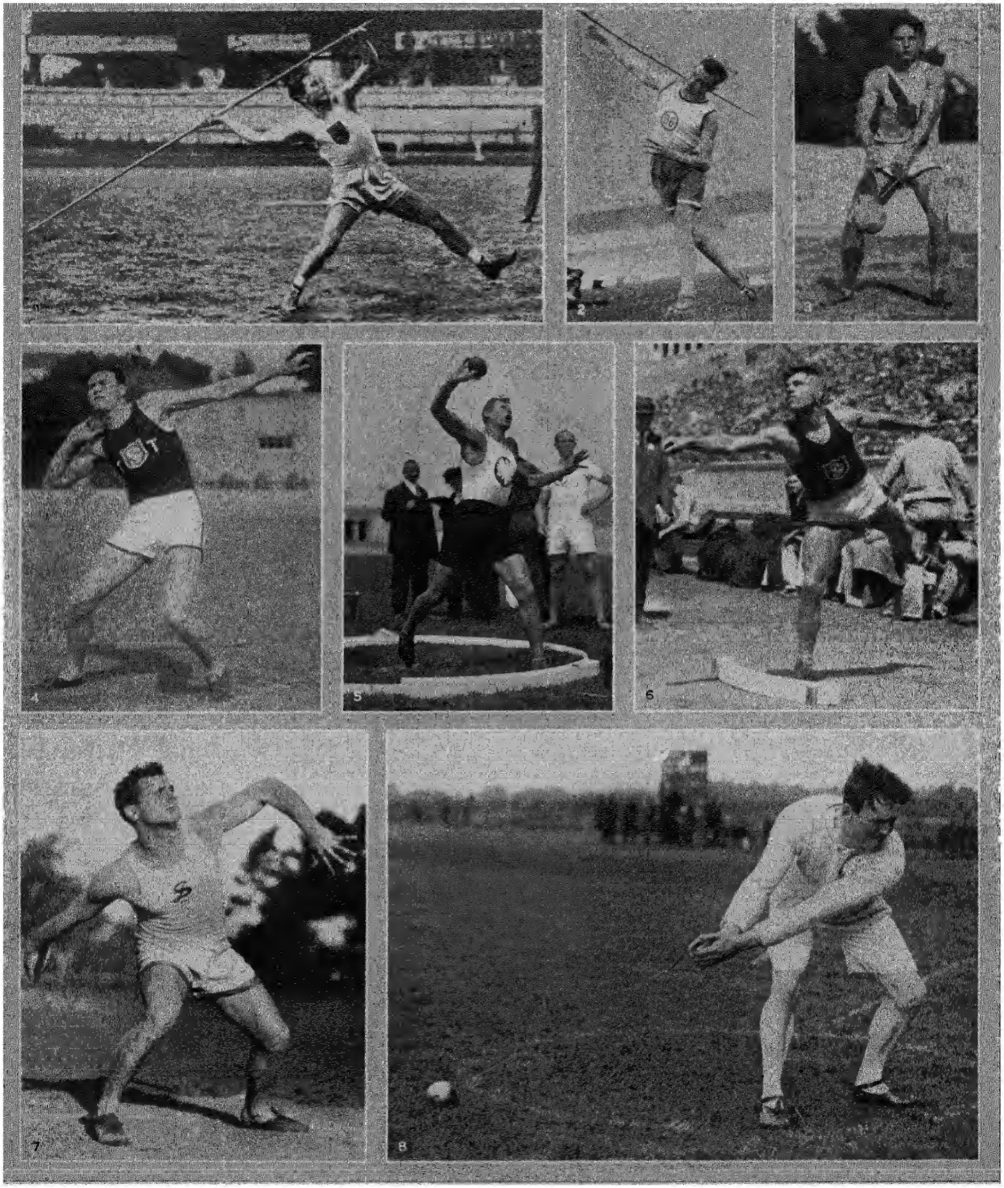
VIEWS OF ATHLETIC EVENTS

1. Pole vaulter starting his run down the cinder track preparatory to vaulting a bar between two standards
2. Perfect muscular co-ordination is required for the double action vault. Photograph shows vaulter barely clearing the bar
3. High jumper in action
4. Another high jumper clearing the bar between the standards
5. Athlete flashing through the air in a running broad jump
6. Front view of a running broad jump
7. Distance runner coming down the track with a smooth, even stride
8. Hurdler clearing one of the high hurdles at a university track and field meet
9. Closely contested high hurdle race
10. High hurdle cleared smoothly by a hurdler

TRACK AND FIELD SPORTS



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ATHLETES IN ACTION

1. Javelin thrower at beginning of the run before hurling javelin
2. Photograph shows position of javelin thrower at the moment javelin is leaving his hand
3. Athlete swinging a 56 lb. hammer preparatory to throwing it. Momentum gained by swinging adds to distance
4. Weight thrower preparing to hurl a 16 lb. shot
5. Putting the shot
6. Throngs in stadium watching a weight thrower in action
7. College athlete in act of throwing a discus
8. Hammer thrower starting his swing. He must not step outside of the 7 ft. circle

system. Unlike most others, this tractor was not fitted with an engine governor by the manufacturer, but several speciality manufacturers offered governors specially designed for it and many owners of the tractor fitted them. The Fordson tractor had a wheelbase of 63 in. and weighed 2,562 lb. complete. The front axle was swivelled at its centre on a saddle casting bolted to the front of the engine and was braced near its ends by radius rods with flexible joints extending to lugs cast on the bottom of the engine crankcase. A belt pulley for power work was provided and ran at engine speed.

General Features.—Belt pulleys formed a part of the equipment of practically all tractors, being used for operating threshing machines, wood saws, silo fillers, etc. Many tractors built after 1924 were equipped with power take-offs or auxiliary drives through gearing and shafting, which were used on the farm when hauling grain binders, corn pickers and spraying outfits; by sawmill owners for operating cut-off saws and edgers, and by road builders for operating concrete mixers. It was customary to apply a double horsepower rating; for instance, a three-plough tractor was often rated as a 12–25 h.p. machine. This signified that the tractor could develop 25 h.p. on the belt and 12 h.p. on the drawbar, the difference of 13 h.p. being required for moving the tractor itself over the field.

Crawler Tractors.—The crawler (British term "caterpillar") tractor had one or two continuous-chain tracks on which it ran. The outside tread of the chain track in contact with the ground had transverse projecting bars or depressions which caused it to grip the ground firmly, while the inside tread of the chain formed a smooth track on which rolled idler wheels mounted on the frame and carrying the weight of the tractor. The power from the engine was transmitted through a suitable reduction gear to a pair of toothed wheels which engaged with teeth or rollers on the inner side of the track and, when power was applied by letting in the clutch, the tractor rolled ahead on the track and the track at the same time rolled forward The power was applied to the two chain wheels through a differential gear, and in order to steer a tractor of this kind, one track was held stationary by a brake on the shaft of its chain wheel, while all the power was applied to the other chain wheel.

The Cletrack tractor shown in Plate I., fig. 3, was one of the smallest tractors of this type. Much of the development work in connection with crawler tractors was done in California, where the Holt, the Best and the Yuba, all tractors made in large sizes, originated. In 1927 many of these large crawler tractors were used for other than agricultural purposes—for example, in oilfields, in lumbering and in road-building. The city of New York in 1920 purchased a large number for use in clearing the streets of snow. The lumbering or logging work done was mainly in swampy districts where horses cannot work except in winter when the ground is frozen, whereas the crawler tractors make logging in such districts possible the year round. The weight on the track of a crawler tractor of the 1927 type was as low as 5 lb. per sq in., and such a tractor could go into boggy places where no wheeled vehicles could follow.

Cost and Uses.—The three chief items of cost in tractor ploughing are fuel, depreciation and labour. At the tractor trials held at Lincoln, England, in the autumn of 1919, the fuel consumption per acre averaged almost exactly 4 imp. gal. for ploughing in heavy clay soil, and 3 gal. for ploughing on cliff lands. In the corn belt of the United States, where the soil is comparatively light, it has been customary to reckon on a fuel consumption (either petrol or kerosene) of 2·5 U.S. gal. (2 imp. gal.) per acre. On the other hand, in a *Bulletin* of the U.S. dept. of Agriculture on "The Gas Tractor in Eastern Farming," a fuel consumption of 3½ U.S. gal. per acre is made the basis of cost calculations for the eastern section, and in the tractor trials held at Harrisburg, Pa., in 1919, the average fuel consumption of all tractors using kerosene worked out at 3·28 U.S. gal. (2·62 imp. gal.) per acre. The fuel consumption in tractor ploughing varies both with the character and condition of the soil and with the depth of ploughing. The average depth of ploughing at Lincoln was 5¼ inches. The resistance of the soil (drawbar pull) averaged 11·5 lb. per sq.in. for the heavy clay soil and 9 lb. per sq.in. for the cliff land. In the corn belt of the United States the soil resistance generally varies between 5·5 and 7 lb. per sq.in., and this explains the low fuel consumption in ploughing there. The estimate here given of the cost of ploughing one acre is based on the results of an inquiry by the U.S. dept. of Agriculture among 400 tractor farmers in the Dakotas concerning their experiences in 1917 and 1918. Only one change is made from the estimate of the department, namely, the assumption of a tractor life of seven instead of nine years.

TABLE II. *Average Cost and Performance of Tractor Ploughing in the Dakotas*

	Two-plough tractors	Three-plough tractors	Four-plough tractors
First cost	$1,050	$1,460	$2,000
Full working days per year	45	52	64
Acres ploughed per 10-hr day	6·3	8·5	10·9

Other factors on which the estimate is based are the following: cost of petrol, $0 276 per U.S. gal ; kerosene, $0.152 per gal ; lubricating oil, $0.50 per gal.; grease, $0 10 per lb.; repairs, 4% of the first cost per year; depreciation on a 7-year basis; man labour at $4 00 per day; interest at 6% on the average investment (one-half of total investment). Such items as housing, insurance and taxes are neglected

TABLE III. *Cost of Tractor Ploughing in the Dakotas, 1917–18*
(Dollars per acre)

Size of tractor	Total cost of ploughing		Fuel		Oil
	Gasolene tractor	Kerosene tractor	Gasolene	Kerosene	
Two-plough	2·21	1·915	0·69	0·395	0·075
Three-plough	1·975	1·680	0·69	0·395	0·075
Four-plough	1·757	1·462	0·69	0·395	0·075
Other Items					
	Grease	Repairs	Depreciation	Man labour	Interest
Two-plough	0·02	0·15	0·53	0·635	0·11
Three-plough	0·02	0·13	0·49	0·470	0·10
Four-plough	0·02	0·11	0·409	0·368	0·085

With these data a close estimate can be made of the cost of tractor ploughing under different conditions, as all the basic costs are given. The average soil resistance in the Dakotas may be assumed to be 8 lb. per sq. inch. In heavier soils the area ploughed per day will be less in substantially the inverse ratio of the soil resistance (provided the latter is not excessive). This is borne out by estimates of the ploughing capacities of the tractors which competed in the Lincoln trials of 1919. Averaging the estimates for heavy clay soil (soil resistance 11·5 lb. per sq.in.), and reckoning on the basis of a 10-hr. instead of an 8-hr. day, the following results are obtained: two-plough tractor, 4½ acres, three-plough tractor, 5⅝ acres, four-plough tractor, 6¾ acres.

Advantages.—To the American and Canadian farmer the advantage of the tractor is not so much that it reduces the cost of ploughing as compared with horses, as that it enables one man to work a much greater acreage. Approximately one-third of several hundred tractor farmers in Illinois circularised by the U S. Dept. of Agriculture had increased their acreage by purchasing tractors. Another great advantage is that the tractor permits work to be done quickly when the weather is favourable. Power farming has proved particularly advantageous in the wheat belt of Kansas where for the best yield the land must be ploughed in August, when the temperature is often above 100° F in the shade and very little work can be accomplished with horses. The tractor works as efficiently at this temperature as in winter. Moreover, the tractor can be used also for threshing, and the old practice of contract threshing has been largely superseded by the plan of four or five farmers owning a small threshing machine co-operatively

and helping each other thresh their grain, each using his own tractor as the motive power. Sometimes it is necessary to get a crop into the ground very quickly, and, with a double shift of operators, tractors can then be operated day and night.

Tractor for Row-crop Farming.—The ordinary farm tractor was designed primarily for ploughing and is not suited to the cultivation of row crops, such as Indian corn, cotton, sorghum, etc. For this work a special type of motor cultivator was developed, and while a certain degree of success was achieved with it, most of the machines of this type brought out disappeared from the market. A compromise design, the Farmall (Plate I., fig. 4), was developed by the International Harvester Company. It had two steering wheels rather close together at the front, on opposite sides of a vertical steering column, designed to pass between adjacent rows; and two driving wheels at the rear, with a tread of 74 in., which was sufficient to straddle two rows of corn. At the front the frame was supported on the steering column above the front wheels (of 25 in. dia.), while at the rear the axle was arched, the center portion being considerably higher than the wheel spindles, giving an axle clearance of 30 inches. One of the objections to many items of farm equipment is that there is use for it only a few days per year and it lies idle all the rest of the time. An all-purpose machine of this type evidently overcomes that objection to quite an extent. A large variety of tools were especially designed and others adapted for use with the Farmall.

Tractors for use in orchards, on which a number of American manufacturers specialise, must be of lower build than those for general use. A distinct type is the garden tractor, for the cultivation of row crops and general work in market gardening The Beeman, the first tractor of this type, was put on the market in 1915, and in 1926 the total number of such tractors produced in the United States (by 13 manufacturers) was 3,921.

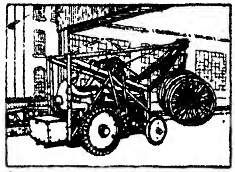
Development in Europe.—Interest in farm tractors increased greatly in Europe during and following the World War. In 1919 and 1920 tractor trials were held at Lincoln, England, the first under the auspices of the Society of Motor Manufacturers and Traders and the second under that of the Royal Agricultural Society. The French Government in 1920 paid a bonus of 25% on the purchase price of tractors of domestic manufacture and 10% on tractors of foreign manufacture. French engineers paid particular attention to tractors which must be very narrow for use in vineyards. Tractor development and application in Europe also received a severe setback about the time of the world-wide business depression of 1921, chiefly owing to the high-cost of the fuel. The tractor trials of the Royal Agricultural Society were not repeated after that date. To reduce the fuel cost item a number of compression-ignition type engines (Diesel and hot-bulb) were brought out, including the Avance in Sweden, the Lanz Acker-Bulldog and Benz-Sendling in Germany, and the Helios in Holland, these tractors using heavy liquid fuels.

In France efforts to reduce the fuel cost of tractors were directed along other lines, the machines being fitted with gas generators operating on charcoal or prepared solid fuels. Most of the tractors exhibited at the Paris Agricultural Show in 1928 had such generators. Considerable development work was done in Germany during the decade following the war, but most of it was along lines that had been covered previously in the United States. Prof. Gabriel Becker of the Charlottenburg Technical College made extensive tests and investigations on American and German tractors and published his results. The German Government in 1927 initiated a scheme for extending credit to farmers for the purchase of (German-built) tractors. The Soviet Government of Russia during the period 1925–1927 bought thousands of tractors from leading American firms and prepared to manufacture similar tractors in Russia.

INDUSTRIAL TRACTORS

These are machines designed for hauling trailer trucks over comparatively smooth surfaces such as railroad terminal and warehouse floors, steamship piers, etc. They were developed from industrial trucks which began to replace hand trucks on steamship docks and railroad platforms about 1904 Such tractors would haul a trailer load ranging from 5 to 20 tons, dependin upon the sizes, and so reduced to a great extent the manual labou required in handling freight and baggage at the terminals anc warehouses.

Industrial tractors for the above purposes generally were electrically driven, since the low fire hazard and the absence of exhaus gases characteristic of this system of drive recommended it fo indoor work. The wheel trea usually was around 30 in., and the wheelbase ranged from 40 to 48 in., while the wheels in most cases were 20 in. in diameter and equipped with solid rubber tires Although the earliest industrial tractors were steered by the front wheels, and were driven by the rear wheels, later designs fre quently were provided with a four-wheel drive and a four-wheel system of steering; the forme to give a sufficient traction even on slippery (oily or icy) surfaces and the latter to manoeuvre the trains more advantageously in restricted spaces.



A POWER WINCH MOUNTED ON A TRACTOR

Four-wheel-drive tractors were usually equipped with four-wheel brakes, which made it possible to stop them quickly in an emergency. Speeds ranged from 6 to 8 m.p h. when light, and around 4 m.p.h. when loaded. On fairly smooth surfaces the trailer trucks required a drawbar pull of approximately 50 lb. per ton. With the usual construction the normal continuous drawbar pull obtainable was about 10 per cent of the total weight of the tractor with battery. The weight of the battery amounted to 30 to 35 per cent of the total tractor weight.

Generally the operator steered by means of a lever or tille which folded out of the way when he left his seat. Three speeds in both directions were obtained by means of a controller. For safety purposes, the main switch, controller and brake were interlocked. Before the tractor could be started a pedal had to be depressed. When the operator withdrew his foot from the pedal the main switch opened and the brake was applied automatically. This tended to prevent accidents, as the tractor would come to a stop if the driver were thrown from his seat. The battery voltage used to drive the tractors was either 32 or 48 volts

ROAD TRACTORS

The road tractor (or tractor-truck, as it is often called in the United States) was developed from the lorry. It differs from the latter only in having a shorter wheelbase and in that, instead of being provided with a platform or other body for carrying loads, it is fitted with a bolster on the frame over its rear axle which carries the forward end of a semi-trailer through a fifth wheel Whereas in the conventional lorry nearly all of the useful load is carried on the rear wheels, in a tractor-trailer combination it can be equally divided between the rear wheels of the tractor and the two wheels of the trailer, so that a much greater load can be carried. Moreover, by far the most expensive part of the combination is the tractor, and this need not be kept idle during periods of loading and unloading, but can be kept busy all the time, providing a sufficient number of trailers is available. When the semi-trailer is being loaded or unloaded its forward end rests on jacks or folding supports with caster wheels. Coupling of the semi-trailer to the tractor is effected automatically by simply backing the tractor up to the trailer, and uncoupling is an equally simple operation. Road tractors for hauling semi-trailers have been built with electric, steam and petrol power-plants.

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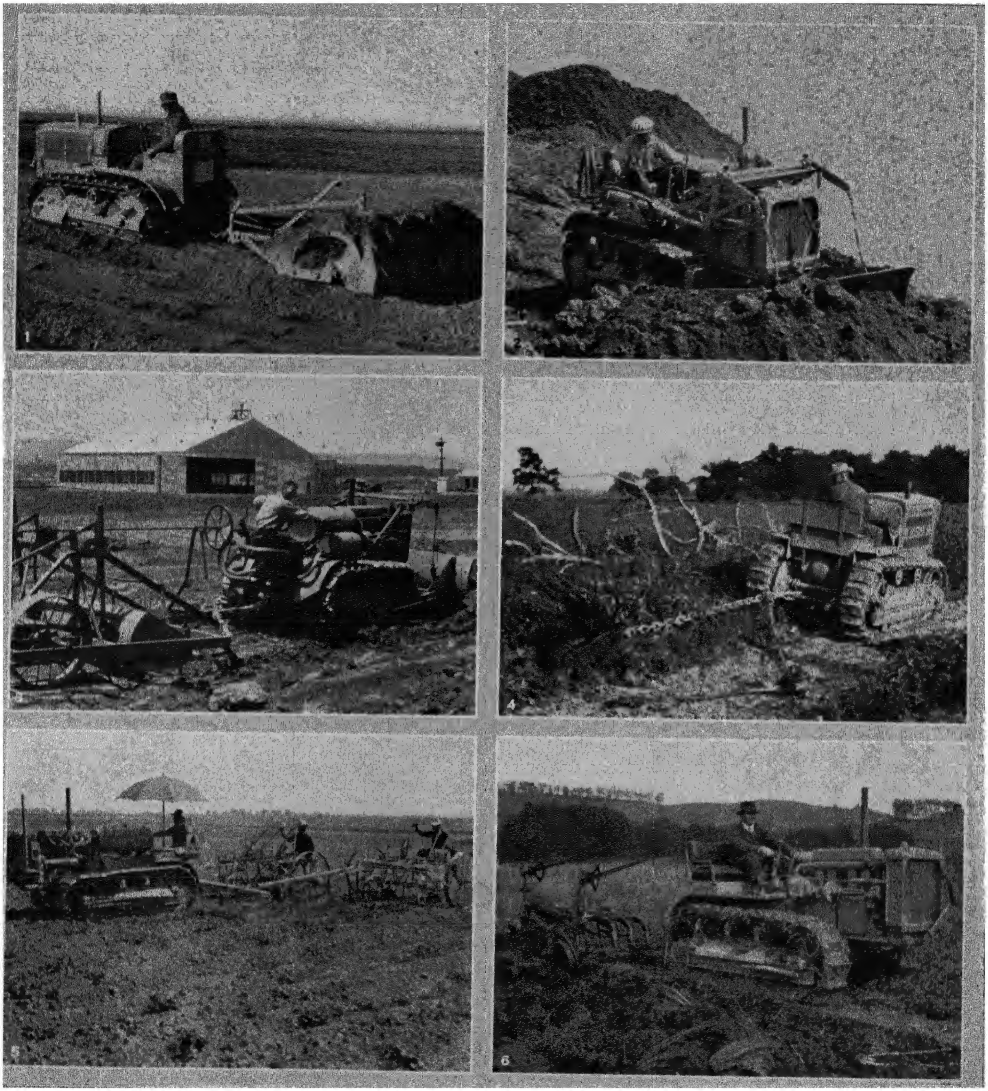
(P. M. H.)

TRACY, ANTOINE LOUIS CLAUDE DESTUTT, COMTE DE (1754–1836), French philosopher, son of a distinguished soldier was born in Bourbonnais on July 20, 1754 He

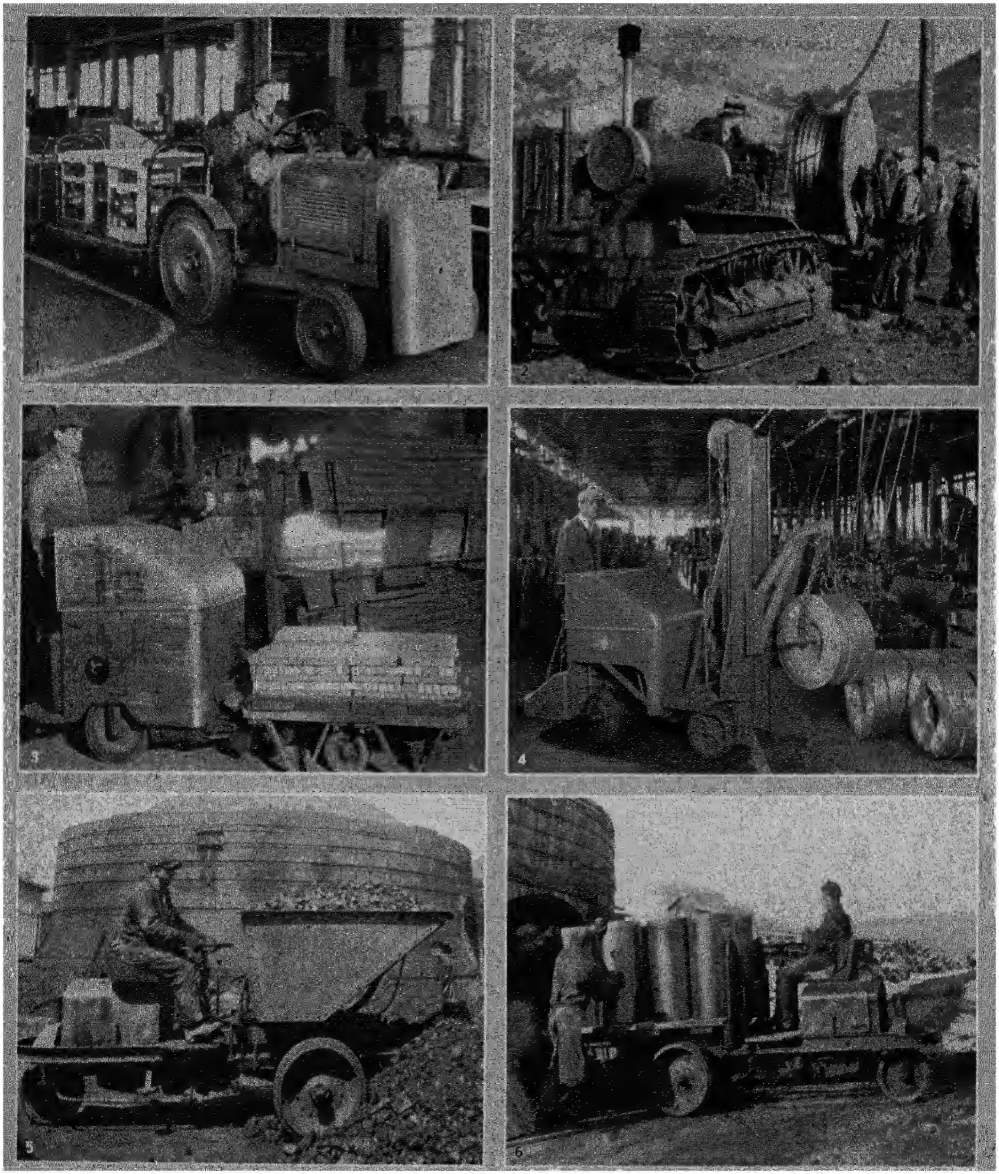


BY COURTESY OF (1, 2, 3, 5, 6) THE CATERPILLAR TRACTOR COMPANY, (4) THE ELECTRIC WHEEL COMPANY

MODERN USES OF TRACTORS

1. Type of tractor used for the development of a 1650-acre potato field on Victoria Island. The scraper is used to level the ground for irrigation purposes
2. Caterpillar tractor of the type largely used in construction work, spreading dirt delivered by trucks
3. Tractor leveling piles of dirt that have been delivered by trucks
4. Five-ton tractor pulling out tree stumps in order to facilitate cultivation
5. Caterpillar tractor pulling two double-row cultivators in a cotton field. Eight rows to the round can be cultivated by this method
6. Discing land with a caterpillar tractor, the first step in preparing the soil for the next year's crop

TRACTORS



BY COURTESY OF (1, 3, 4, 5, 6) THE CLARK TRUCTRACTOR COMPANY, (2) THE CATERPILLAR TRACTOR COMPANY

TRACTOR ADAPTATIONS

1. "Clarktor" Tructractor pulling heavy trailer trains
2. Stringing telephone cable with a caterpillar tractor equipped with a Willamette winch on the rear. Cable comes in reels weighing 2½ tons each
3. A Clark Truclift standing up under a heavy load in foundry
4. Clark Tructier crane lifting three heavy car wheels
5. An automatic end dump Tructractor at work in an Ohio clay manufacturing plant
6. Tructractor in operation in a clay plant in Pennsylvania. Side stakes of the platform have been removed to facilitate loading

belonged to a noble family of Scotch descent, settled in France in the 15th century. He studied at Strasbourg, entered the army, and when the Revolution broke took an active part in the provincial assembly of Bourbonnais. He was elected a deputy of the nobility to the states-general, where he sat with his friend La Fayette. In the spring of 1792 he received the rank of *maréchal de camp* in command of the cavalry in the army of the north; but when the Left became predominant took indefinite leave. He settled at Auteuil, where, with Condorcet and Cabanis, he devoted himself to scientific studies. Under the Terror he was imprisoned for nearly a year, during which he studied Condillac and Locke, and abandoned the natural sciences for philosophy. As an associate of the Institute he wrote the papers which formed the first draft of his comprehensive work on ideology. The society of "ideologists" at Auteuil embraced, besides Cabanis and Tracy, Volney and Garat (1749–1833), professor in the National Institute. Destutt de Tracy died in Paris on March 9, 1836.

Destutt de Tracy was the last eminent representative of the sensualist school which Condillac (*q.v.*) founded in France upon a one-sided interpretation of Locke. He pushed the sensualist principles of Condillac to their last consequences, being in full agreement with the materialistic views of Cabanis, though the attention of the latter was devoted more to the physiological, that of Tracy to the psychological or "ideological" side of man. His ideology, he frankly stated, formed "a part of zoology," or, as we should say, of biology. The four faculties into which he divides the conscious life—perception, memory, judgment, will—are all varieties of sensation As a psychologist de Tracy deserves credit for his distinction between active and passive touch, which developed into the theory of the muscular sense. His account of the notion of external existence, as derived, not from pure sensation, but from the experience of action on the one hand and resistance on the other, may be compared with the account of Bain and later psychologists. His chief works are *Eléments d'idéologie* (1801–15; 2nd ed, 1824–25), *Commentaire sur l'Esprit des lois de Montesquieu* (1806, 5th ed., 1828; Eng. trans., President Jefferson 1811), *Essai sur le génie et les ouvrages de Montesquieu* (1808).

See F. Picavet, *Les Idéologues* chs. v. and vi. (1891), V. Stepanowa, *Destutt de Tracy, eine historische psychologische studie* (Zürich, 1908).

TRADE. *See* COMMERCE, TRADE; WORLD STATISTICS; BALANCE OF TRADE; FREE TRADE; PROTECTION; TARIFFS; TRADE ORGANIZATION; and also the sections dealing with trade and commerce under the various countries. For the English Board of Trade, *see* GOVERNMENT DEPARTMENTS; for international trade congresses, *see* INTERNATIONAL TRADE ASSOCIATIONS AND CONGRESSES; for trade disputes, *see* STRIKES AND LOCKOUTS.

TRADE, PRIMITIVE. The importance of trade to primitive races is seldom realized. Exchange of goods among them is certainly limited in extent; often only specified classes of objects are allowed to change hands, and many commodities are exempt from such traffic, as the land of the clan or tribe. Nevertheless trade, *i.e.*, a regular series of acts of exchange, is a distinct feature in the life of primitive peoples, even the lowest, who live by hunting and collecting forest products. The principle of reciprocal transfer of goods, of giving and taking, seems in fact to be deep-rooted in human nature.

Trade has two aspects, intra-communal, between members of the same community, and extra-communal, between members of different communities. The latter is of more interest, especially since, by the widely accepted theory of Karl Bücher, those few primitive folk who have advanced beyond the pre-economic stage of existence are still in a state of closed household economy. Each little group is imagined as self-sufficient, its needs and products in equilibrium, and trade between them, being unnecessary, is therefore held to be absent. More adequate study, however, shows that this idea is quite erroneous.

Types of Trade.—1. Most spectacular is the institution variously described as the *silent trade*, "dumb barter" (*Stummer Handel*) or depot trade (*Le Commerce par dépôts*). Mentioned by Herodotus, this method of exchange was practised by the Carthaginians in their traffic for gold with the African tribes beyond the Pillars of Hercules, and was noted by Fa Hien, Ibn Batuta and other early travellers. In the most general form of procedure one party goes to the customary spot, lays down goods and retires into the bush or to a distance, giving as a signal a call or a gong-stroke. The other people then come, lay down what they consider to be articles of equivalent value, and retreat in their turn. The first party then comes back and if satisfied with the bargain removes the newly-deposited goods; if not, these are allowed to remain until suitable additions are made. The people of the second party then take away the original wares and the transaction is concluded Neither party holds any communication with the other, beyond giving the customary signal, hence the name of "silent trade." This widespread institution is reported from such diverse regions as north Russia, Lapland, west Africa, Timor, Sumatra, India, Ceylon and north New Guinea. It is found especially where people of a fairly primitive type conduct habitual exchange with those of a somewhat higher culture. Thus the Akka pygmies obtain bananas in exchange for meat from neighbouring agricultural tribes, and the Veddah obtain iron implements from Singhalese smiths in return for game. Elements of shyness and fear are obviously involved in this custom, which thus secures economic benefits for people who shun foreign contracts

2. In the *gift-exchange* the transaction takes the form of present and counter-present often between host and guest. A good example is afforded by the Maori of New Zealand. Exchange was conducted quite in the manner of gift-making; no bargaining upset the proceedings; such was not *tika* ("correct"). At the same time a very strict system of reciprocity was in force, by which the recipient of the gift was bound, as he valued his name and reputation, to make adequate repayment. This was expected by the donor Such was the idea of *utu*, equivalence, which ran through all Maori social life. But the recipient usually tried, if possible, to give back greater value than he received, not through generosity, but since his own prestige would thereby be enhanced. Even where the exchange was primarily a matter of securing necessaries of life, as food or garments, the desire to obtain fame by being liberal strove with the wish to have the economic advantage. As Malinowski, Thurnwald, Radcliffe-Brown and Raymond Firth have shown, these are the twin psychological factors lying at the root of every exchange of gifts.

3. *Barter* consists in the direct transfer of goods against goods Unlike the gift exchange, it implies agreement as to rates, with the possibility of haggling over quantities and values. A system of barter in certain commodities may co-exist with gift-exchange in others of greater social import, as in the Trobriands, where, as described by Dr. Bronislaw Malinowski, the *Kula*, or exchange of valuable arm shells and necklaces is conducted along polite, strictly ceremonial lines, while the *gimwali*, the barter of fish for vegetables, is carried on with haggling as to size and quantity, and even acrimonious wrangling. Barter in abstract form is often supposed to be typical of primitive peoples. But very rarely in any native community is the rate of exchange for goods determined by purely economic considerations of supply and demand working on the principle of rational utility alone.

4. *Buying and Selling* avoids the awkwardness of barter by the use of some medium of exchange. Much of what is often described as "primitive money" is wrongly so termed, but in various parts of Africa, for instance, cloth, iron, cowrie shells and salt do act as true currency, as also, apparently, do coconuts in the Nicobar islands. (*See* CURRENCY, PRIMITIVE.)

Occasions of trade on a large scale among primitive peoples are provided by expeditions and markets.

Trading Expeditions.—In some areas itinerant traders, as the Hausa hawkers in parts of Africa, play an important rôle in economic life. In others their place is taken by caravans, as those of the Arabs, regularly equipped and following recognized trade routes. Of great interest, again, as being accomplished by more primitive folk, are such group expeditions as those of the Dieri and other Central Australian tribes, who will travel on foot for 400–500 miles to procure red ochre and the *pituri* plant. Noteworthy also are the trading voyages, in unwieldly dug-out canoes,

of the people around the New Guinea coast, as the sailing trips of the Siassi of the North, the *hiri* of the Motu, in which pots are taken to the Papuan gulf and exchanged for sago, and the *Kula* of the Trobriands, the ceremonial exchange of valuable ornaments.

Primitive Markets are of varied kind and wide distribution. Their great home is Africa, but they have also been described from Guiana, old Mexico and Peru, Hawaii and various Melanesian areas. A typical example at either end of the scale will serve for illustration. The inhabitants of certain small islets off the coast of Malaita, Solomon islands, barter fish with those of the mainland for vegetables and pigs. Almost every day at times arranged beforehand with the bush natives, the islanders resort in their canoes to recognized places on the beach. The men then stand guard with spears, while the actual bartering is done by the women, who, thus covered, advance slowly towards one another, produce in hand. Disputes at these markets are rare, though at other times the island natives cannot venture ashore without risk. In parts of Africa this institution is more imposing. Among the Akikuyu of the East, markets in a thickly populated district are no more than ¾ m. apart, and are of great importance in the life of the people. They occur very frequently in the week, but are so arranged as not to clash with others in the neighbourhood, so that a person may visit them all in turn. About 9 o'clock in the morning the paths begin to fill with natives carrying loads of corn, firewood, beer or iron to exchange, and between 11 and 1 business is at its height, the concourse numbering perhaps 4,000–5,000 people. Order is maintained by special officers and no weapons are allowed within the precincts. The main characteristics of a market as a mode of conducting trade are its set time and regular recurrence, the definite place of assembly and the regulations by which order is preserved.

Psychology of the Trading Process.—The motives behind primitive trade are many-sided. The central factor is undoubtedly the desire for rational gain, for securing objects of economic utility otherwise unprocurable owing to variations in natural conditions or specialized skill. But the psychological background is more complex than this. Trade is often carried on in articles charged with great social and ceremonial meaning, as in ornaments, but of no direct practical interest. Moreover, the desire for renown and prestige is often a prominent element in the exchange, while the transaction itself may assist in cementing social bonds.

The value of goods, too, is determined by a complex set of factors. Even in the case of things apparently desired merely for their practical utility there is not such an objective standard of valuation as obtains in modern society, *i.e.*, personal factors enter much into the exchange. The extent to which emotional elements lie at the root of value is shown in the case of such objects as *tiki* and other greenstone ornaments of the Maori, heirlooms of great wealth and the principal articles of ceremonial exchange. Their worth lies in their historical association with dead chiefs and ancestors of renown, in their sacredness and importance as symbols of the tribal greatness rather than in their practical use for adornment.

Theory of Primitive Trade.—The principal types of trade in primitive culture were once regarded as successive products in evolutionary development. Modern research, however, tries to study each particular system of trade in its own cultural setting. The primitive market in its various forms, for instance, cannot be understood if conceived simply as an evolutionary sequence from the customs of silent trade (Grierson) or as a development from previous hostile relations (Müller-Lyer) or as the result of a recurring assemblage of people for religious or ceremonial purposes (Ling Roth). It is explicable only as an institution *sui generis* which emerges in response to certain needs, and is conditioned by the natural situation and the social structure of the community which it serves. So also with primitive trade in general. It is more than a mere matter of economic trafficking on abstract principles of national advantage; it is a complex social mechanism linked to many aspects of native life. The true problem does not lie in theorizing about its historical or evolutionary origins but in disentangling the various social and psychological factors which together determine the form of the living institution.

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TRADE: WORLD STATISTICS. 1. The 16th, 17th and 18th Centuries.—The sea is the great highway of international commerce and it was the discovery of the Cape of Good Hope route to the East Indies and the discovery of America at the end of the 15th century which opened the world to commerce. Before that time the spices, sugar, silk and other luxuries of the East came into European hands only when they had filtered overland to the seaboards of the Mediterranean and Black seas. Thus the carrying trade of Europe was focussed in the Mediterranean, and in the fifteenth century Venice had established herself as the great market and carrier of Europe. Statistics relating to these early times are far between and generally unreliable, but it is said that Venice, at the height of her glory in the 15th century, could dispose of 3,300 ships, 36,000 mariners and 16,000 dock hands. The number of the crew was in proportion to the burthen, one man for every 10,000 lb. of capacity, so that the carrying capacity of the fleet may well have approached 150,000 tons. Complementary to the eastern trade route was the western route extending by sea to the ports of England and Flanders; thus Venetians exchanged the luxuries of the East for the wool and woollen cloth of the North. Further north, the carrying trade was largely in the hands of the Hanseatic League

With the discovery of the Cape route to the Indies, the centre of trade shifted from the Mediterranean to the western seaboard of Europe. The Portuguese were bending all their energies to the development of the Indian sea-route and, by the end of the 15th century, the Dutch had established their supremacy in the carrying trade and Amsterdam had become the emporium of Europe.

As Sir Walter Raleigh showed in 1603 in his famous *Observations concerning the trade and commerce of England with the Dutch and other foreign nations,* it was largely owing to the development of their herring fishing industry, which trained both sailors and shipbuilders, that the Dutch were able to become the great carriers of Europe's trade. They maintained this position till the end of the 17th century when the wars in which they were involved, together with the economic development of England and France, destroyed their trade supremacy.

Sir William Petty in one of his essays on "Political Arithmetick," published in 1690 but written some years earlier, gives some interesting estimates of Europe's mercantile marine at that time. He wrote, "The value of the shipping of Europe, being about two Millions of Tons, I suppose the English have Five Hundred Thousand, the Dutch Nine Hundred Thousand, the French an Hundred Thousand, the Hamburgers, and the subjects of Denmark, Sweden, and the Town of Dantzick Two Hundred and Fifty Thousand, and Spain, Portugal, Italy, etc. Two Hundred and Fifty Thousand." Later in the same essay, he estimates the total value of the merchandise carried by Europe's shipping at £45,000,000 a year. Petty appears to have based his estimates of shipping on one seaman being required for every ten tons of shipping. He probably meant to include Scotland and Ireland with England but even so his figure of 500,000 tons appears to be on the high side. The first complete return of England's mercantile marine was obtained by the commissioners of customs in 1701–2, when it appeared that there belonged to all the ports of England and Wales 3,281 vessels, measuring (or rather supposed

to measure) 261,222 tons and carrying 27,196 men. By 1760, on the eve of the industrial revolution, the number of vessels had grown to 6,105 of the reputed burden of 433,922 tons, while in addition there belonged to Scotland 976 vessels of 52,818 tons.

There is one exception to the general absence of real statistics of shipping in the age before the industrial revolution. From about the year 1429 all vessels passing the Sound were liable to pay dues to Denmark and particulars of each ship passing, varying from time to time in their detail, were entered in the records. Some of the earlier records are missing but two volumes entitled *Tables de la Navigation et du Transport des Marchandises passant par le Sund, 1497–1660,* edited by Fröken Nina Bang, contain the available information. The figures naturally reflect the commercial progress of the countries bordering on the Baltic. The first two years for which the records are extant are 1497 and 1503; averaging these two years, the number of vessels passing the Sound (each vessel is counted both outwards and inwards) was 1,009 of which 712 were Dutch and most of the rest belonged to the Hanseatic towns. In the ten years 1538–47 the average number of ships a year was 1,442. The average annual number in each decade then rose steadily till the end of the 16th century, being 5,623 vessels per annum in the years 1590–99 Then the numbers fell off again and in the period 1650–57 averaged only 3,015 per annum. Throughout the period, with rare exceptions, over half the vessels were Dutch and usually about two-thirds of them were Dutch. From 1536 to 1645 the Dutch vessels are shown according to their capacity—over 100 lasts (a last is about 2 tons), 30–100 lasts, and under 30 lasts About 40% of the Dutch vessels were recorded as over 100 lasts in the early years but thereafter the proportion so recorded fell off. About the year 1618, however, the regulations appear to have been tightened up and in the following decade about half the Dutch vessels were recorded as over 100 lasts. Thereafter the proportion of vessels of over 100 lasts increased and accounted for about 90% of all vessels in the period 1640–45. Throughout the period the number of English and Scottish vessels rarely exceeded 10% of the total

In the century or so preceding the industrial revolution, the development of international trade was normal in degree, depending mainly on the increase of population and any cheapening in transport caused by improvements in the arts of navigation and shipbuilding. Nations were on the whole self-dependent for the means of livelihood of their people and international commerce consisted of the exchange of surplus products for luxuries from other lands But with the industrial revolution all this was changed. First England and later other industrial countries became essentially dependent on external trade. Manufactures were made largely from imported materials and the industrial population tended to depend more and more on imported supplies of foodstuffs, both received in exchange for exports of manufactures. International trade increased at a tremendous rate. About the middle of the 19th century a further great stimulus was given to commerce by the cheapening and acceleration of transport through the development of the steamship and the railway.

We have already seen that in 1760 the reputed burden of the vessels belonging to England and Wales was 434,000 tons. By the year 1800 the figure had grown to 1,467,000 tons, in spite of severe losses in the war with France. The tonnage of all vessels entering and clearing ports of Great Britain from or to foreign countries also increased about fourfold in this period of 40 years. On the other hand the wars practically destroyed the carrying trade of Holland. Reverting for a moment to vessels entering and leaving the Baltic, the numbers passing the Sound in certain years were as given in the table in the next column.

Vessels Passing the Sound in Certain Years

Flags	1772	1791	1798
Dutch	2,145	1,736	None
British	1,894	3,720	3,313
Danish	973	1,394	1,825
Swedish	805	1,816	2,120
Prussian	326	430	1,621
Other flags	537	1,356	629
Total	6,680	10,452	9,508

2. Commerce of the United Kingdom, United States, France and Germany to 1913.—In the foregoing sketch of the development of commerce up to the end of the 18th century, the carrying capacity of shipping has been our best guide. With the development of trade in highly manufactured and valuable articles occupying comparatively little space, shipping capacity becomes a less satisfactory measure; a ton of coal or of iron ore and of cotton piece-goods or machinery have values of quite different orders. About the same time figures of the total value of imports into and exports from the principal trading countries become available and, as late as 1880, about 75 per cent. by value of the goods passing in the trade of world were imports or exports of the United Kingdom, the United States, France and Germany.

In interpreting figures of value the effects of changes in the level of prices must be borne in mind. The following table shows the fluctuations in general prices in the United Kingdom at ten-yearly intervals between 1791 and 1926, as shown by Jevons' index numbers from 1791 to 1846 and Sauerbeck's index numbers from 1846 to 1926 The average of the years 1867–77 is taken as 100 and the two series have been linked on the respective index numbers in the year 1846.

1791	107	1871	100
1801	168	1881	85
1811	164	1891	72
1821	113	1901	70
1831	99	1911	80
1841	102	1921	155
1851	75	1926	127
1861	98		

At the time of the revolutionary and Napoleonic wars prices increased very greatly. After the wars, prices drifted downwards on the whole till about 1850 In the next 25 years they moved upwards reaching a high point (111) in 1873 but dropped back again in the last quarter of the century to some 30 per cent. below the datum line Prices then increased steadily till the outbreak of the World War. The effect of the war was to increase them very greatly, but since 1920, there has been a substantial fall in the general level, as there was after the wars a century earlier.

(*a*) *The United Kingdom* —A systematic record of the official value of the imports into and exports from England from 1699 to 1778, the same for Great Britain from 1779 to 1800, and for the United Kingdom from 1801 to 1853 is given in *Custom Tariffs of the United Kingdom, 1800–1877* (1897) The official values were based on the old valuations laid down at the end of the 17th century. It follows that, while they may afford a basis for estimating the volume of trade from year to year, they give no correct idea of the value of the trade of each year at current prices In 1798, however, an *ad valorem* convoy duty was imposed on domestic exports and this made it possible to ascertain the real current value of exports. For imports and re-exports, it was not till 1854 that the old official values gave way to current values. Trade with Ireland is excluded from the following figures throughout.

Around the year 1700 the official value of imports into England was about £5,500,000 and that of exports about £6,000,000. During the next 60 years the figures increased slowly but steadily and around 1760 were about £8,500,000 for imports and £13,000,000 for exports. From 1760 to 1785 imports continued to grow, exceeding £14,000,000 in the latter year, but exports remained stationary. In the next 15 years, however, both imports and exports about doubled. From the beginning of the 19th century the figures relate to the United Kingdom and about the same time real values become available for exports of domestic produce and manufactures. In the year 1805, the official value of the imports was £28,561,000 and that of the exports £31,064,000, of which £23,377,000 represented exports of domestic produce and manufacture and the remainder exports of imported merchandise; the real value, however, of the domestic exports was £38,077,000, *i.e.*, about 60 per cent. above the official value.

The volume of imports, so far as it can be judged on the basis of these official values, remained about steady from 1805 to 1822, doubled in the next 15 years and again about doubled in the fol-

lowing 15 years (up to 1853). The official values of British exports in this period have little significance beyond illustrating, by comparison with the real values, the enormous decline in the prices of our exports, due partly to the general fall in prices and partly to the effects of the development of the factory system in cheapening manufacturing costs While, as shown above, the real value in 1805 was over 60% above the official value, by 1840 the real value was only half the official value: in other words export prices in 1840 were, on average, less than one-third of what they had been 35 years earlier. The real value of domestic exports was £36,966,000 in 1822, £47,381,000 as late as 1842 and then increased rapidly to £98,934,000 in 1853. The following table shows the real value of the domestic exports, and of the retained imports (*i.e*, total imports less re-exports) in annual averages from 1855 to 1913, together with the population.

Annual averages	Retained imports	Domestic exports	Population
	Million £	Million £	Millions
1855–9	146·1	116·1	28·2
1860–4	193·8	138·4	29·2
1865–9 . . .	237·7	181·1	30·4
1870–4	290·6	234·8	31 9
1875–9 .	319·5	201·5	33·6
1880–4 . . .	343·6	234·3	35·2
1885–9 . .	318·8	226·2	36·6
1890–4 . .	357·1	234·4	38·2
1895–9 .	392·7	237 8	40·0
1900–4 .	466.1	{ 282·8 / 288·7* }	41·9
1905–9	522.1	377·3*	43·7
1910–3	611.0	474 2*	45·5

*Including value of exports of ships and boats (new) with their machinery recorded from 1899 only.

Throughout the period shown in the table imports have consistently exceeded exports in value This difference has been more than made up by receipts from such items as shipping earnings and returns from overseas investment

Considering first domestic exports, there was a very rapid rate of progress up to 1872, when the figure of £256,000,000 was reached. In the next 25 years there was comparatively little increase in values, owing partly to increased competition from other countries which were now manufacturing on a substantial scale and partly to the fall in prices Then followed a period of rapid expansion till 1913 when the figure was £525,000.000 In 1854, 90%, by value, of the domestic exports consisted of articles wholly or partly manufactured, while in 1913 the proportion of manufactured articles had fallen to 78% of the total Exports of coal accounted for a considerable proportion of the remainder

The course of retained imports was similar. Their value was £134,000,000 in 1854 and increased rapidly to £315,000,000 in 1873; then till 1895 progress was slow, the figure in that year being £356,000,000, but thereafter there was, on the whole, a rapid increase till 1913 when the figure of £659,000,000 was reached Of the retained imports, only 15% in 1854 consisted of articles wholly or partly manufactured, but by 1913 the proportion had increased to 25 per cent The great bulk of the imports consisted of foodstuffs and raw materials of industry, raw materials predominating in the earlier years, and foodstuffs (including drink and tobacco) from about 1875

In 1855–9 imports and exports per head of population averaged about £9.5s and by 1870–4 the figure had grown to about £16. As late as 1895–9 the figure was still about £16, but by 1910–13 it had increased to nearly £24

(*b*) *The United States*—Figures of the value of imports and exports are available for the United States as far back as 1790. At that time the population was rather under 4,000,000 and being concentrated mainly on the seaboard, was more dependent on overseas trade than later when the internal resources of the continent were developed This is reflected in the trade statistics. In the decade 1790–1800 the value of imports and exports together averaged $22 per head of population; and in the decade 1821–30 the value per head dropped to rather under $10. The value per head then gradually increased to about $25 in the period 1871–80. Thereafter there was a set-back and progress was not resumed till the beginning of the present century. On the annual average of the years 1910–13, the imports and exports per head had increased to $39.

But while the external trade per head of population has been comparatively small, the aggregate value of the trade has increased enormously, owing to the rapid rate of the growth of population. In the decade 1790–1800, imports and exports together averaged annually $100,000,000; in 1821–30 the annual average was $142,000,000; and in 1841–50 it had increased to $244,000,000. The following table shows the value, both in dollars and sterling, of the domestic exports and the retained imports in five-year annual averages from 1850 to 1913, together with the population·

5-year annual averages	Retained imports		Domestic exports		Population
	Million dollars	Million £	Million dollars	Million £	Millions
1855–9	288·0	59·2	256·9	52 8	28 9
1860–4	266·0	54·8	208 7	42·9	32·7
1865–9	354·7	72·9	221·4	45·5	36·2
1870–4	550·8	113·2	468·1	96 2	40·6
1875–9	468·1	96·2	606 8	124·7	46·4
1880–4	681·7	140·1	804·8	165 4	52·5
1885–9	677·8	139 3	711·4	146·2	58·7
1890–4	791·7	162·7	898·7	184·7	65·1
1895–9	708·0	145·5	1,034·5	212·6	71·6
1900–4	905·1	186·0	1,422·4	292 3	79·0
1905–9	1,247·7	256·4	1,730 9	355 7	87·3
1910–13	1,624·3	333 8	2,109 5	433·5	94·6

Up to the year 1873 the value of imports exceeded that of exports, in spite of the fact that the United States authorities value imports in the country of shipment and so exclude the freight and insurance charges from the recorded values This excess of imports was mainly due to the fact that the United States was borrowing large amounts of capital from Great Britain for purposes of internal development; another reason is that the United States was still earning considerable sums from its mercantile marine, since the era of wooden ships, of which they had a large merchant navy, was not yet over From 1873 to 1895 exports only slightly exceeded imports in value, but in the next ten years exports developed more rapidly than imports From 1905 to 1913 both imports and exports increased at about the same rate

The following table shows the relative distribution of (1) foodstuffs (crude or manufactured), (2) raw materials for industry and (3) articles wholly or partly manufactured among the total imports and domestic exports from 1860 In the thirty years before that date the changes were comparatively small

Years ended June 30	Total imports			Domestic exports		
	Food-stuffs	Raw materials	Manufactures	Food-stuffs	Raw materials	Manufactures
	%	%	%	%	%	%
1860	29·9	11·6	58·5	16 1	68·6	15 3
1870	34 4	13 0	52·6	24 0	56·8	18·6
1880	32·7	21·3	46·0	55 8	29·4	14 8
1890.	33·2	22·8	44·0	42·2	36·6	20·2
1900.	27·2	33·1	39·7	39·8	24·8	35·4
1910.	21 0	37·1	41·9	21·6	33·6	44·8
1913.	22·4	35·8	41·8	20·7	30 5	48 8

The above table brings out very clearly the growth in the relative importance of industry in the United States during the fifty years before the war Among the imports, the relative importance of raw materials for industry increased threefold while the relative importance of manufactured articles declined by about one-third. On the export side the United States has tended more and more to export manufactures instead of raw materials of industry The high proportion of foodstuffs exported in the last quarter of the 19th century was mainly due to the rapid development of cereal cultivation. As the population and the standard of living steadily increased, the surplus available for export relatively declined, while at the same time the exports of manufactures increased.

(*c*) *France.*—Satisfactory figures of French trade first become available in 1815. Up to and including 1846 standard official unit values (fixed in 1826 and applied retrospectively to the recorded quantities for earlier years) were used, so that the figures represent the volume of trade rather than its real value. The following table gives the figures at decennial intervals throughout this period, together with the population.

	Imports for consumption	Domestic exports	Population
	Million £	Million £	Millions
1815	8·0	16·9	29·4
1825	10·0	21·8	31·4
1835	20·8	23·1	33·3
1845	34·2	33·9	35·2

Imports increased fourfold in the thirty years while exports doubled in volume. In the same period the population increased by about 20 per cent.

From 1847 onwards, the official unit values were revised annually, so that the figures more nearly represented actual values. The development of French trade subsequent to that date is shown in the following table.

Annual averages	Imports for home consumption	Exports of domestic produce	Population
	Million £	Million £	Millions
1850-4	40·3	51·5	35·9
1855–9	69·3	75·8	36·3
1860-4	91·9	90·1	37·4
1865-9	119·3	119·7	38·2
1870–4	136·5	135·4	36·7
1875-9	150·7	138·4	37·0
1880-4	190·0	138·5	37·7
1885-9	160·0	132·3	38·3
1890-4	168·8	136·8	38·4
1895-9	163·7	144·3	38·6
1900–4	182·1	168·6	39·1
1905–9	228·1	212·0	39·3
1910–3	318·9	259·0	39·6

Up till the Franco-Prussian War the value of imports was about equal to that of exports but thereafter the value of imports was consistently the higher Imports increased rapidly in value up to 1880–4 and exports up to 1870–4. There followed a distinct check till the end of the century. This check was mainly due to the heavy fall in prices. In France prices fell by rather over 40% between 1874 and 1896 when the lowest point was reached, while between 1896 and 1913 they increased by about 40 per cent With rising prices, the value of imports practically doubled between 1895–9 and 1910–3 while the value of exports increased by 80 per cent.

The growth in population has been small in France. In 1825 imports and exports amounted to about 25/- per head; in 1850–4 the figure had about doubled and by 1870–4 it had increased to about £7.10s per head. There was then little increase till the end of the nineteenth century, but by 1910–13 imports and exports had grown to nearly £15 per head

The distribution of imports and exports according to the principal classes of goods is shown in the following table, at decennial and other intervals from 1850

Year	Imports			Exports		
	Food	Raw materials	Manufactures	Food	Raw materials	Manufactures
	%	%	%	%	%	%
1850.	16·6	78·2	5·2	30·1		69·9
1860.	20·8	76·1	3·1	37·3		62·7
1869.	22·4	68·9	8·7	46·7		53·3
1880	39·0	49·1	11·9	23·4	23·5	53·1
1890	32·6	53·5	13·9	22·8	23·9	53·3
1900.	17·4	64·6	18·0	18·7	26·4	54·9
1910	19·7	60·6	19·7	13·8	31·0	55·2
1913.	21·6	58·7	19·7	12·2	27·0	60·8

(*d*) *Germany.*—It is only a hundred years ago that the first attempt was made at a co-ordinated commercial policy between the many independent states, large and small, which were to form in 1871 the German empire. The formation of the customs union between Prussia and certain North German States and between Bavaria and Württemberg in 1828 was followed in 1834 by the amalgamation of the two unions and thereafter other states gradually came into the Zollverein. Before 1871, a bird's-eye view of the rate of development of Germany's oversea trade may best be gained from the shipping statistics of the port of Hamburg. The following table shows the number and tonnage of vessels entering Hamburg at decennial intervals from 1791 to 1871:

Year	Number	Tonnage
1791	1,504	
1801	2,177	
1811	(Blockade)	
1821	2,008	161,066
1831	2,347	223,443
1841	3,194	371,804
1851	4,169	558,403
1861	5,219	992,419
1871	5,439	1,887,505

Progress was fairly slow in the period up to 1831, but thereafter the tonnage entering Hamburg increased at a rapid rate down to 1871 Forty years later, in 1911, the tonnage had increased to over thirteen million

From 1872, the trade of the Zollverein practically represents the trade of the empire The following table shows the development of this trade, together with the population from 1872 to the outbreak of the World War

Annual average	Imports for consumption	Domestic exports	Population
	Million £	Million £	Millions
1872–4	*	113·7	41·3
1875–9	*	132·3	43·1
1880–4	151·8	152·8	45·2
1885–9	159·9	151·0	47·3
1890–4	198·9	152·5	50·5
1895–9	232·8	181·3	53·8
1900–4	287·0	235·6	58·0
1905–9	304·3	314·0	62·2
1910–3	492·9	425·7	66·0

*Comparable figures not available

The general trend of both imports and exports was similar to that of the trade of the United Kingdom and France; a period of hesitancy in the last quarter of the nineteenth century, mainly due to the fall in prices, was followed by a period of rapid expansion of the value of trade in the early years of the present century, when prices were rising In the 'eighties the values of imports and exports about balanced and thereafter the value of imports was distinctly higher than that of exports. Imports and exports together were about £6.15s. per head of population in 1880–4, about £7.15s. in 1895–9 and by 1910–3 had risen to nearly £14 per head

Turning to the classes of goods imported, the following table shows the percentages of imports and of exports, classified as articles of food, raw materials, and manufactures.

	Imports			Exports		
	Food	Raw materials	Manufactures	Food	Raw materials	Manufactures
	%	%	%	%	%	%
1880	32·6	39·6	27·8	22·1	20·2	57·7
1890	33·5	42·0	23·6	14·2	21·3	64·5
1900.	30·6	48·6	20·8	11·2	24·1	64·7
1910	27·6	52·2	20·2	10·0	23·4	66·6
1913.	27·8	52·2	20·0	10·1	23·8	66·1

Such changes as occurred mostly took place before the end of the 19th century. The growth in imports of raw materials of industry is the most significant feature on the import side. Among exports, it will be seen that foodstuffs have decreased in importance, while raw materials and manufactures have increased. It

should be mentioned that the term "raw materials" in the German statistics includes considerable quantities of goods in a semi-manufactured state (*e g.*, pig-iron, steel, ingots, etc).

3. The World's Trade 1860–1913.—In the preceding section, the progress of the external trade of the United Kingdom, the United States, France and Germany has been traced throughout the 19th century and up to the outbreak of the World War. The earliest authoritative figures of the value of the trade of the world as a whole go back to 1867–8 and are given (up to 1894) in Dr. Neumann-Spallart's *Übersichten der Weltwirtschaft* and, for the later years up to 1908, in Otto Hubner's *Geographisch-Statistische Tabellen* The following figures (converted into sterling at 20 marks to the £) are taken from these publications. Imports and exports have been added together so that the value of the goods actually passing in the trade is about half the figures shown The figures for 1860 and 1865 are rough estimates.

Annual averages	£ millions	Sauerbeck's price index (1867–77 = 100)
1860	1,450	99
1865	1,750	101
1869 70	2,317	97
1872–3	2,888	110
1874/5–9	2,822	93
1880–4	3,283	83
1885–9	3,142	70
1890–4	3,508	69
1895–9	3,901	63
1900–4	4,791	71
1905–8	6,106	75

These figures cover the trade of some 75 to 100 countries; the additions to the number of countries in later years do not seriously affect the table, because the trade of the new countries, when first included, was relatively small in value.

The gold value of the world's trade appears to have about doubled between 1860 and 1872–3, but part of this increase was due to rising prices From 1872–3 till about 1895, when prices fell heavily, the gold value of the world's trade increased but slowly. Prices then rose again slowly till 1913, and the value of the world's trade rapidly increased.

It is of interest to compare the value of the trade of the four principal countries considered above with that of the value of the world's trade For the year 1880, Dr. Neumann-Spallart's tables show the value of the trade (imports and exports together) of these four countries to be just over 50 per cent of the world's total. Now, in considering alone the trade of these four countries, only those goods which pass *inter se* are duplicated in the total, while in the world total all goods are duplicated Making the necessary adjustments for this duplication, it may be estimated that in 1880 about 75 per cent, by value, of the goods passing in the trade of the world was imported into or exported from those four countries

The following table shows the values of the imports into and exports from the principal countries of the world and each continent at ten-yearly intervals between 1874–5 and 1905 according to the above authorities Figures for 1913, taken from the League of Nations publications and not comparable in all respects with the earlier figures, have been added

Between 1874–5 and 1905, the gold value of the world's trade rather more than doubled and, allowing for the fall in prices, its volume probably about trebled The trade of the United Kingdom and of France increased more slowly than the world's total trade, while that of Germany and the United States increased more rapidly Among other European countries, the trade of the Western countries shown increased far more rapidly than that of the Eastern countries. In other parts of the world, remarkable rates of increase are shown by Japan and Argentina. Considering the proportions of the total attributable to each continent, Europe's share fell from 72 per cent. of the total in 1874–5 to 64 per cent. in 1905 and (according to the League of Nations figures) to 61 per cent. in 1913. On the other hand, the share of America increased from 15 per cent. of the total in 1874–5 to

Figures in million £					
Area	1874–5	1885	1895	1905	1913
United Kingdom*	656	584	657	914	1,186
Germany	300	290	353	719	1,021
France	296	287	287	380	607
Russia	148	157	128	170	303
Austria-Hungary	110	123	125	187	271
Netherlands	104	169	221	386	576
Belgium	96	102	124	219	328
Italy	91	96	90	153	244
Total Europe	1,976	2,077	2,305	3,587	5,127
United States	200	268	333	584	868
Canada†	42	42	51	86	216
Argentina	23	36	43	107	201
Total America	407	533	649	1,068	1,734
India**	95	139	127	187	279
Japan	9	11	60	85	143
Total Asia	212	285	374	629	956
Australasia	84	120	104	125	202
Africa	61	70	123	215	335
World total	2,740	3,085	3,555	5,623	8,357

*The United Kingdom figures for 1874–5 relate to total imports and total exports, those for 1885–1905, to total imports and domestic exports, and those for 1913 to retained imports and domestic exports.
†British N. America prior to 1905
**British E. Indies prior to 1895

19 per cent. in 1905 and to 21 per cent in 1913, the share of Asia also increased from 8 per cent of the total in 1874–5 to 11 per cent in 1905 and 1913

4. The Progress of Trade Since the World War.—The war completely upset the normal commercial interchange of commodities between the nations and the unsettled conditions prevailing immediately after the war—sharp variations in the value of money, depreciated exchanges, changes of frontiers, etc — render aggregate figures up to the end of 1923 of little value The following paragraphs are therefore devoted to a study of the world's trade in the years 1913 and 1924–7.

In making comparisons based on 1913, there are several factors of which account must be taken. Firstly, 1913 was a year of excellent trade—the crest of the wave following the trough of 1908. Secondly, prices have increased substantially since 1913; according to estimates made by the League of Nations, average gold values of world imports and exports were in 1924 about 50 per cent. above the 1913 level, in 1925 about 55 per cent. and in 1926 about 45 per cent Thirdly, the multiplication of frontiers resulting from the war, particularly in Europe, has the effect of swelling the recorded value of a given volume of trade, because much trade that was formerly internal became external, probably the recorded value of the world's trade has been increased by about 5 per cent owing to this cause.

The following table shows, in gold pounds, the value of the world's trade (imports for consumption and domestic exports) in 1913 and in 1924–6 The figures are taken from the League of Nations' "Memorandum on International Trade and Balances of Payments" and have been converted from dollars at $4 867 to the £.

Million gold £			
	Imports	Exports	Total
1913	4,009	3,772	7,781
1924	5,769	5,586	11,355
1925	6,609	6,310	12,919
1926	6,403	6,013	12,416
1927	6,669	6,234	12,9[illegible]3

The difference in the total figure for 1913 from that previously quoted is due to the exclusion of the trade of the Netherlands in the present table, owing to the pre-war figures not being comparable with the post-war figures. Making allowances for the changes in prices and multiplication of frontiers, it appears prob-

able that, in 1924, the volume of the world's trade was about 7½% smaller than in 1913, that in 1925 it had increased to slightly above the 1913 volume and that in 1926 it further increased to about 5% above the 1913 volume. The figures of value for the year 1927 are about 4% greater than those for 1926, and, making allowance for changes in prices the increase in volume was probably somewhat greater.

While, on the average of the years 1924–6, the volume of the world's trade was about as great as in 1913, there has been a marked change in the relative importance of the continents and principal countries. The share of Europe has sharply declined, while those of America and Asia have increased considerably. As already seen, a similar movement, due to the resources of the world being opened up, was taking place gradually before the war. The following table, taken from the League of Nations' "Memorandum," shows the percentage distribution of the world's trade by continents in 1913 and 1924–6.

Continent	Percentage share of imports and exports			
	1913	1924	1925	1926
Europe*	58 5	50 4	49 5	47·9
America	22·3	26·7	26·6	27·4
Asia	12·3	15·5	16·4	17·1
Africa	4·3	4 2	4·3	4·4
Australasia	2·6	3 2	3·2	3·2
World total	100 0	100 0	100·0	100 0

*Excluding the Netherlands, owing to the 1913 figures not being comparable with those of post-war years

The increased share of America is almost entirely attributable to the great increase in the trade of the United States, while that of Asia was mainly attributable to Japan and British Malaya. The fall in Europe's share of the total is mainly attributable to eastern and central Europe, though western Europe's share of the total also decreased somewhat

Special Trade in Merchandise
(Imports+Exports in Million gold £)

Country	1913	1924	1925	1926	1927
United Kingdom*	1,186	1,759	1,925	1,765	1,805
Germany*‡	1,021	765	1,034	967	1,192
France*	607	875	893	795	873
Russia*	303	101	154	146	157
Netherlands†	576	316	352	346	367
Belgium*	328	300	315	284	318
Italy*	244	302	364	356	378
United States	868	1,659	1,849	1,875	1,836
Canada	216	382	473	473	480
Argentina	201	296	328	306	370
India	279	397	464	415	429
Japan	143	354	396	414	401

*Changes of customs frontier have considerably affected the trade of these countries since 1913.
†Owing to changes in statistical method, the figures for post-war years are not comparable with those for 1913
‡Excluding reparation deliveries.

World Trade in Manufactures.—The World War stimulated the development of manufactures in most countries of the world because of the difficulty of obtaining the usual supplies of manufactures from the principal manufacturing countries. It is, therefore, of interest to ascertain whether, after the war, the trade in manufactured goods has become relatively less important than it was in 1913. Owing to the different classifications of goods adopted by the various countries this is a difficult task, but the British Board of Trade has made an estimate of the world's exports of manufactures (as defined in the Brussels International Convention classification) in respect of the years 1913, 1924 and 1925. The general results obtained were that in 1913 about 35% of the world's exports of merchandise consisted of manufactures, in 1924 about 36% and in 1925 about 35½%. Thus what slight change there has been appears to be in the direction of a comparative increase in the trade in manufactures. Such an increase may be due to prices of manufactured goods having risen relatively more since 1913 than those of foodstuffs and raw materials

Share of Various Countries in the World's Exports of Manufactures

Countries	Percentage of World Total		
	1913	1924	1925
United Kingdom*	28·0	26 6	25·5
United States	11·2	14 8	15 4
Germany*	23·2	12·7	14 2
France*	11 7	13 1	11·4
Austria, Hungary, Czechoslovakia and Yugoslavia*	3·3	5 5	5·2
Italy*	2·6	3 7	3·9
Japan	1·9	3·7	4·0
Belgium*	4·1	3·4	3 4
Switzerland	2 9	3 1	2 9
Canada	1 3	2 7	2 7
India	2·5	2 4	2 7
Netherlands	2 6	2 1	2 3
All other countries	4 7	6 2	6 4
World total	100 0	100 0	100 0

*Considerable changes of customs frontier affect these countries.

In 1913 the first four countries accounted for about three-quarters of the world's exports of manufactures, and in 1924 and 1925 for about two-thirds Germany's share decreased substantially, while that of the United States increased. Among other countries, the most significant features are the increased shares of Japan and Canada. The increased share of Austria-Hungary and the Succession States is more apparent than real, owing to the additional frontiers created between these territories. (*See* also MANUFACTURES, COMMERCE IN)

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TRADE BOARD, a term applied in Great Britain to one of a system of industrial wages boards established to fix legal minimum rates of payment for workers in certain industries under the Trade Boards Acts of 1909 and 1918.

The principal Trade Boards Act of 1909 was based on the minimum wage provisions contained in the Factory and Shops Act of Victoria, Australia, passed in 1896. The Trade Boards Act was the result of long and vigorous agitation for legal protection on behalf of the "sweated" women workers, particularly in the chain making industry centred in Cradley Heath, and in the clothing trades of London and the great towns. Boards were first established in four trades set out in the act, namely, ready-made and wholesale bespoke tailoring; paper-box making; machine-made lace finishing and chain making. Before 1914 five new trades were added, making nine in all.

Each of these boards was composed of an equal number of representatives of employers and workers in the trade plus from one to three neutral persons, called "appointed" members designated to sit on each board in order that a deadlock might be avoided.

The bodies so constructed had two powers under the Act of 1909: 1. A mandatory power to fix minimum rates of wages for time workers in the specified trades; 2. A discretionary power to

fix general minimum rates of wages for piece workers in a trade. Rates of both kinds were subject to confirmation by the Board of Trade before becoming effective, and even then had to undergo the test of a six months' limited operation before they became obligatory upon all employers.

The action of these early boards was very cautious and in general their effect upon wages of women workers was to raise the general level of rates to that of the firms which were already paying the highest or very nearly the highest in the trade. Rates fixed for men, on the other hand, fell, on the average, below the rate for all men in a trade though they were higher than rates for the average unskilled man

Between 1912 and the signing of the Armistice in 1918 the principle of state wage regulation became widely recognised through extended legislation in Australia, the United States and Great Britain The tendency of the early months of the war in England was to favour suspension of Trade Board activities, but that attitude was soon abandoned in the interests of efficiency Then, in addition to the Coal Mines (minimum wage) Act passed in 1912, came the Munitions of War Acts of 1915, 1916 and 1917, the Corn Production Act of 1917 and finally the Wages (Temporary Regulation) Act of 1918, each of which provided for state control of wages in some form and thus strengthened the Trade Board idea

In line with the general movement towards state control and self-government in industry the second Whitley Report in 1918 recommended to Parliament the extension of the Trade Boards system to unorganised and spasmodically organised trades as a complement to the establishment of voluntary "Whitley" Councils in the better organised industries It was hoped that eventually organisation of both employers and workers in Trade Board trades would become strong enough to warrant their removal from Government surveillance to the category of Whitley Council industries, governed by a body of representatives of organised employers and workers co-operating voluntarily together for the good of the whole industry.

The background for the new Trade Boards Act which became effective on October 1, 1918, therefore, was threefold—first, more general acceptance of the principle of state regulation of wages; second, articulation of the democratic ideal of self-government in industry set in motion by the war; third, the foresight of those who realised that the aftermath of war would be a sharp drop in wages especially for unprotected workers, unless some machinery were provided to meet the exigency.

The Act of 1918 was thus born in an entirely new set of economic circumstances and was the result of a quite different concept from that of 1909 It consequently made several important changes in the Act of 1909. First, the situation conditioning establishment of a Trade Board was altered, emphasis being thrown upon inadequate organisation of workers or employers in a trade instead of relatively low wages; second, the rate fixing powers of boards were considerably enlarged; third, the responsibility of the Minister of Labour, who since 1917 had acted in place of the President of the Board of Trade, was increased and the onus of establishing boards was placed upon him rather than upon Parliament

By 1921 a total of sixty-three Trade Boards covering 39 trades and governing the wages of approximately 3,000,000 workers in the United Kingdom had been set up Of these boards nineteen, being established for Irish industries, now fall under the control of the Irish Free State, one is inoperative and one new board has been set up since 1921, making 44 boards active in Great Britain in 1928.

The Trade Boards System as it now stands is bi-partite. Legislative, that is rate-fixing power, is vested in the board set up for each trade, while administrative and executive functions rest with the Ministry of Labour and in practice involve four distinct features: 1. Setting up of boards; 2. Confirmation or rejection of rates decided upon by the Trade Boards; 3. Enforcement of legal rates; 4. Decision in matters relating to the demarcation between boards and their spheres of activity

The general composition of a Trade Board remains the same under the Act of 1918 as that of 1909. The underlying principle is that of representation and it falls to the Minister of Labour to discover the component parts of each industry, to assign appropriate weight to each and to find acceptable persons to represent each interest, so that the board as a whole can represent the trade in entirety and work in harmony. It is customary for the Minister to consult the various organised sections of a trade concerning these appointments and also to name persons who can express the point of view of such unorganised sections of the trade as there may be. The "appointed" members are usually chosen from among the professional classes such as professors, lawyers, social workers, etc. It is provided by statute that where a considerable body of women are engaged in the trade at least one of the appointed members must be a woman.

The Minister of Labour is empowered to make regulations with respect to the constitution and proceedings of Trade Board meetings including the method of voting, but apart from those rules which he chooses to lay down boards govern themselves.

Rates are arrived at by a process similar to bargaining assisted by the appointed members in the capacity of conciliators. Appointed members, however, have the power to vote just as other members of a board, but in practice this vote is seldom cast unless agreement between the two sides after negotiation becomes impossible and then it is done with reluctance.

As to the matter of what is a minimum wage, the Act of 1918 gives no more guidance than that of 1909, and experience shows that the two sides of a board as well as the appointed members usually hold divergent views as to the terms of their reference Employers probably most frequently interpret a minimum wage for a trade to be that already "payable to the lowest grade of worker in the least well equipped factory in the least expensive part of the country," while those on the workers' side stand for the current trade union rate in that or an allied trade as the minimum Appointed members, on the other hand, are most likely to construe the minimum in terms of their philosophy of what wages are and should be. In practice the failure of the Act to provide a more definite guiding principle works both for good and ill, on the one hand giving leeway for a broad construction of the purposes of the Act, and on the other, in certain cases making for confusion and too wide divergency in rates between trades When it comes to the bargaining co-incident to wage fixing in a board, workers generally press the argument of the "living wage" as a basis for negotiation, and employers adhere to "what the trade can bear." The result is almost invariably a compromise In this way the Trade Boards system enables the circumstances of each separate trade to be considered when the rate is fixed Each trade, moreover, is able to vary its own minimum rates at any time without waiting upon the remaining trades For an employer to pay wages below those fixed by a Trade Board is an injustice remedial by criminal law.

Abundant proof is available to show that in broad terms the three original objects of the Act of 1918 have, in some degree, at the least, been attained, *i.e* —

(1) To create instruments of self-government in poorly organised trades.

(2) To prevent a sudden fall in wages after the World War.

(3) To adjust wages upon a fair basis in future.

The chief defects in the system as shown by experience are:—

(1) The tendency for wage variations to take place too long after the conditions requiring change have arisen This is a fault in machinery easily remedied, and not serious except in time of rapid fluctuations in prices.

(2) Too little use of scientific investigation in comparison with "hearsay evidence" when rates are being set. This has been the cause of a large part of the mistakes made.

During the severe industrial depression of 1921 while European exchange rates were out of joint and wages remained relatively higher than prices, considerable opposition towards the Trade Boards system was evinced, and a Government investigation instituted. No important changes were made in the Act, however, though certain mistakes in wage rate fixing were voluntarily corrected as a result of experience

Since other economic conditions have somewhat settled down, therefore, the system seems to work smoothly and without undue adverse criticism, even though in some few instances boards have, as is measured by the level of the rates they fixed, gone slightly beyond what is considered the strict scope of minimum wage fixing and touched the fringe of the field of wage regulation.

(D. M. Se.)

United States.—In the United States the closest equivalent of the Trade Board is commonly known as a minimum wage commission. Acts creating minimum wage commissions for the purpose of fixing and enforcing minimum rates of wages have been held unconstitutional. (*See* Minimum Wage. *United States.*) Even in the case of the compulsory arbitration law of Kansas, because the board was given authority by the act to fix wages, the court held the act, to this extent, unconstitutional. The Minimum Wage Act of Massachusetts has been held constitutional in the Massachusetts courts but the decision was based on the fact that the act was not compulsory and that the rates of wages fixed by the board depended upon public opinion for their enforcement

In Massachusetts the board of conciliation and arbitration of the department of labour and industries devotes part of its time to the subject of minimum wages and while doing so is known as the minimum wage commission. The board is made up of three members, one of whom must be a representative of labour and one of employers of labour. The assistant commissioner of labour is given charge specifically of all matters relating to women and minors and is to exercise duties and authority in accordance with the directions of the commissioner with the approval of the minimum wage commission. The law provides that the commission shall investigate the wages paid to female employees in any occupation, if it has reason to believe that the wages paid to a substantial number of such employees are inadequate to supply the necessary cost of living and to maintain the worker in health. If after such investigation the commission is of the opinion that in the occupation in question the wages paid to a substantial number of female employees are inadequate to supply the necessary cost of living and to maintain the worker in health, it shall establish a wage board consisting of an equal number of representatives of employers in the occupation in question, and of persons to represent the female employees in that occupation, and of one or more disinterested persons appointed by it to represent the public, but the representatives of the public shall not exceed one half of the number of representatives of either of the other parties. The commission shall give notice to employers and employees in the occupation by publication or otherwise of its determination to establish a wage board and of the number of representatives of employers and of employees to be chosen therefor, and shall request that said employers and employees, respectively, nominate such representatives by furnishing names to it. The representatives of employers and employees shall be selected by the commission from names furnished by the employers and by the employees, respectively. The commission may transmit to each wage board all pertinent information in its possession relative to the wages paid in the occupation in question.

Each wage board shall take into consideration the needs of the employees, the financial condition of the occupation and the probable effect thereon of any increase in the minimum wages paid, and shall endeavour to determine the minimum wage, whether by time rate or piece rate, suitable for a female employee of ordinary ability in the occupation in question, or for any or all of the branches thereof, and also suitable minimum wages for learners and apprentices and for minors under eighteen. When a majority of the members of a wage board shall agree upon minimum wage determination, they shall report such determination to the commission, together with the reasons therefor and the facts relating thereto. Upon receipt of a report from a wage board, the commission shall review the same and may approve or disapprove any or all of the determinations recommended, or may recommit the subject to the same wage board or to a new one. The commission shall, after a public hearing, publish at such times and in such manner as it may deem advisable also at such times and in such manner as it shall deem advisable publish the facts, as it may find them to be, as to the acceptance of its recommendations by the employers engaged in the industry to which any of its recommendations relate, and may publish the names of employers whom it finds to be following or refusing to follow such recommendations

(E Ste.)

TRADE CYCLE. The phrases trade cycle, business cycle and cyclical fluctuation of trade are all convenient methods of labelling those alternating upward and downward sweeps in the volume of business activity which have constituted, for at least a century and perhaps more, one of the outstanding phenomena of the modern business world The most obvious manifestations of the trade cycle are a quasi-rhythmical fluctuation, extending over several years, in the level of prices, the level of money profits and the level of employment In the absence of satisfactory statistics, it is difficult to be sure how far there occurs a corresponding fluctuation in the level of production and consumption, *i e.*, in the real income of the community affected While it is certain that these latter quantities fluctuate to some extent, it seems probable (*a*) that the fluctuations in output are less intense than the fluctuations in prices, (*b*) that the output of ordinary goods for immediate consumption fluctuates as a rule far less than the output of instrumental or constructional goods (typified by iron and steel); and (*c*) that the fluctuations in output do not entirely synchronize with the fluctuations in prices, but that, in the later stages of a "boom" of prices, production may cease to make any significant advance, while in the later stages of a "depression" of prices production may make a marked recovery. Nor is it safe to dogmatize about the length of the trade cycle or about the degree to which its phases synchronize in the leading industries and the leading industrial countries Before the World War there were indications that the normal period of the cycle had shortened from about 10 to about six or seven years. The dates of "crisis" or turning-point from boom to depression, during the past century, are for England 1825, 1836, 1847, 1857, 1866, 1873, 1882, 1890, 1900, 1907, 1913, 1920, while in the United States the booms of the late '80s and '90s were prolonged, somewhat precariously, to 1893 and 1903 respectively. Again, the post-War boom, which in England and America broke in 1920, was prolonged in Germany till 1923, and while the recovery in America from the great slump of 1921 has been rapid and complete (with a slight set-back in 1923), recovery in England has been partial and slow. Again, the change-over from depression to prosperity, or prosperity to depression, does not affect all trades at the same moment, or even always in the same order In the main, however, it still seems to be fair to describe the trade cycle both as a *general* movement and as a rhythmical one, and any explanation of its causes must take these two factors into account Very many such explanations have been offered—too many to expand or criticise fairly in the course of a short article It must be enough to set out and classify certain roads of thought, as it were, along which economists have been led to travel in search of the truth.

The Psychological Approach.—The first road leads into the domain of psychology. We are invited to find the chief explanation of the trade cycle in the nature of man himself, and especially of those men who are responsible for conducting and controlling the operations of modern industry, commerce and finance. These business leaders are bound together not only by their business dealings but by ties of sentiment and environment: they operate, necessarily, in an atmosphere of uncertainty and any error of forecasting which they make, whether of an optimistic or of a pessimistic kind, is apt to be magnified by their mutual contact into a great wave of erroneous judgment, which gathers strength for a time and then breaks, yielding place to an equally exaggerated movement in the opposite direction There seems to be little doubt of the importance of this factor both in aggravating the amplitude of the trade cycle and in moulding it into its quasi-rhythmical shape. But we must be on our guard against supposing that all decisions made by business men to vary the scale of their purchases or their output are erroneous. Many such

if not of society as a whole.

The Monetary Approach.—The second road leads into the tangled wood of monetary theory. Those who follow it lay stress on the dependence of the scale of industrial activity on the general level of prices, and on the dependence of the latter, in its turn, on the monetary policy of the Government and the banks. The independent leaders of business are advantaged during a period of rising prices, because the rise in many of their money costs of production (such as debenture interest, salaries and in some degree wages) lags behind the rise in their money receipts. They are accordingly both enabled, and furnished with a real inducement, to expand the scale of their operations; and owing to their habit of concentrating their attention on the movement of the price of *their own products*, the inducement is likely to seem greater to them than it actually is Conversely, in time of falling prices, business men are both disadvantaged by the relative fixity of some of their money costs, and believe themselves to be more disadvantaged than they are; and they are impelled therefore to contract the scale of their operations. These price movements, if left unchecked, act *cumulatively*, in both directions; for as long as prices are expected to go on rising, business men continue to rush in to buy; and as long as prices are expected to go on falling, business men continue to liquidate their stocks of goods, and to refrain from replenishing them.

Now modern currency and banking systems, even when anchored to a gold standard, are of such a kind, that, unless consciously operated with another end in view, they permit considerable play to these price movements. Indeed they exaggerate them by displaying an excessive timidity in altering those rates of interest whose magnitude has an important effect in determining the volume of loans issued by the banks, and consequently the volume of purchasing power put, in the form of cheque currency, into the hands of the public. In the last resort, therefore, it is held, both the unhealthy activity and speculative excesses of the period of boom, and the wasteful stagnation of the period of depression, are due to a faulty loan-policy on the part of the banks, or a faulty currency policy on the part of the Government, or a combination of the two One objection to this explanation in its cruder forms is that the level of prices depends not only on the quantity of purchasing power issued to the public by the Government and the banks, but on the willingness of the public to *use* the purchasing power when it has got it; and that it does not seem certain that this latter factor, especially in a time of deep depression, when everybody is determined to hoard money rather than spend it, is entirely explicable in monetary terms or controllable by monetary means. Nevertheless, there seems little doubt that a monetary policy consciously aimed at keeping the general price level approximately stable, would do a good deal to damp down the violence of the trade cycle; and a policy of this kind has apparently been followed with some success by the Federal Reserve Board in the United States since 1922.

Instabilities Inherent in the Economic Process.—The third and fourth groups of roads lead to an examination of certain *real*, as opposed to merely monetary or psychological, features of modern industry. The third group runs through a landscape of *physical* and *technical* features, the fourth through a landscape of *legal* and *social* ones. Let us consider the former by asking the question: "What rational reasons are there why industry as a whole should automatically increase and diminish the scale of its output?" and glancing at three possible lines of reply:—

(1) Because of a self-renewing rhythm in its real costs of production. During the later stages of a depression, there is a progressive advance in the effectiveness of labour, a progressive writing off of inflated capital charges, a progressive overhauling of methods of technique and organization, which breed renewed activity. During the later stages of a boom there is a progressive recourse to inferior instruments of production, a progressive utilization of over-tired and recalcitrant labour, wasteful methods of management, and inferior business leadership, which ultimately breed collapse.

(2) Because of variations, due to fluctuations in the bounty of nature, in the amount of agricultural produce offered in exchange for the products of industry. Normally, the effect of good harvests is to stimulate industry and of bad harvests to depress it; but there seem to be exceptional cases (as perhaps in 1920) where an over-abundance of agricultural products leads to such a fall in their price as to impair seriously the purchasing power of agricultural producers over the products of industry, and so to induce industrial depression. Many attempts have been made to connect the trade cycle directly with a cycle of crop-yields dependent on meteorological phenomena: the most famous is that of Prof. W. S Jevons to connect the supposed ten-year period of the trade cycle with the sun-spot period, and the most recent that of Prof H. C. Moore to establish an eight-year period in economic affairs, depending on the behaviour of the planet Venus. Without accepting any such views, it is possible to hold that harvest variations, through their influence on the demand for transport and in other ways, frequently exercise an important influence in moulding the shape and the intensity of the trade cycle. It follows that the more numerous the sources of supply of any crop and the greater the facilities for carrying it over from year to year, the better for industrial stability; and it has been suggested in certain quarters that governmental purchase and storage of the leading crops would assist materially in the process of industrial stabilization

(3) Because of variations in the intensity of the desire for the fixed instruments of production and transport—buildings, machinery, railways, ships, etc. These instruments are large and expensive; they take a long time to construct, but once a batch of them is constructed, it will serve to satisfy the increased needs of the community for many years Investment in such instruments is therefore discontinuous, and their rate of output especially variable; and variations in the prosperity of the trades making them react severely on other trades. The rate of investment in instruments depends a good deal on the progress of technical invention, and it is tempting to connect a good many of the booms of the last century with inventions, *e g*, that in England in 1847 with railway-building, that of 1900 (especially in Germany) with electric transport, etc.

Instability Resulting from Organization of Industry.—We come finally to certain legal and social features of modern industry which may be held to promote instability of prices and output

(1) There is first the fact of *competition*, which aggravates miscalculation, since individual producers do not gauge correctly the share of an increased market which will fall to their own lot, nor the effect which their rivals' action will have in driving up their own costs of production It might be hoped, therefore, that the progress of the movement toward the formation of "trusts" and combines would damp down the violence of the trade cycle; but so far it is difficult to be sure that this hope has been fulfilled, partly because it is not always in the interest of combinations to promote stability, and partly because they are apt to interpret stability as stability of *prices*, which is not always consistent with stability of *output* and employment.

(2) There is secondly the *wage-system*, which may lead to a real disharmony between the interests of the employing class, which dictate the course of production, and those of society as a whole. For generally speaking the employer has more interest in intensifying production during a boom and curtailing it during a depression than the workman, who suffers during the boom from speeding-up and during the depression from unemployment.

(3) Finally, there is the *unequal distribution of wealth*, which in the view of many writers leads to a chronic tendency to "over-saving," manifesting itself during the boom in the construction of more instruments than will be able ultimately to find remunerative employment, and during the depression in, among other things, a piling up of idle bank-balances. The remedy proposed is to increase the purchasing power of the wage-earner, whose desire for necessaries and comforts is held to be steadier and more elastic than the desire of the rich for luxuries.

It remains to add that much work has been done in recent years, especially in America, in compiling statistical data con-

cerning the trade cycle, and attempting to forecast its course. The more accurate the forecasts can be made, and the more widely business men act upon them, the greater will be the extent to which the course of the trade cycle is smoothed and evened out under the influence of the forces of instructed self-interest.

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TRADE FACILITIES. In Great Britain the trade facilities scheme formed part of the remedial measures laid before the House of Commons by the Coalition Government of the United Kingdom in the autumn of 1921. Prices were then at their lowest; trade was acutely depressed; and unemployment had reached an alarming figure. One of the factors retarding the recovery was the difficulty experienced in raising capital, and it was proposed to use the credit of the Government to overcome the obstacle. The Trade Facilities Act of 1921 empowered the Treasury to guarantee the principal and interest, or either the principal or interest, of loans for capital purposes. No loans could be made by the Treasury, but with the aid of the Government's credit the applicant would of course be able to borrow his requirements on exceptionally favourable terms. Under the original Act the aggregate amount to be guaranteed was fixed at £25,000,000, but by subsequent legislation the amount was added to from time to time. The Act of 1926 raised the total to £75,000,000 and extended the period of operation to March 31, 1927.

Results of the Scheme.—The extent to which advantage was taken of the scheme affords some indication of the stimulus which it gave to industry and to employment. The quarterly return issued for the period ending March 31, 1927, gave the total figure of guarantees approved by the Treasury, after deduction made on account of applications sanctioned but subsequently cancelled by the applicants, at £74,251,780. The greater part, in fact about two-thirds of the whole, was given for enterprises in Great Britain. A remarkable proportion went to the shipping industry, mainly for new shipbuilding. A considerable percentage was also allocated for railway development, the London underground group alone having obtained some £12,500,000 for improvements and extensions. Another prominent category was electrical propositions both at home and overseas. Unquestionably, therefore, the undertaking of many projects of diverse kinds was expedited.

A cognate scheme relating especially to imperial development and arising out of the discussions at the Imperial Economic Conference of 1923, was also embodied in the Trade Facilities Acts (Act of 1924). The Treasury was empowered, subject to certain terms and conditions, to make a contribution of an amount not exceeding three-quarters of the interest payable in the first five years of the currency of a loan raised in the United Kingdom by or on behalf of any public utility undertaking in any part of the Empire overseas. An important condition required that the expenditure should be in anticipation of expenditure which would normally have been incurred at a later date. The scheme had currency for three years from its commencement—*i.e.*, to May 14, 1927, and the maximum amount payable by the Treasury was not to exceed £5,000,000. Contributions sanctioned under this scheme, spread over periods of three to five years, were in round figures £148,000 to the Sudan Government in respect of two schemes for the purchase of railway materials; £29,000 to the government of Newfoundland for the same purpose; and £37,000 to Western Australia for the purchase of a new ship. (W. H. Cl.)

TRADE FORECASTS. The expressions "trade forecast," commonly used in Great Britain, and "business forecast," commonly used in the United States, are synonymous and, unless qualified, refer to the outlook for business as a whole in a given country in the immediate future for, say, a period of not more than a year or a year and a half. The terms "trade" and "business" are used in their broadest sense to include all branches of economic activity. General forecasts are, of course, frequently supplemented by specific forecasts for sections of a country and for industrial groups, individual commodities, security markets or money conditions.

The Typical Period.—A forecast begins properly with an appraisal of conditions at the time of forecast and follows with a prediction of the direction and magnitude of the movement during the immediate future. Such a forecast may include estimates of prospective variations expected to appear with the round of the seasons, and the "normal," or long-time, growth that is expected from one year to the next assuming no disturbing influences. But estimates of seasonal variation and the growth element are not usually the factors of primary importance in a business forecast. The factor of primary importance is the nature of the ensuing "cyclical" movement of business or of the "state trade."

A "business cycle" is at the basis of the great majority of business forecasts. (*See* TRADE CYCLE.) Some business forecasters contend that business cycles are "periodic"; in other words, they hold that an approximately uniform time interval exists between a given phase of each business cycle and the same phase in the succeeding cycle. They base their forecasts upon the assumption of a fixed period, but they are not all in agreement as to the length of it. Periods of ten, eight, seven, and three or four years have been held to exist by different investigators. In the United States, for example, between 1879 (when that country resumed specie payments) and the World War severe business disturbances—during which a period of high or expanding business was followed by a period of contracting business—occurred in 1882, 1887, 1890, 1893, 1895, 1899, 1903, 1907, 1910 and 1912. Some of these years of business disturbance were followed by deep business depression (1884–85, 1893–94, 1896–97 and 1908), others by more moderate depressions (1904 and 1911), and still others by periods of less pronounced business recession not ordinarily thought of as veritable depressions (1887–88, 1891 and 1900). Forecasters who base their forecasts upon the assumption of a "typical" cycle of standard form, amplitude and length (say 40 months, with 25 months of expanding business and 15 months of contracting business) are obliged, in practice, to depart from the rigidity of the concept in order, to make it consistent with history and to provide for the probability that future business cycles may prove to be as variable as those of the past.

Variations in Time.—A second group of forecasters finds it more in accordance with business history to drop the concept of a "typical" periodic cycle and substitute the concept of a business cycle of *variable* time, duration, amplitude (intensity of cyclical deviation from normal) and form (reflected by the steepness of the recovery from depression and ascent into prosperity and by the swiftness of the subsequent decline). If this concept be adopted, forecasts must be made on the basis of uniformities or regularities other than time-duration, amplitude, or form of the cyclical movements. Regularities have, in fact, been found in the sequence of the movements of various statistical series reflecting speculation, business and credit, a sequence which has been found to be much less subject to variation than the cycle itself. This sequence has been found in the United States, England, France and Germany and it affords a valuable means of forecasting the movements of series of one type from a knowledge of the movements of series of other types. Such forecasting requires a careful interpretation of the economic significance of the situation reflected by the various types of movements and hence the sequence itself is not a sufficient

means of forecasting In other words, a mechanical application of the sequence doctrine may not give satisfactory results. Particularly, the systematic regulation of credit by banking authorities, gold movements and other factors operating on the money markets must be considered.

Other Methods.—A third group of forecasters holds that (*a*) the alternation of business prosperity and depression and (*b*) the sequences between movements of individual statistical series are both so irregular that the concept of a business cycle should be discarded. In making business forecasts the members of this group rely upon general economic analyses of the current situation and evaluations of the movements which they find, at any time, to be in progress This group is, perhaps, less homogeneous than the others

A fourth group of forecasters rely upon mechanical statistical relationships (which can seldom be interpreted adequately in economic terms) as a basis for their predictions. For instance, forecasts have been made on the assumption that "action and reaction are equal and opposite" in business fluctuations as well as in mechanics Frequently, such forecasts are accompanied by general economic analyses that make them on their face indistinguishable from those of the third group

Development of Forecasting.—Business forecasting has received its greatest development in the United States and the description, just given, of methods of forecasting is based primarily on usage in that country. Systematic forecasting, however, is being developed in England, France, Japan and other countries. Forecasting is an outgrowth of statistical studies of business fluctuations rather than of the application of general theories of the causes of such fluctuations A condition for satisfactory business forecasting is the existence of adequate business statistics, promptly available at weekly or monthly intervals. This condition has been more fully met in the United States than in any other large commercial country.

Agencies Publishing Forecasts.—Various agencies in the United States and some in other countries publish more or less definite forecasts of general business conditions. Among such agencies in the United States are banks, journals, Government bureaux and commercial forecasting organizations. In other countries, forecasts are published by certain journals, but regular forecasting services have only recently been established outside the United States. There is such a service, however, in Japan A development has been the establishment of economic services under the auspices of Harvard university (Harvard Economic Society) in the United States, under the London School of Economics and Political Science and the Department of Economics of the University of Cambridge (London and Cambridge Economic Service) in England, under the Institute of Statistics of the University of Paris (Mouvement Général des Affaires en France et en Divers Pays) in France, and under the Institute of Statistics of the University of Padua and the Institute of Economic Statistics and Economic Politics of the University of Rome (Indici del Movimento Economico Italiano con Alcuni Confronti Internazionali) in Italy. These four services are associated

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TRADE MARKS. A "trade mark" may be defined as a symbol, consisting in general of a picture, a label or a word or words, applied or attached to the goods of a trader for the purpose of distinguishing them from the similar goods of other traders, and of identifying them as his goods, or as those of his successors, in the business in which they are produced or put forward for sale. A trade mark differs in its legal character both from a patent and from a copyright. In the case of a trade mark the property and the right to protection are in the device or symbol adopted to designate the goods to be sold, and not in the article which is manufactured and sold The article is open to the whole world to manufacture and sell and all that the owner of the trade mark is entitled to prevent is such use of his mark by other traders as will lead purchasers to buy, as his, goods which are not his. On the other hand, patent-right and copyright protect the substance of the article, and any unauthorized manufacture of it in the former case, or reproduction of it in the latter, while the protection lasts, is prohibited. The grounds, however, on which trade marks, patent-right and copyright obtain legal recognition, though they are to a certain extent dissimilar, have a common element Patent-right and copyright rest upon the view that the results of the original labour of the inventor and the author ought, as a matter alike of justice and of public policy, to be secured against piracy; while, as regards the proprietor of a trade mark, the question of originality does not arise so long as the mark is sufficiently distinctive really to identify his goods and, for purposes of registration, to satisfy the Trade Marks Acts In truth, the registration of a trade mark is rather the recognition of a fact than the grant of a privilege (Kerly and Underhay, *Trade Marks Act*, 1905, p. 3).

The law as to trade marks as well as that as to patents or copyright is based on a man's rights to have guaranteed to him the profit derivable from his own property

British Trade Marks Before the Registration Acts.—English trade-mark law practically commences with the first years of the 19th century. The use of trade marks was indeed of far earlier date, for in 1742 we find Lord Hardwicke declaring that "every particular trader had some particular mark or stamp" But in the very case in which Lord Hardwicke made that statement (*Blanchard* v *Hill*, 2 Atkyns, 484) he refused to protect the "Great Mogul" stamp on cards, being apparently under the influence of the notion that the legal recognition of trade marks would involve the creation of a new species of monopoly But although the actual law of trade marks cannot be traced farther back than the beginning of the 19th century, Lord Eldon repeatedly granted injunctions to restrain one trader from fraudulently "passing off" his goods as those of another, and thus laid a foundation on which the present law has been built up. It was decided by Lord Cottenham in 1838, in the leading case of *Millington* v. *Fox* (3 Mylne and Craig 338), that an injunction to restrain the infringement of a trade mark could be obtained, even although the defendant had acted without fraudulent intent. On the common law side, on the other hand, fraud was an essential ingredient in the cause of action, and remained so till the fusion of law and equity by the Judicature Acts

The effect of Lord Cottenham's decision in the case of *Millington* v. *Fox* clearly was to recognize a right of property in trade marks, and the action for infringement became a familiar species of litigation. Under the then existing law, however, the plaintiff in such actions generally found himself in a very disadvantageous and unsatisfactory position. The basis of his action was the reputed association between his trade mark and his goods. This association the defendant—often a person of no means—would deny, and it had to be proved as a fact by witnesses at a cost to the plaintiff which there was little hope of his recovering. Moreover, even if the trade mark proprietor secured a judgment in his favour, it carried with it no immunity from the obligation of again establishing his right to the mark against any subsequent infringer who chose to dispute it. To complete this statement of the shortcomings of the law before the Merchandise Marks Act, 1862, it should be noted that the infringement of trade marks—except in cases where the seller of spuriously marked goods cheated the buyer—was not a criminal offence.

Under the Registration Acts.—Provision was first made for the registration of trade marks by the Trade Marks Registration

Act, 1875. This act was a considerable success, but no provision was made under it for the registration of words unless they either were old marks or were registered in combination with one or more of the "essential particulars" prescribed by the act, such as a distinctive device, heading, mark, label or ticket. These limitations excluded from registration most of the trade marks ordinarily in use.

The Patents, Designs and Trade Marks Act, 1883, remedied this defect besides altering the law in other important respects. The act of 1883 was amended in 1888 on the recommendation of a committee presided over by Lord Herschell. Neither the act of 1875 nor those of 1883 and 1888 altered the common law definition of a trade mark, nor contained any definition of the term. The description in the acts of what was registrable as a trade mark led to much litigation, and the interpretations of the judges left commercial men dissatisfied on three points: (1) The number of good and valuable trade marks which were not registrable; (2) that on allowing registration the Patent Office insisted on disclaimers which hampered the owner in obtaining protection in the Colonies and foreign countries; (3) that there was no effective period of limitation to attacks on registered trade marks, because, though registration for five years was declared conclusive by sec. 76 of the act of 1883, the powers of the court to rectify the register could be invoked even after the lapse of the five years (*re Gestetner's Trade Mark*, 1907, 2 Ch. 478). In re-enacting and enlarging the provisions of the act of 1875 the act of 1883 laid down certain essential particulars of one at least whereof a trade mark must consist to be registrable. The act of 1883 first provided for "word marks," and included among them "a fancy word or words not in common use" (sec. 64 [1] [c]).

The expression "fancy word," used in the act of 1883, gave rise to considerable difference of opinion. It was interpreted by the court of appeal as equivalent to "obviously meaningless as applied to the article in question," or "obviously non-descriptive" In accordance with this interpretation, the words "gem" for guns, "melrose" for a hair restorer, "electric" for velveteen, and "washerine" for a soap were all held not to be registrable. On the recommendation, however, in 1887, of a committee appointed by the Board of Trade, and presided over by Lord Herschell, the expression "invented word" was substituted for "fancy word" by the act of 1888

In 1905, 1907, 1914 and 1919 the statute law as to trade marks was amended and remodelled A bill was introduced in 1905 at the instance of the London Chamber of Commerce, and after consideration by a select committee became the Trade Marks Act, 1905. This act repeals the bulk of the provisions of the Patents, etc., Acts of 1883 and 1888 with respect to trade marks, and embodies them with amendments in a separate statute.

The Act of 1905.—This differs from the preceding acts in containing a definition of trade mark for the purposes of the act unless the context otherwise requires; viz., that it "shall mean a mark used or proposed to be used upon *or in connection* with goods for the purpose of indicating that they are the goods of the proprietor of such mark by virtue of manufacture, selection, certification, dealing with or offering for sale"; and "mark" is defined as *including* "a device, brand, heading, label, name, signature, word, letter, numeral or any combination thereof" (sec. 3). The act, modifying to the extent indicated in italics the acts of 1883 and 1888, prescribes (sec. 9) that a trade mark to be registrable must contain or consist of at least one of the following essential particulars:

1 The name of a *company*, individual or firm represented in a *special* or particular manner (under the act of 1883 it has been held that the name must be in the nominative case, and that ordinary printing is not representation in a particular manner).

2. The signature of the applicant for registration or some predecessor in his business. It is not clear that this includes descriptive trading styles.

3. An invented word or words.

4. A word or words having no *direct* reference to the character or quality of the goods, and not being *according to its ordinary signification* a geographical name *or a surname*.

5. *Any other distinctive mark; but a name, signature, or word or words other than such as fall within the descriptions in the above paragraphs 1, 2, 3 and 4, shall not, except by order of the Board of Trade or of the court, be deemed a distinctive mark.* By distinctive, is meant "adapted to distinguish in Great Britain, not in foreign markets (*In re Gallahero Application*, 1924, 41 T.L.R. 139) the goods of the proprietor of the trade mark from those of other persons": and "in determining whether a trade mark is so adapted the tribunal may in the case of a trade mark in actual use take into consideration the extent to which such user has rendered such trade mark in fact distinctive for the goods in respect of which it is registered or proposed to be registered." Where the mark is limited to specified colours, that fact may be taken into account in deciding whether the mark is distinctive (sec 10)

Trade marks containing the essential particulars are not registrable if they contain any matter which would by reason of its being calculated to deceive or otherwise be disentitled to protection in a court of justice or would be contrary to law or morality, or any scandalous design (sec. 11).

Old marks are registrable, *i e.*, any special or distinctive word or words, letter, numeral or combination of letters or numerals, used by the applicant or his predecessors in business before Aug. 14, 1875 (sec. 9). In the case of new marks, but not of old marks, a trade mark is not registrable except by order of the court in respect of any goods or description of goods which is identical with a mark already on the register with respect to such goods or description of goods, or so nearly resembles such registered mark as to be calculated to deceive (sec. 19). The expression "calculated to deceive" has been considered by the courts in very many cases. It is not merely or chiefly the retailer or dealer who has to be kept in view when the question of the likelihood of deception is under consideration. The courts have regard also, and mainly, to the ultimate purchaser whom the trade mark may reach, and careless or unwary persons are considered as well as those who are careful and intelligent. The judge's eye is the ultimate test as to the degree of resemblance that is calculated to deceive, although expert evidence on the point is admissible. The following words have been held to give rise to a probability of deception and confusion. "Oxot" with "Oxo" (meat extract: *Oxo, Ltd.* v. *King*, 34 R.P.C. 135); "Nuvol" with "Nujol" (heating or lubricating oils: *In re McDowell's Application*, 1926, 43 R P.C. 313); "Angora" with "Onsoria" (hair cream: *Lewis* v. *Vine and Vine's Perfumery Co.*, 31 R P C 12), "Peps" with "Pan-Pep" (cough pastilles: *In re United Chemists Association's Trade Mark*, 1923, 40 R.P.C. 219); "Anchola" with "Anchovette" (fish pastes and potted meats: *In re Waide and Co.'s Application*, 33 R.P.C 320); "Limit" and "Summit" (shirts and collars: *In re Smith* [Thomas A.], *Ltd.'s Application*, 30 R P.C. 363); "Lavnoma" with "Lavona" or "Lovona" (toilet preparations: *Tokalon, Ltd.* v. *Davidson and Co.*, 32 R.P.C. 133).

Invented Words.—An invented word need not be wholly meaningless, nor is it disqualified because words may have suggested it. Thus "mazawattee" was held to be an "invented word," although the latter part of it was a Sinhalese term meaning "estate," and there were estates in Ceylon (*In re Densham's Trade Mark*, 1895, 2 Ch. 176), having names ending with "wattee" from which tea came; and in a leading case on the construction of the clauses under consideration (*Eastman Co.'s Trade Mark*, 1898, A.C. 571), the word "solio" was held to be registrable as a trade mark for photographic printing paper under both clauses, although it was objected that "solio" was equivalent to "sunio." "Savonol" for soap (*J. C. and J. Field, Ltd.* v. *Wagel Syndicate. Ltd.*, 1900, 17 R.P.C. 266), "tachytype" for typographical and composing machines (*In re Linotype Co.'s Application*, 1900, 17 R.P.C. 380), have been held to be invented words. But the following have been held not invented: "uneeda" (=you need a), *In re National Biscuit Co.* (1902; 1 Ch. 783); "absorbine" for an absorbent preparation (*Christy and Co.* v. *Tipper and Son*, 1905, 21 R.P C. 97, 775); "bioscope" (*Warwick Trading Co.* v *Urban*, 1904, 21 R.P.C. 240); "cyclostyle" (*Re Gestetner's Trade Mark*, 1907, 2 Ch. 478); and *cf In re Kodak and Trade Marks*,

1903, 20 R.P.C. 337; "lactobacilline" for a lactic ferment (*In re La Société Le Ferment's Application* [1912], 81 L.J., Ch. 724).

Identical marks (except old marks) may not be registered in respect of the same goods, or goods of the same description, for two different persons (sec. 19); and where several applicants make rival claims to identical marks the registrar may refuse to register until their rights have been determined by the court or settled by agreement in manner approved by the registrar, or, on appeal, by the Board of Trade (sec. 20). In the case of honest concurrent user or of other special circumstances making it proper so to do, the court (or registrar: act of 1919, sec. 12, sched. 2), may permit the registration of the same mark or of nearly identical marks for the same goods by more than one owner, subject to such conditions or limitations, if any, as to mode or place of use or otherwise as the court (or registrar) may think it right to impose (sec. 21).

New provisions were made in 1905 as to what are called "associated trade marks" Where registration is sought for a mark so closely resembling a mark of the applicant already on the register for the same goods as to be calculated to deceive or cause confusion if used by any one but the applicant, the registration of the new mark may be conditional on entering both marks as associated trade marks (sec. 24).

In the case of combined trade marks provision is made for registering as separate trade marks the part in which the applicant has exclusive rights, and as associated marks trade marks of which the exclusive portion forms a part (sec. 25).

A series of trade marks of the same owner may be registered on one registration as associated marks (sec. 26).

Provision is made for allowing the registration of marks used upon or in connection with goods by an association (or person) which undertakes the examination of goods in respect of origin, material, mode of manufacture, quality, accuracy or other characteristic, and certifies the result of the examination by marks used upon or in connection with the goods. These marks cannot be registered unless the Board of Trade consider their registration of public advantage. Their registration is not conditional on the association or person being a trader or having goodwill in connection with the examination or certification. The registration gives the association or person the rights of the owner of a registered trade mark, except that assignment and transmission needs permission of the Board of Trade (sec. 62).

In respect of cotton piece-goods, marks consisting of a line heading alone or a word alone are not registrable, and no word or line heading is treated as distinctive in respect of such goods. In respect of cotton yarn the same rule applies with respect to words, and no registration of any cotton mark (in respect of cotton piece goods or cotton yarn: Trade Marks Act, 1914, sec. 1) gives any exclusive right to the use of a word, letter, numeral, line, heading or combination thereof (sec. 64 [10]).

By sec. 68, which is a re-enactment of sec. 105 of the Patent, etc., Act, 1883, it is made illegal for any person without the authority of the King to use the royal arms in any trade in such a manner as to create the belief that he has authority so to do.

Registries.—The central register of trade marks is kept at the Patent Office, Southampton buildings, London, and is under the charge of the comptroller-general of patents, designs and trade marks, who is appointed by, and acts under the superintendence of, the Board of Trade, and has a deputy—the registrar of trade marks. There is a branch registry at Manchester, whose chief officer is the keeper of cotton marks, which deals with all applications for the registration of trade marks for cotton goods falling within classes 23, 24, 25 in sched. 3 of the Trade Marks Rules, 1906.

There is a branch at Sheffield containing the marks for metal goods ("Sheffield marks") registered by persons carrying on business in or within 6 m. of Hallamshire. The care of this register is vested in the Cutlers' company, who are substituted for the comptroller as to registration of "Sheffield marks" (sec. 63). Applications made to the company are notified to the registrar, and may not be proceeded with if he objects. Any person aggrieved by the registrar's objection may appeal to the court. Applications made to the registrar for metal marks are notified to the Cutlers' company. Persons aggrieved by the decision of the Cutlers' company have an appeal to the courts (sec. 64).

A trade mark must be registered in respect of particular goods or classes of goods (sec. 8). The procedure for obtaining registration is regulated by the acts of 1905–19 and the statutory rules made thereunder (March 9, 1920, and Sept. 29, 1925). The registrar has power to refuse applications or accept them absolutely or subject to conditions, amendments and modifications (sec. 12). His discretion is not absolute, but subject to the provisions of the act (*Re Birmingham Small Arms Co.'s Application*, 1907, 2 Ch. 396), and must not be unreasonable or capricious (*Eno* v. *Dunn*, 1890, 15 A.C. 252; *Registrar of T.M.* v. *W. and G. Du Cros, Ltd.*, 1913, A.C. 624; *In re Garrett*, 1916, 1 Ch. 436). He must, if required, state his reasons, and his decision is subject to appeal to the Board of Trade or the court at the option of the applicant (sec. 12 [3]).

"New marks" may not be placed on the register except by order of the court for any goods or description of goods which are identical with marks already on the register with respect to the same goods, etc., or so nearly resemble a registered mark as to be calculated to deceive (sec. 19).

Applications as accepted are advertised; the advertisements state the conditions, if any, imposed on acceptance (sec. 13). Notice of opposition to the registration of a trade mark may be given under sec. 14 of the act of 1905 (which replaces sec. 69 of the act of 1883). The registrar after consideration decides whether the opposition is well or ill founded. His decision is subject to appeal to the High Court or by consent of the parties to the Board of Trade (1905, sec. 14 [5]).

There may be added to any one or more of the "essential particulars" above enumerated any letters, words or figures, or a combination of these. But the right to the exclusive use of the added matter must be disclaimed A man is not required, however, to disclaim his own name, or trade name, or that of his place of business, if the name appears in the mark.

The register may be corrected on the request of the registered owner of a trade mark as to errors or changes of address in the name of the registered owner, or by cancelling entries of marks or by striking out classes of goods for which a mark is registered or by entering disclaimers or memoranda as to a mark, provided that they do not extend the rights given by the existing registration (sec. 33).

A registered trade mark may be altered or added to in matters not substantially affecting its identity (sec. 34). A registered trade mark may be taken off by order of the court on the application of a person aggrieved, on the ground that it was registered without a *bona fide* intention to use it in connection with a particular class of goods, and that there has not been any such *bona fide* user, or that there has been no such *bona fide* user during the five years preceding the application. Non-use may be excused if proved to be owing to special circumstances and not to any intention not to use or to abandon the use of the mark (sec. 37). (See *Re Hare's Trade Mark*, 1907, 24 R.P.C. 263.)

The register may be rectified by order of the court on the application of any person aggrieved, or in the case of fraud in registration or transmission of the mark on the application of the registrar (s. 35).

Effect of Registration.—Registration is effective for 14 years but is renewable (sec. 28). The registration if valid gives the proprietor the exclusive right to the use of the mark on or in connection with the goods in respect of which it is registered (1905, sec. 39). This rule is subject to the following qualifications. (*a*) Where two or more persons are registered owners of the same or substantially the same mark in respect of the same goods, no one of them shall as against any other of them have any right of exclusive user except so far as their respective rights have been defined by the court. (*b*) Registration of a trade mark does not entitle the proprietor to interfere with or restrain the user by any person of a similar mark upon or in connection with goods upon or in connection with which such person has by himself or his predecessors in business continuously used such trade mark from

a date anterior to the use of the mark by the registered proprietor, or to object to the registration of the other man's similar mark for concurrent user.

In all legal proceedings relating to a registered trade mark registration is *prima facie* evidence of validity, and after seven years from the original registration, or seven years from the passing of the act of 1905, whichever shall last happen, the original registration shall be taken to be valid in all respects unless it was obtained by fraud, or the mark is disentitled to protection as being calculated to deceive or (act of 1919, sec. 6 [11]) is the only practicable name of an article or substance manufactured under an expired patent. No word which is the only practicable name of any single chemical element or compound is registrable as a trade mark. This provision does not apply to a mark denoting only the proprietor's brand or make of such substance (act of 1919, sec. 6 [2]).

Registered trade marks are assignable and transmissible only with the goodwill of the business concerned in the goods for which they are registered, and are determinable with the goodwill (sec. 22). Associated marks are assignable and transmissible only as a whole and not separately (sec. 27) The owner of a registered mark may assign the right to use his registered mark in any British possession or protectorate or foreign country in connection with any goods for which it is registered, together with the goodwill of the business therein of such goods (sec. 22).

The assignments, etc., on proof of title, are recorded on the register (sec. 33). It is a condition precedent to an action for the infringement of a new trade mark that the plaintiff should be the registered proprietor of the mark at the time when the action comes on for hearing This last provision does not apply to an action for "passing-off" (*see* TRADE NAME). In actions for infringement, evidence of passing off, or that the infringing mark is calculated to deceive, is not necessary The court decides on the probability of deception by inspecting and comparing the marks (*Hennessy* v *Keating*, 1907, 24 R P C. 485).

The right to a trade mark lapses if the mark ceases to be distinctive and becomes *publici juris;* if it is separated from the goodwill (a trade mark can only be assigned with the goodwill); if the mark is applied by the trader to spurious goods (as where boxes of cigarettes were so labelled, in conformity with an alleged custom of the trade, as to indicate that they were of Russian manufacture, which was not the fact); or when the mark is abandoned (temporary disuse, however, is not abandonment unless the mark has in the meantime become associated with the goods of another trader), or where, as in the "linoleum" case (7 Ch. D 834) it has become the name of the goods, and so merely descriptive; or after 14 years where registration is not renewed. In dealing with a claim for infringement the court must admit evidence of the usages of trade as to the get-up of the goods for which the mark is registered, and of any trade marks or get-up legitimately used with such goods by other persons (sec. 43).

The Trade Marks Act, 1919, provided for the registration in a separate division (Part B) of the register of trade marks, of a new class of trade marks, viz., marks which for not less than two years had been *bona fide* used in Great Britain in connection with any goods whether for sale in Great Britain or for exportation abroad, in order to indicate that they are the goods of the proprietor of the mark (sec. 2). Such registration is *prima facie* evidence of exclusive right to the use of the trade mark (sec 4) The use of the word "Anzac" with any trade, business, calling or profession without the authority of a secretary of State, or the request of the Government of Australia or of the Dominion of New Zealand, is prohibited by a statute passed in 1916.

International Arrangements.—The Trade Marks Act, 1905, applies to the British Islands. By the international convention for the protection of industrial property (*see* PATENTS), which was signed at Paris in 1883, and revised at Washington in 1911, the signatory States (others have since acceded) agreed that the subjects or citizens of each State should, in all the other States, enjoy as regards trade marks and trade names the advantages that their respective laws then granted, or should thereafter grant, to their own subjects or citizens. So far as Great Britain is concerned the provisions made for carrying out this convention are contained in sec. 65 of the Trade Marks Act, 1905, and in sec. 91 of the Patents and Designs Act, 1907. The effect of that section is to confer on an applicant for the protection of a trade mark in one of the other contracting States a priority over other applicants for registration in Great Britain during the space of four months. The section does not, however, exempt the applicant from the conditions and formalities incumbent on ordinary applicants for registration in Great Britain; nor does the fact that the foreign application has been successful of itself give the applicant a right to have his mark accepted for registration. Guatemala and Salvador, also signatory parties, have withdrawn from the convention

The following is a list of the British Orders in Council that have been issued, applying to foreign countries sec. 91 of the Patents and Designs Act, 1907: Austria, Hungary, May 17, 1909 (art. 237 of Austrian Peace Treaty; as to Hungary, art. 220 of Treaty of Trianon); Belgium, June 26, 1884; Brazil, June 26, 1884, Bulgaria, July 14, 1921; Cuba, Jan. 12, 1905; Czechoslovakia, March 11, 1920; Danzig, Free City of, Nov. 21, 1921; Denmark (including the Faroe Islands), Nov. 20, 1890; Dominican Republic, Oct 21, 1890; Ecuador, May 16, 1893; Estonia, Feb. 20, 1924; Finland, Oct 11, 1921; France, June 26, 1884; Germany, Oct. 9, 1903; Greece, Oct 9, 1924; Honduras, Sept. 26, 1901; Italy, June 26, 1884; Japan, Oct 7, 1899; Latvia, Oct 12, 1925, Luxembourg, July 14, 1922; Mexico, May 28, 1889; Morocco Protectorate (French), Feb. 12, 1918; Netherlands, June 26, 1884 (East Colony), Nov. 17, 1888 (Curaçoa and Surinam), May 17, 1890; Paraguay, Sept 24, 1886; Poland, Nov. 25, 1919; Rumania, Oct 13, 1920; Yugoslavia, July 14, 1921; Spain, June 26, 1884; Sweden (and Norway), July 9, 1885; Switzerland, June 26, 1884, Syria and Lebanon, Oct. 9, 1924; Tunis, June 26, 1884; Turkey, Oct. 12, 1925; United States, June 12, 1887; Uruguay Sept. 24, 1886

By Orders in Council, made under the provisions of the Foreign Jurisdiction Acts, penalties have been imposed on British subjects committing offences against the imperial Trade Mark Acts or the Orders in Council issued thereunder, *e g*, Abyssinia; China and Korea (1904); Egypt (1899); Muscat (1904); Turkey (1899), Persia, Persian coasts or islands (1889–1901); Siam (1906); and Zanzibar (1906). Penalties for offences against the trade mark laws of British India are contained in the Bahrein, Muscat and Somaliland Orders in Council

The following is a list of the orders issued as to British possessions: Australia, Commonwealth of, March 26, 1907; British India, Oct. 13, 1920; Canada, Oct 11, 1923; Ceylon, Aug 7, 1905; New Zealand, Feb 8, 1890; South Africa, June 25, 1918; Trinidad and Tobago, Aug. 12, 1907. These Orders in Council are printed in the Index to the *Statutory Rules and Orders Revised*, in force up to Dec. 31, 1927.

Colonial Trade Mark Laws.—The British Colonies generally follow the model of English trade mark legislation

Legislation on trade marks is one of the subjects which the Commonwealth of Australia Constitution Act, 1900 (sec. 9, pt v., 51, xviii) places within the exclusive competence of the Federal parliament By the Commonwealth Trade Marks Act, 1905, sec. 20, provision is made for registration of trade marks throughout the Commonwealth, and subject to this act and other Commonwealth legislation the common law of England as to trade marks is applied throughout the Commonwealth. *See* also the Commonwealth Acts, 19 of 1912 and 7 of 1919, and 25 of 1922, extending the English acts, 1905–19 to territories under the authority of the Commonwealth.

In Canada the law as to trade marks (*Rev. Stats.* c. 63) has been regulated by Dominion acts, similar to English statute law. The following colonial laws also are based on imperial legislation: British Guiana, 27 of 1914; Ceylon, 15 of 1925; Cyprus, 17 of 1920; Union of South Africa, 9 of 1916, chap. iii.; Nigeria, 17 of 1910; Mauritius, 8 of 1913; Sierra Leone, 17 of 1913; Trinidad and Tobago, 15 of 1913.

Trade marks are excluded from the legislative power of the Government of Northern Ireland (Government of Ireland Act. 1920, sec. 4 [1] [13]), not from that of the Irish Free State (Irish

Free State, Constitution Act, 1922, sched 16 [8]), which has established its own law of trade marks by the Industrial Property Protection Act, 1927 (No. 16 of 1927).

United States.—Provision for the registration of trade marks in the United States was first made by an act of Congress of 1870; but that enactment was subsequently declared invalid by the Supreme Court (*U.S.* v. *Steffens*, 1879, 100 U.S. 82), on the ground that the Constitution of the United States did not authorize legislation by Congress on the subject of trade marks, except such as had been actually used in commerce with foreign nations, or with the Indian tribes. Congress legislated again on the subject in 1881 (act of March 3, 1881, Revised Stats, U S. secs. 4,937–47). The act of 1881 was repealed by an act of Feb 20, 1905 (sec. 592), which, as modified by an act of May 4, 1906, now regulates the subject. A trade mark may be registered by the owner if he is domiciled within the United States, including all territory under the jurisdiction and control of the United States (sec. 29), or resides or is located in any foreign country which by treaty, convention or law affords similar privileges to citizens of the United States (sec. 1) The right of persons domiciled in the United States was in 1906 extended to owners of trade marks who have a factory in the United States, so far as concerns the registration, etc, of trade marks used in the products of the factory (1906, sec. 3)

The United States policy is to require registration of all trade marks unless they (*a*) consist of or comprise scandalous or immoral matter; (*b*) consist of or comprise the flag or insignia of the United States, or of any State or municipality, or of any foreign nation, (*c*) are identical with another known or registered trade mark owned and used by another and appropriated to merchandise of the same description, or so nearly resemble such other marks as to be likely to cause confusion or mistake in the mind of the public or to deceive purchasers; (*d*) consist merely in the name of an individual, firm, corporation or association, unless it is written, printed, impressed or woven in a particular or distinctive manner, or is associated with a portrait of the individual; (*e*) consist merely in words or devices descriptive of the goods with which they are used, or of the character or quality of such goods, or merely of a geographical name or term; (*f*) contain the portrait of a living individual unless his consent is evidenced by an instrument in writing

Decisions of the examiners on applications or oppositions are subject to appeal to the commissioner of patents, and from him to the court of appeals for the District of Columbia (secs 8, 9) The general jurisdiction in trade mark cases is given to the Federal courts below the Supreme Court, which has power by certiorari to review the decisions of circuit courts of appeal upon such cases (secs 17, 18) The maximum protection given by registration is 20 years The protection given to marks already registered in a foreign country lapses when the mark ceases to be protected in the foreign country (sec 12) Certificates of registration are issued under the seal of the Patent Office.

Other Countries.—In France (laws of June 23, 1857, and March 3, 1890) trade marks are optional, but may be declared compulsory for certain specified articles by decrees in the form of administrative orders The decrees regulating registration are of Feb. 27, 1891, and Dec 17, 1892 The following are considered trade marks: Names of a distinctive character, appellations, emblems, imprints, stamps, seals, vignettes, reliefs, letters, numbers, wrappers and every other sign serving to distinguish the products of a manufacture or the articles of a trade. By legislation of Aug 1, 1905, and July 11, 1906, provision is made for marking certain classes of commodities, mainly food products, to prevent falsification and the sale of foreign products as French. *See* also law of March 9, 1911, ratifying the convention between France and Japan for the mutual protection of trade marks in China

Under the German trade mark law of May 12, 1894, any person whatsoever can acquire protection for a trade mark, and all foreigners in Germany are placed on an exactly equal footing with Germans in the eyes of the law, so long as they have a domicile (*Niederlassung*) within the State, *i.e*, a place of business or a residence which involves the payment of German taxes The registration of a trade mark expires *ipso facto* after ten years from its date, but may be renewed for a similar period. *See* also laws of June 2, 1911, and May 12, 1924, and regulations of April 30, 1920.

The following other foreign trade mark laws may also be noted: *Austria*, law of 1890 (published in Vienna on Jan. 6, and in Budapest on April 6, 1890), and amending laws of July 30, 1895, which enactment protects additions to trade marks, and Jan. 17, 1913, and law of May 24, 1919, providing for the renewal of trade marks under the old law. *Denmark* (law of April 11, 1890, an amending law of Dec. 19, 1898, which enabled traders to register words or figures, provided that these are not indicative of the origin, kind, use, quality or price of the goods, and a law of April 29, 1913, permitting associations to register collective names, and a law of Nov 13, 1903, as to Iceland). *Japan* (law of July 1 and regulations of July 2, 1899, and law of April 1, 1921) For offences against the Merchandise Marks Acts or Trade Marks Acts *see* MERCHANDISE MARKS

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TRADE ORGANIZATION. The province of this article is defined by the limits of "trade" in the strict sense of exchange of commodities on a commercial scale and excludes the organization of production as well as that of the more special developments or concomitants of commerce such as banking, insurance and transport, and finally that of the final retail distribution. The unit in this restricted field which may properly be called "commerce" is the merchant, the man who buys and sells but neither produces nor consumes commodities; he does produce values. An essential element, even in early stages of civilization, he figures in the 14th century as an individual among the company of Chaucer's "wel nyne and twenty" pilgrims The corresponding group unit of his class, the chamber of commerce, had not arisen in the British isles when Adam Smith in the 18th century observed and demonstrated the essential nature of the evolution which had taken place in industry through the already substantially advanced division of labour. This was due partly to the inherent "individual" nature of the simple process of commerce and partly to the national independence of character

In France, as is related in more detail later, a more centralizing Government had created organizations of this name "chambres de commerce" which were incorporated into the administrative system of the country and given an official status and functions such as the control or management of public commercial institutions, including inland waterways and port and harbour works the construction of which is usually financed by the chambers of commerce either wholly or jointly with the State or other authority The relatively high position of French chambers of Commerce in the administrative sphere is further illustrated by the fact that during the war of 1914–18 they in common with municipalities were allowed even to issue paper money and tokens for small change, a function which was in fact exercised by practically all these bodies and so extensively that by 1919 their notes formed the chief currency for small change in France. These powers were terminated by the Stabilization Law of 1928.

In the British isles, on the other hand, chambers of commerce were, and remain, voluntary associations of a somewhat loose texture, exercising very little, if any, compulsion upon their members, and endowed with few definite functions in relation to the comparatively light administrative framework within which trade has to be conducted.

PART 1. TRADE ORGANIZATION IN GREAT BRITAIN, AND GENERALLY

The earliest British chambers of commerce were formed in

Jersey in 1768, in Glasgow in 1783, in Dublin in 1785 and in Edinburgh in 1786, the year in which the Board of Trade was re-established by the order in council which is still the statutory authority for that body's existence. It was not until 1794 that a similar body, the "Commercial Society" of Manchester was founded in England This society had the definite objects of preventing "the depredations committed on mercantile property in foreign parts"; of obtaining increased safety for trade and more regular payments, and of co-operating jointly in all applications to Government. (*Chapters in the History of the Manchester Chamber of Commerce* by Elijah Helm.) It at once engaged in active correspondence with the Government in regard to difficulties arising out of the war with France Other Commercial Societies soon came into existence at Birmingham, Leeds and elsewhere, and joint meetings of delegates from these several bodies were held in London The Manchester society, however, ceased to hold meetings after 1801 and was not revived until 1820, then as "the Manchester chamber of commerce" Meanwhile chambers had been established at Belfast (1796), Birmingham (1813) and Newcastle-upon-Tyne (1818). The subsequent chambers of outstanding importance were those established at Liverpool (1851), Sheffield (1857), Bradford and Cardiff. The London chamber, which was not founded until as late as 1881, has a direct membership of over 8,000, apart from 52 affiliated associations (covering thus an indirect membership of 50,000) The requisites for the merchant, apart from the main material need for money-credit are integrity and the reputation for integrity, knowledge and judgment; also a general state of lawfulness with stable and liberal economic conditions Similarly the main functions of the typical British chamber of commerce may be analysed as follows —

(a) Maintenance of a high standard of integrity and commercial conduct among their members

(b) Provision of information in the shape, *e.g*, of trade statistics, foreign tariffs and regulations, exhibitions of foreign samples

(c) Provision of advice —
- (i) general as to business methods and overseas markets
- (ii) particular, as regards individual difficulties
- (iii.) legal, *e g*, as to shipment of goods and contract conditions
- (iv) expert opinions on values and qualities, *e.g.*, through testing houses such as those at Bradford and Manchester

(d) Provision of assistance, legal, *e g*. for contesting issues of general importance to merchants and for recovery of individual debts, also in regard to difficulties encountered in dealing with foreign administrations in regard to which Government assistance will frequently have to be sought

(e) Performance of administrative service, *e g*, certificates of origin and other documents necessary to foreign trade

(f) Arbitration and settlement of disputes

(g) Formulation of policy and representations to Governments, in regard, *e.g*, to
- (i) domestic legislation affecting commerce
- (ii.) foreign tariffs and regulations
- (iii.) other matters of common interest to their members

Trade Protection Societies.—Among their functions that of recovering debts or of protecting the trader from loss through the insolvency or dishonesty of those with whom he has to deal is to a large extent fulfilled by *trade protection societies* which afford special facilities for the collection of debts where this presents difficulty. In towns of minor commercial importance the chamber of commerce is often combined with such a society. The Association of Trade Protection Societies of the United Kingdom has been formed to promote the common purposes of these bodies.

In the typical chamber of commerce the merchant is predominant, but the manufacturer or industrialist who, to a large and increasing extent, is also the merchant for his own goods is also strongly represented An analysis of the membership of the London chamber (1928) gives out of a total of 8,061 members, 3,264 merchants (to which may be added 376 brokers and agents) and 2,906 manufacturers; other groups illustrative of the diverse interests included in commerce are banking (214) insurance (170) and transport (144)

Chambers of commerce have themselves become highly organized bodies. The London chamber is divided into 69 sections according to overseas countries dealt with, commodities or trades, and special aspects; Manchester has 15 general sections including the Testing House, 7 being on a geographical basis Apart from this there are numerous committees to deal with the various aspects of commerce—transport rates and services, postal and telegraphic matters, commercial law. Of special importance are those on arbitration and education.

The London court of arbitration is jointly managed by the London chamber and the corporation of London by which bodies it was formed in 1892. It consists of 12 representatives of the chamber and 12 of the corporation. Its function is not itself to hear cases but to appoint duly qualified arbitrators to deal with disputes which are referred to it. It serves a very useful purpose in providing a ready, efficient and inexpensive means of settling commercial disputes Manchester also possesses a tribunal of arbitration, a special department which itself gives awards. The Dublin chamber of commerce has established (1927) a court of arbitration for commercial disputes at its offices in Dublin available both for voluntary references to arbitration and for arbitration of cases referred by the law courts.

The provision of a continuous supply of educated young men and women who can carry on the great work of commerce, which tends always to become more exacting, is one of the chief cares of the chambers of commerce. Valuable work is done in London and other large centres by the institution of examinations for certificates in commercial subjects and by the grant of scholarships enabling chosen students to study languages and commercial conditions abroad In 1927 over 26,000 entered for the London junior and senior commerce certificates and 13,499 certificates were granted. Apart from these direct incursions into the educational field the chambers watch educational policy from the business man's standpoint

In addition, chambers of commerce undertake from time to time special pieces of work of which a good example is afforded by the enquiry which the joint committee of Cotton Trade Organizations convened by the Manchester chamber of commerce made into the costs of production and marketing overseas in the Lancashire cotton trade in 1927–28 The object of the Committee was described by themselves as being "to bring about the changes required by changed conditions more speedily, more efficiently and with greater regard for the common good of all sections than would be done by individuals in the trade, if left to themselves"; in other words a voluntary organization is to be developed

True to their independent and voluntary character the British chambers of commerce were slow in associating together for common purposes in any permanent form The Association of British Chambers of Commerce was formed in 1860 but then it consisted only of 16 chambers and it was not until the closing years of the 19th century that the association can be said to have embraced the whole body of chambers Even now the association is in the nature of a loose federation, though it plays an important part in the formation of the policy of the commercial community and is the channel for authoritative advice and appeal to the Government.

Trade Associations.—Chambers of commerce, and such closely allied bodies as the Manchester Importers and Exporters Association, may be said to organize the trade of the country on a territorial basis In some cases, such as notably Manchester for cotton or Sheffield for steel, the district which is served by the chamber produces the main share of the country's whole output of the commodity in question. But this is exceptional, and with the great majority of the modern industries the factories of each are found in several distant parts of the country, and for this reason, and because naturally each industry presents its own special problems, practically every one has set up its own national trade association The nature and activities of these bodies vary greatly. Apart from employers' associations formed primarily to deal with trade unions in regard to wages, hours, and conditions of labour (as to which *see* LABOUR), there are general associations capable of dealing with all other subjects of interest to the producers or traders in each particular industry While in general these exert little control over the actual conduct of each member's business as, *e g*, in the matter of prices or credit terms, there are examples of bodies which exhibit closer degrees of association for definite purposes, and the study of these gradually impinges

upon that of cartels, trusts and amalgamations. (*See* TRUSTS.) Important examples of the more common type of trade association for general purposes are the Mining Association, the National Federation of Iron and Steel Manufacturers, the Cotton Spinners' and Manufacturers Association, the Wool Textile Delegation and the British Engineers' Association. Such bodies are in general concerned in a greater measure with production than with any problems of the merchant, but their work provides a valuable supplement to that of the local Chambers in the efficient organization of commerce. (*See* also INDUSTRY.) Just as the Association of British Chambers of Commerce constitutes a centre and head for these bodies, the trade associations of Great Britain are grouped under the Federation of British Industries, which was founded in 1916, and numbers among its members over 160 separate Trade Associations as well as over 2,350 individual firms. The federation does not deal with questions affecting wages and conditions of labour, such questions being left to the National Confederation of Employers' Associations. It co-ordinates and supplements, from a national point of view, the work of the individual associations It has representatives and correspondents in nearly every country in the world and is thus able, apart from its more general work, to promote immediately the sale of its members' products.

The federation deals primarily with its members on the industrial group system, but it approximates to the organization of the chambers of commerce in maintaining district offices and secretaries in most of the principal cities of Great Britain and in providing its members with a method of expressing their views on the geographical basis through district committees.

In the United States, where trade associations are greatly developed, the central commercial organization, the United States chamber of commerce, corresponds with both the Association of British Chambers of Commerce and the Federation of British Industries, since it is a federation not only of local chambers of commerce, but also of other bodies included among which are many national trade associations.

Chambers of Trade.—The bodies known as Chambers of Trade form a territorial organization representative of the distributive side of trade and so supplementary to the Chambers of Commerce. They are linked together by the National Chamber of Trade inaugurated in 1897 and incorporated in 1925 which has a membership of upwards of 350 local chambers of trade and traders' associations The Incorporated Association of Retail Distributors which commenced its operations in 1920 and has attained a membership of 200 large retail stores forms a complement in this respect to the National Chamber of Trade. These bodies are mentioned here in view of their part in the national organization of trade as a whole, but their main activities lie outside its proper sphere and are treated under RETAILING.

Produce Markets.—Again parallel with the development of topographical associations of merchants and of associations for particular "trades" has been that of the organization of the process of buying and selling of specially important individual commodities or of produce markets. For the more important basic foodstuffs and raw materials the markets became concentrated so as to serve increasingly large areas, and, for the more regular and efficient conduct of their primary purpose, system and regulation arose, the market becoming a "produce exchange." Following the same distinction in character that is found between British and Continental chambers of commerce, the British "Exchange," originating from voluntary association, is self-governing and derives its effective powers from custom and not from statute; on the other hand the French "bourses de commerce" work under strict Government control; so, also in Germany and generally on the Continent. Some of these institutions, *e.g.,* the "Baltic" (Baltic Mercantile and Shipping Exchange Ltd.) dealing chiefly in shipping (charter parties) and grain, and the Corn and Coal Exchanges of London, were founded about the middle of the 18th century, but the greater number are of much later origin. The Liverpool Corn Trade Association dates from 1853, provides a futures market for wheat and maize and controls the whole of the wheat trade of the port; a similar body is the London Corn Trade Association dating from 1878 working closely with the "Baltic." The London Produce Clearing House Ltd., established in 1888 deals with forward contracts in coffee, sugar and many other commodities. The largest corn exchange is that of Chicago dating from 1848 and operating under a State Charter of 1859. The New York Produce Exchange was formed about the same time and provides for the markets in a number of commodities; cotton and coffee, however, had their separate exchanges in New York in 1870 and 1887 respectively, and the great southern cotton exchange is at New Orleans. The Liverpool Cotton Association Ltd., assumed its present form in 1882. These bodies are generally owned and managed by their members. They develop the organization of the markets by standardization of grades and by perfecting the general methods of business and the rules under which the sales are conducted.

With Chaucers' Merchant, whose interest in safe navigation was limited to the narrow seas between Holland (Middelburg) and the East coast of England (Orewell), went to Canterbury a shipman who knew all the havens from the Baltic (Gothland) to Spain. Two centuries later the merchants were joining together to engage in large enterprises of trade in distant waters with their own ships. In 1555, for example, the Muscovy Merchants Company was granted a royal charter to trade with the newly discovered northern ports of Russia and other new markets. Another royal charter was granted to the Eastland Company in 1579 to continue their trade with the Baltic. The Levant Company received charters from Elizabeth (1581–1593) and survived until the 19th century, as did the London East India Company (1600). The rival merchant venturers on the Continent followed with the Dutch United East India Company (1602) and the French East India Company (1664). True to the divergent British and French conceptions of policy these trading companies were, with England, merely developments of individual enterprise self-governing and self-supporting; with France, like the chambers of commerce they were rather organs of the State controlled bureaucratically.

These developments were of political importance rather than economic; politically they were a powerful example for the joint stock organization of business enterprise, but they did not assist markedly in the special evolution of trade or merchant organization. At the same time they do, however, represent yet another direction in which trade has become organized, *i e*, according to the region of the world with which the trading activities are carried on. Shipping and commerce have separated so that examples of shipowners acting as merchants or vice versa are rare; it is also rare that the trade between any particular parts of the world is concentrated in the hands of a single group of merchants or of a trading company in the old sense. Consultative bodies devoted to such special trades exist, however, such as the China Association and the British Merchants' Morocco Association, both of long standing. Among the more modern bodies of this kind may be mentioned the British and Latin American chamber of commerce founded in 1916 and open to all firms in the United Kingdom or in Latin America. There are also special committees of the larger chambers of commerce devoted to the trade with special geographical regions as, *e.g.,* the Far Eastern and Uruguayan committees of the London chamber and the China and Far East and Central and South America committees of the Manchester chamber.

Chambers of Commerce in the British Empire.—The earliest chamber of commerce to be established in British territory overseas was that founded at New York in 1768. After that the Commercial Exchange of Cape Town which later, 1861, became the Cape Town chamber of commerce, was the earliest "colonial" body of the kind, having been founded in 1804. Between 1830 and 1840 a group of chambers of commerce were founded in British India—at Calcutta (1834), Bombay and Madras (1836) and Ceylon (1839). In 1840 chambers were founded in Australia (Adelaide) and Jamaica; in 1845 in Canada (Toronto). During the second half of the 19th century the commercial communities of all the chief cities of the empire formed chambers which are very similar in character to those of Great

Britain. In most of the dominions there are general associations of these chambers corresponding to the Association of British Chambers of Commerce in Great Britain, *e.g.*, the Canadian chamber of commerce (1927), the Associated Chambers of Commerce of India which embraces 17 chambers, the Associated Chambers of Commerce of the commonwealth of Australia and the Association of Chambers of Commerce of South Africa. There are a Canadian, and an Australian, Chamber of Commerce in London.

The further concentration of the commercial opinion of the empire was early recognized as desirable and a series of congresses of the chambers of commerce in all parts of the British dominions began in 1886 with that convened by the London chamber when 97 such bodies were represented; at the third congress in 1896 when Joseph Chamberlain was honorary president 162 chambers took part. In 1911 a permanent body called the British Imperial Council of Commerce was established which is now known as the Federation of Chambers of Commerce of the British Empire. This body continues the series of congresses at intervals of three years and at the eleventh held at Cape Town in 1927 74 chambers participated The membership of the federation itself is 169 chambers of commerce and associations of chambers, fully representative of every part of the empire. By means of these congresses matters affecting to inter-imperial commerce are examined and a common policy postulated mainly for the guidance of the Governments of the empire, on such subjects, as taxation, communications, empire development and trade policy, research and education. Their work is thus ancillary to that of the imperial conferences and the imperial shipping and economic committees together with the Empire Marketing Board (as to which *see* below).

Organization in regard to the several trades or industries is established in the dominions as in Great Britain and naturally to an extent commensurate with their industrial development

British Chambers of Commerce in Foreign Countries.—British chambers of commerce in foreign countries advise and assist British diplomatic and consular officers and serve the general interests of British trade with the respective countries or districts in which they are situated They vary in constitution especially in regard to the extent to which foreign elements are admitted; while some are closed to foreigners others admit them on equal terms; in yet others a midway course is adopted. On the question of subsidation of these bodies by the Government a Foreign Office committee in 1920 reported definitely against the grant of Government subsidies and British chambers of commerce abroad are quite independent of Government funds Such chambers exist in nearly every important foreign country and they are particularly strong in China

Foreign Chambers of Commerce in Great Britain.—Reciprocally, foreign chambers of commerce are free to establish themselves in Great Britain and generally throughout the empire and to carry on the normal activities of such bodies In this way most of the leading commercial countries are represented in London.

In some countries on the other hand foreign chambers can only work under certain restrictions. This is easily understood in the case of those countries in which the national chambers of commerce have an official character.

Commercial Travellers.—Commercial travellers may be regarded as a separate species of the genus merchant; they are employed by merchant firms or by manufacturers who, to that extent, act as their own merchants to obtain orders from the retailers and they generally carry with them samples of the goods their principals wish to sell. The beginning of this development of trade coincided roughly with the industrial revolution, the consequent need for extended markets for factory production and the provision of better facilities for travelling and transport; thus commercial travellers and chambers of commerce.both date from the late 18 century, though both have developed enormously since that time.

Co-operative System.—The co-operative system of trade, which in recent years has assumed greatly increased importance, in so far as it succeeds in bringing together under one management the manufacture or distribution of commodities replaces the merchant, the intelligent centre of distribution guided by his sense of profit or reward for getting the right goods into the hands of the right people, by the appropriate official of the co-operative enterprise guided in the same task by, no doubt, more precise information and possibly free from the necessity, as from the opportunity, of showing in the shape of a demonstrable "profit" the positive success of his transactions. This is equally true whether the system is co-operative in the special sense as embracing the consumer or is simply an amalgamation of ordinary private enterprises, cutting out the independent merchant to a greater or less extent. Whatever may be the ultimate expansion of such systems of trade organization the essential function of distribution which the merchant performs will remain and it is difficult to imagine the rise of any economic practice which will render him or the chamber of commerce obsolete

Closely connected with co-operative marketing is standardization which has attained a considerable development in the case of agricultural produce and is receiving an increasing amount of attention as part of the general process known as "rationalization" which appears to consist largely in the application of common sense principles to trade organization

International Trade Organization.—Organization, in no matter what sphere, is tending towards the establishment of international principles and institutions. In the sphere of commerce the International chamber of commerce has already attained wide recognition, and plays an important part in the work of unifying and ameliorating the conditions under which the trade of the world may be conducted A piece of work of particular importance in the proper organization of merchant business is being undertaken by the International Law Conference in drawing up rules relating to c i f contracts and cognate questions of the rights and duties of the buyer and seller. The common interests of the various national trades, which it has been noted are served by innumerable trade associations, are dealt with by such bodies as the International Association of Federations of National Industries, while international cartels, trusts or combines are growing slowly, if with much difficulty and in face of apprehension (*See* INTERNATIONAL TRADE ASSOCIATIONS AND CONGRESSES)

League of Nations.—Above all the economic branches of the League of Nations afford a means of co-ordinating the different efforts of the various countries and interests and giving their more practical aims and ideals an authority which increases steadily In particular, apart from the work of removing trade barriers. the League is lending valuable aid to the actual organization of world commerce in such matters as the attempt to establish uniform nomenclatures for customs and statistical purposes, to codify the law and practice respecting bills of exchange and cheques, and to promote the study of *rationalization* (*q.v*). Of definite achievements which contribute positively to the organization of international trade, the protocol on arbitration clauses in commercial matters of 1923 which has been ratified by 17 States together with the complementary convention on the execution of foreign arbitral awards of 1927, afford important guarantees to merchants of effective means for the settlement of disputes

THE BRITISH GOVERNMENT AND TRADE ORGANIZATION

So far we have been concerned with that part of the organization of trade which has been in the main voluntary; we now come to consider the extent to which the British Government has engaged in that sphere. The functions of the British Board of Trade in relation to commerce had, in consequence of the disappearance of the English protecting tariff in the middle of the 19th century and of the creation of a commercial department in the Foreign Office (1871), been reduced practically to those of obtaining information as to the tariffs of other countries and of preparing trade statistics. Subsequently the Board regained its functions in connection with the negotiation of commercial treaties, with representations to foreign Governments and generally with the protection of British trade interests abroad The proper performance of these duties required improved means of

obtaining information as to commercial conditions abroad and the complete triumph of the laissez faire principle in its application to foreign trade in the middle of the nineteenth century was followed by a gradual policy of the State taking a judicious interest in commerce This development in policy was marked by the appointment of a few commercial attachés to embassies and legations dating back to 1880; by the establishment in 1900 of a commercial intelligence branch of the Board of Trade to provide a new service of commercial information for British traders; and by the establishment in 1908 of trade commissioners in Canada, Australia, New Zealand and South Africa as a result of recommendations approved by the Colonial Conference in the previous year The State thus began to take a share in the provision of information which, as we have seen, may be claimed to be one of the functions of the chamber of commerce

During the World War, Government intervention in matters affecting trade and commerce was, of course, urgently necessary in many directions. These activities were gradually discontinued after the cessation of hostilities but one permanent development remained. This was the conversion of the commercial intelligence branch into a department of commercial intelligence which in turn became in 1917 the department of Overseas Trade, a joint department of the Foreign Office and Board of Trade

The department of Overseas Trade has now at its disposal for the purpose of obtaining commercial information and of assisting British commerce generally a much more comprehensive organization overseas than has ever existed previously In the empire there are 13 trade commissioners stationed in the dominions, India, and some of the more important colonies In other parts of the empire the department has the assistance of imperial trade correspondents In foreign countries in place of the prewar commercial attachés a new service, styled the commercial diplomatic service, has been established consisting of officers styled commercial counsellors in the higher grades and commercial secretaries in the lower grades These officers are stationed in the most important foreign capitals—about 25 in number They are members of the staff of the British embassy or legation at the place in question and an important part of their duties is to give the ambassador or minister assistance in all matters affecting commerce with which he may have to deal The service is administered by the department of Overseas Trade

Consular Service.—The consular service has been under the control of the department of Overseas Trade since Oct 1919 The work of British consular officers has necessarily always been of a very diverse character but since the service has been associated more directly with the department of Overseas Trade, greater stress has been laid upon the commercial side of their work, in respect of which they are under the general supervision of the commercial diplomatic officer.

Department of Overseas Trade.—The department of Overseas Trade, which has its headquarters in London, is organized on a carefully planned system On the one hand there are geographical sections consisting of officers with specialized knowledge of particular markets, on the other hand, there are trade sections staffed by officers specializing in groups of commodities, who are in contact with the particular industries of this country

The main function of the department at home and of the three overseas services is to bring to the attention of British manufacturers and traders not only specific openings for export trade which come to their notice, but all general information of an economic or commercial nature which may be of assistance in their trade abroad All information received by the headquarters office from its overseas officers, is brought by that office before traders by direct dissemination, or by publication in the Board of Trade *Journal*, which was established in 1886, has been issued weekly since 1900 and forms a continuous record of the various commercial laws and regulations, and especially of the customs tariffs of the world. The trade commissioners, commercial diplomatic officers and certain of the consular officers furnish reports on the economic conditions of the countries forming their district which are published in a regular annual series Apart from the work of distributing information, the department and its overseas officers are able in many ways to be of assistance to British firms in connection with difficulties which they may be experiencing or in providing their representatives with facilities when paying business visits abroad. The overseas officers are constantly in touch with representatives of British firms visiting their country and as an additional means of direct contact between them and commercial men at home systematic arrangements have been made for official visits by the overseas officers to Great Britain bringing them into contact not only with the headquarters of the department but also with the business community.

Exhibitions.—Another branch of the department is the exhibitions and fairs division, whose principal function is the organization of the British Industries Fair. This fair was first held in 1915 and is held annually in London and Birmingham. It consists exclusively of a display of goods of British manufacture in a great variety of trades Bona fide trade buyers are alone admitted, except for special hours when it is thrown open to the public and the fair has now become a permanent feature of the trade organization of this country The London section of the fair is organized and controlled by the department of Overseas Trade, whereas the Birmingham section is organized under the auspices of the Birmingham chamber of commerce.

The exhibitions and fairs division is also responsible for the organization of official participation in international exhibitions

Export Credit.—As regards Government provision for export credits, the first scheme adopted by the British Government was started in 1919 after the war of 1914–18 had left the finances and currencies of Europe in a more chaotic state than commercial men of that generation had ever known, and at a time when some external aid was required to facilitate the resumption of trade with countries whose commerce and industries had been crippled by the war. Under the original scheme advances were made to exporters without recourse in respect of shipments to such countries, but importers were required to provide approved collateral security This scheme was replaced in 1921 by a system which was extended to all countries except Russia, and under which payment of a proportion of bills of exchange was guaranteed by the exports credits department The scheme of 1921, which was devised to meet still rather abnormal trading conditions was by no means simple, but it undoubtedly brought to this country a certain volume of business, which would otherwise have been placed elsewhere As the major disturbances in international trade passed away a new scheme was instituted in 1926 on the recommendation of a committee of bankers and others appointed to examine the general question of credit insurance Under the present (1929) system the exports credits guarantee department insures the payment at maturity of a proportion, not exceeding 75%, of bills of exchange drawn upon approved importers overseas in respect of goods manufactured in the United Kingdom The greater part of the department's business is done under contracts or insurance policies designed to facilitate normal business in the principal exporting industries.

British Imperial Trade Problems.—There were also created, in accordance with resolutions of imperial conferences, during the period of reconstruction after the World War, special new organs for the authoritative study of the economic problems of the British empire, the first being the imperial shipping committee appointed in 1920 This body, which was the first to be responsible to all the several Governments of the empire, included within its early activities matters of such primary importance to merchants as the rebate system and the liability clauses in bills of lading. In 1925 came the appointment on the same basis of the imperial economic committee, which has since presented reports dealing with the preparing for market and marketing of meat, dairy produce, fish, poultry and eggs and honey, and has conducted enquiries into empire tobacco and empire timber trades.

On the recommendation of the imperial economic committee there was appointed in 1926 the Empire Marketing Board to advise the secretary of state for dominion affairs in the administration of a parliamentary grant of £1,000,000 placed at his disposal for the purpose of furthering in the United Kingdom the sale of empire produce from home and overseas. The main work of

this board falls under three headings, publicity, scientific research and economic investigation.

The Board's contributions to the merchant side of the complex undertaking of furthering the sale of empire produce include the furnishing of information as exemplified in the *Weekly Fruit Intelligence Notes* and the organization of trial shipments, while assistance is given to experimental and research work on refrigeration and the grading, packing and transport of foodstuffs.

III. TRADE ORGANIZATION IN THE UNITED STATES

A. **Commercial Associations.**—Trade organization in America naturally commenced on the lines of the British system and its independent development since has not fundamentally departed from those lines. The oldest American commercial organization is the New York chamber of commerce which, as has already been stated, was founded in 1768 In the words of its charter, dated 1770, its object was "to carry into execution, encourage and promote by just and lawful ways and means such measures as will tend to promote and extend just and lawful commerce" It has formed the prototype of all the very numerous chambers of commerce and boards of trade (as some of them are called) which have now been formed in every place of importance throughout the United States The commercial interests of the United States as a whole are represented by the important voluntary organization known as the United States chamber of commerce which is a federation of local chambers of commerce, boards of trade and similar bodies, including a considerable number of national trade associations It is organized into departments relating to all the more important aspects of business. Its chief functions are those of co-ordinating and giving effective expression to the views of its member bodies on questions of national policy and of furnishing commercial information

A number of American chambers of commerce have been established in foreign countries, the earliest of which was the American chamber of commerce in Liverpool dating from 1801, a body which has now been replaced by the American chamber of commerce in London The American chamber of commerce in Paris is one of the most important foreign associations on the Continent of Europe and there are other American chambers of commerce in Germany, Italy, Spain and Belgium; also in the chief South American countries and in Mexico In China there are American chambers of commerce at Peking and at several ports.

American commercial museums such as those at Philadelphia and San Francisco have been founded to assist American manufacturers and merchants in securing wider foreign markets for their products Besides possessing valuable collections of commercial samples the museums have elaborate indexes of foreign customers and of American manufacturers which are available to chambers of commerce and similar bodies.

B **State Departmental Organization.**—The Government department of the United States which is primarily responsible for Government policy in relation to commerce is the department of Commerce but the department of State (which corresponds to the British Foreign Office) gathers trade information through its consular officers, their reports being disseminated by the department of Commerce Besides the usual statistics of trade and production, the United States department of Commerce issues a monthly *Survey of Current Business* which covers in addition such items as stocks, new orders, unfulfilled orders for every field of industry and commerce of importance, and to gather some general indications from this mass of separate data index numbers have been devised so that the *Survey* concentrates into a very small compass the entire commercial and industrial situation in the United States. It is the department of State which is looked to by American trade interests when these encounter difficulties abroad such as discriminatory or arbitrary treatment on the part of foreign Governments. In the matter of tariff policy, however, it is the United States tariff commission which has to gather the facts relating to all aspects of the United States tariff and to report them to Congress and the president.

U.S. Bureau of Foreign and Domestic Commerce.—The bureau of Foreign and Domestic Commerce is the department of Overseas Trade of the United States—it is the chief source of information of foreign markets for the American exporter, information which it derives from 45 commercial attachés and trade commissioners abroad. There is also a domestic commerce division established in 1923. The bureau is organized similarly to the British department of Overseas Trade on a combined basis of 14 commodity divisions and of three regional sections. Latin American, Far Eastern and European It publishes weekly *Commerce Reports* conveying a mass of information on every aspect of foreign trade. Other divisions of the bureau whose titles sufficiently indicate their general function are the finance and investment division, the transportation division, the foreign tariffs division and the division of (foreign) commercial laws, statistics and statistical research. The commercial intelligence division compiles an index of foreign business firms and indicates the general nature and standing of some 75,000 firms.

The bureau maintains local offices in several American cities and has made arrangements with representative chambers of commerce whereby these are used as local branches of the bureau.

C. **Unfair Practices.**—An important function in relation to the ordinary practice of commerce is exercised by the Federal trade commission which deals with complaints of unfair methods of competition or trade practices In important cases it calls together the representatives of the trade concerned and gets them to agree to declare what practices should be considered unfair Having commenced its activities in this direction in 1917 it is building up a body of law to guide American business men

For details *see* FEDERAL TRADE COMMISSION

IV. TRADE ORGANIZATION IN FRANCE

Chambers of Commerce.—French chambers of commerce owe their origin to the city of Marseilles, where, in 1599, the town council, which had hitherto looked after the commercial interests of the city, found it no longer possible to combine commercial with municipal functions, and established an association which it called the "chamber of commerce" to take up the commercial part of its duties This seems to be the first time that the title was used Although the new chamber soon became a most important body, *lettres patentes* were not granted until 1779 It settled the merchant law and the customs of the port, was entrusted with the appointment of consuls and the control of French consulates in the Levant. fitted out expeditions against corsairs, owned fleets, sent embassies to the Barbaresque countries, and also organised commercial missions Louis XIV. conceived the idea of a system of organizations which, whilst not being allowed to become so dangerously powerful as that of Marseilles, would nevertheless be useful in other towns, and in 1700 he caused an *arrêté* to be published, ordering the creation of chambers of commerce, which were entrusted with the nomination of deputies to the royal council of commerce which had just been created in Paris. Chambers were consequently established in Lyons, Rouen, Toulouse, Montpelier, Bordeaux, La Rochelle, Lille, Bayonne, Amiens and other towns. These bodies, however, did not exercise much influence under the monarchy. Including the Marseilles chamber, they were suppressed, with all trade guilds and other trade associations, in 1791. Napoleon re-established the chambers by decree of Dec. 24, 1804

They are now (1929) regulated by the law of April 9, 1898, modified by the law of Feb 19, 1908, which codified, altered and completed previous legislation on the subject Under this law, chambers of commerce can only be established by a decree countersigned by the minister of commerce, upon the advice of the municipal council of the place where the chamber is to be, of the general council of the department, and of the existing chambers of commerce of the district The members of French chambers of commerce, whose number is fixed for each chamber by the minister of commerce, are elected by the commercial houses paying *patente*, a special tax levied upon persons engaged in trade

Their functions, which are consultative and administrative, are set out in part ii. of the law of 1898. The government is bound to take their opinion regarding the regulation of commercial usages, the establishment of public institutions of a commercial or finan-

cial nature, such as "bourses de commerce" or commercial exchanges, and of tribunals of commerce, the improvement of transport and communications, the application of laws of a local character, the sale price of prison-made goods and the tariff for prison labour, and local public works, and loans or taxation in connection therewith. On the other hand, they are allowed to submit observations to the government, without being asked, on proposed changes in the commercial or economic legislation of the country; on customs tariffs and regulations; on railway, canal and river rates; and on transport regulations. As regards their administrative functions, they may be authorized to establish and administer such institutions as bonded warehouses, public salerooms, fire-arm testing establishments, conditioning rooms for wool, silk and other commodities, commercial, professional, or technical schools and museums They may be granted concessions for public works, and may undertake the carrying out of public services, especially in regard to the ports, docks, canals and navigable rivers in their districts, which in general they manage under the supervision and control of the State exercised through local resident officials In 1924 a new policy was incorporated by laws which made Havre and Bordeaux autonomous, *i.e.*, independent of State control, and placed them under bodies nominated as to the great majority of their members by the chambers of commerce of the city and of neighbouring towns in each case. Since the World War the chambers of commerce have undertaken most of the burden of new expenditure on ports.

Previous to 1898 it was illegal for chambers of commerce to hold joint meetings for the discussion of matters of public interest, and they were not even allowed to correspond or consult in any way, except through the medium of the minister of commerce. The law passed in that year relaxed this prohibition.

French Chambers of Commerce Abroad.—When, in 1873, British merchants in Paris started a British chamber of commerce in the French capital, the French government looked rather askance at the new venture, and M. Léon Say, when minister of commerce, even threatened it with forcible dissolution unless the title "chamber of commerce" was dropped. This demand was not ultimately pressed, and the services rendered by the British chamber soon opened the eyes of the French government to the advantages which they might derive from the formation of similar institutions to represent French commercial interests abroad In 1883 the minister of commerce started the organization of such chambers, which endeavoured to combine to a certain extent the French and the British systems, and upwards of 50 French chambers of commerce have been established in foreign countries, including six in Spain, four each in Belgium and Western Germany, and the only foreign chamber of commerce in British India (the French chamber of commerce for Western India and the Persian gulf at Bombay). There is a French chamber of commerce in London and another at Liverpool.

Foreign Chambers of Commerce in France.—Most of the leading commercial countries of the world are represented by chambers of commerce established in Paris, of which the British chamber is the oldest. There are also Belgian, British, Italian, Spanish and Swiss chambers at Marseilles. Spain has in all as many as seven chambers in France.

Consultative Chambers of Arts and Manufactures.—These institutions bear to industry, as their name indicates, much the same relation as do chambers of commerce to commerce. They were instituted by Napoleon as part of the complete system of economic organization which he intended to give France, but are now regulated by decrees of 1852 and 1863. They consist of 12 members elected by manufacturers and merchants and are under the control of the minister of commerce; they are supported by the municipality of the town to which they belong.

Syndical Chambers of Trade and Industry.—By the side of the official trade organizations other associations have grown up, which, although regulated by law, are in the nature of voluntary and self-supporting bodies, viz., the syndical chambers of trade and industry. The repeal in 1884 of the law of 1791, which prohibited the formation of trade or professional associations, was the signal for the formation of those chambers, which soon acquired great influence.

These bodies are organized primarily for the purpose of representing and bringing together the interests of the employers and the employed severally, and are divided into chambers of each of these two groups, except in regard to professions where there is a single syndical chamber, as for example, in the case of the brokers (agents de change) of the French bourses de commerce. Syndical chambers do not require Government authorization, and they can only be dissolved by the French courts on the ground of infringement of the provisions of the law of 1884. They take part in the election of judges of the tribunals of commerce.

Out of this organization has been created since the war the central organ of French industry known as the Confédération Générale de la Production Française, formed on the proposal of the minister of commerce in 1919 "to contribute to the development of the productive power and export trade of France, and to co-ordinate the activities of the syndicates and professional associations." It consists of 1,500 such associations subdivided into 26 groups, and its function is to interest itself in all the more important problems of industry and commerce which affect the interests of its members. It may be said to focus the aims of practically the whole of the economic forces of the country.

French State Departmental Organization.—The state commercial departments and offices are chiefly centred round the Ministry of Commerce, to which is assigned the commercial part of the duties fulfilled in England by the Board of Trade This ministry received its present form in 1886. Attached to it is the Conseil Supérieur du Commerce et de l'Industrie, which acts as an advisory council to the minister

Contemporaneous with the commercial intelligence department of the Board of Trade, and founded with the corresponding object of promoting French export trade, the Office National du Commerce Extérieur was established by a law of the 4th of March 1898, and carried on jointly by the Ministry of Commerce and the chamber of commerce of Paris, the latter having provided it with an installation at a cost of over 1,200,000 francs

Since the war the French Government has replaced the Office National by the department of Overseas Trade, which also follows in large measure the lines on which the British department of that name is constructed and works. There are, similarly, numerous commercial attachés in foreign countries to co-operate with it, and to advise it a committee of foreign trade experts chosen from among exporters in France and French merchants abroad The French consular service is also of course charged with the duty of providing such information and general assistance as may be requisite for the promotion of French trade.

A new organ of Government for the perfection of the French economic system was instituted in 1924 in the shape of the Superior Consultative Commerce Committee which includes in its 68 members, besides senators and deputies, representatives of the chambers of commerce and of the more important trade associations It is appointed as to the great majority of its members by the Ministry of Commerce. The sphere of activity of this body embraces commerce, industry and economic organization.

In France the series of trade fairs began in Paris with that of 1904; in 1917 it was resumed after some interruption on a larger scale with the support of 36 chambers of commerce, of 140 trade associations and of the French Government. Organized on a business footing to serve French industry it receives financial support from the Paris chamber of commerce. In 1925 this Paris Fair assumed an international aspect since British, Belgian and other foreign exhibits were included.

The annual fairs at Lyons, commencing in 1916, have always been international in scope; in those inaugurated in the same year, at Bordeaux, French colonial products are predominant, but the fair became international in 1926.

The representation of French production at foreign exhibitions is effected under the guidance and supervision of a permanent foreign fairs committee of the French department of Overseas Trade, and much importance is attached by the French Government to such methods of promoting French export trade.

V. TRADE ORGANIZATION IN GERMANY

Commercial Associations.—In Germany there are two kinds of trade organizations:—

(1) Official organizations established by law, *i.e.*, officially recognised, public legal bodies, the chambers of industry and commerce.
(2) "Free" associations and unions, *i.e.*, unofficial unions.

An intermediate class, the so-called semi-official bodies, dating back to the 18th or beginning of the 19th century, and recognised or even instituted by the Governments of the day, always preserved their official character down to recent times, but have now either been converted into chambers of industry and commerce or ceased to exist. Such are the "Aeltcste der Kaufmannschaft zu Berlin" (established 1820), the "Kommerz-Deputation in Hamburg," the "Handelszunft in Mannheim" (established 1728); the "Handelsvorstände" in Frankfort-on-Main (established 1707), Leipzig, and Cologne, the Merchants' corporations in Stettin, Danzig, Memel, Tilsit, Königsberg, Elbing and Magdeburg (these last dating from the years 1821–25).

Chambers of commerce in Germany (since 1920 almost all called chambers of industry and commerce, in order to denote the equal representation of industry and commerce) show little uniformity, especially as regards historical development, which varied widely in the various states, according to economic and political circumstances. In certain parts of Germany their foreign origin may be easily discerned, while in other parts, as in the Hansa towns, in south Germany (*e g.*, in Nuremberg, Heilbronn, Mannheim), their origin dates back to the private initiative of local merchant circles at the end of the 17th century. Shortly after 1800, chambers of commerce and industry were set up by Napoleon in many towns in the Rhineland territories then ceded to France (*e g.*, Aachen, Eupen, Trier, Krefeld, Mainz). In 1830 a royal statute brought into being a large number of chambers in the rest of Prussian territory.

It was not, however, until 1848 that chambers of commerce in *Prussia* received their first legal status in virtue of a Royal Ordinance When in 1870 a new law re-organized the whole system of chambers of commerce, 33 new chambers had already been established under the first royal ordinance The law of 1870 is still in force, though with many modifications, the most important of which were made in 1897; in *Bavaria* the first ordinance was issued in 1842, and a complete revision was made by the law of Feb. 1908 In *Württemberg* the first ordinance of 1854 was replaced by a law of 1897, which organized the chambers of commerce system on the lines followed in Prussia. In *Saxony* the provisions of the industrial ordinances of 1861 and 1920 apply; in *Baden* the Law of Dec. 1878, with various amendments

In the course of this development the variations in the organization and functions of chambers of commerce as between the various German States have largely disappeared. The following description may be regarded as applying to all chambers of commerce in Germany. They are more autonomous and independent than French chambers of commerce. They have indeed an official character, but are not a corporate part of Government organization. Subject to the provisions of the relevant laws, the chambers fix their own constitution and determine election procedure. Members are freely chosen, and they are quite free as to what resolutions they pass.

The chambers' activities may be divided into two groups:—

(1) Duties imposed on them by State laws; these include drawing up an annual report on the economic position and development in the preceding year, giving advice to officials in questions touching trade and industry, nominating and swearing-in publicly appointed experts, weighers and assessors, and assisting the courts in keeping the commercial register.

(2) Voluntary duties undertaken by the chambers as falling within their scope, *e g*, giving information in questions of customs and transport or home and foreign trade, information regarding trade practice, setting up and conducting commercial schools, administering exchanges, harbours, public and customs warehouses, instituting arbitration courts, and issuing periodical announcements.

To meet expenses the chambers of commerce in Prussia and Württemberg levy a surtax on the industrial tax on profit and capital, to which trade and industry is subject. In Baden a surtax is levied on the income tax and corporation tax. In Bavaria a special tax is levied. In addition, very many chambers of commerce have an individual income from fees for certificates of origin and other attested documents, from exchange and market fees, from receipts for rent of space in the buildings belonging to them. They receive no contributions from the State.

In order better to carry out their duties, the members and constituent firms are divided into three groups (industrial, wholesale and retail), each of which considers matters specially affecting it. Special committees composed of members and non-members exist for separate branches of trade, where necessary.

All chambers of industry and commerce in Germany are united in a central organization in Berlin (the Deutsche Industrie und Handelstag, founded 1861). Further, the chambers of the various States have their own special central organization, and besides this many chambers in the larger districts have united into associations (*Verbände*) for the purpose of pursuing common interests and duties. The following are some examples: Lower Saxon Association of Chambers of Industry and Commerce, Cassel, the Association of Hesse—Nassau Chambers of Commerce and Industry, Association of North-East German Chambers of Industry and Commerce, Association of Central German Chambers of Industry and Commerce, Association of Chambers of Industry and Commerce of the Lower Rhenish and Westphalian Industrial District, etc.

Among individual chambers of commerce, the following may be mentioned:—

(1) *Chamber of Industry and Commerce, Berlin,* founded in 1902, united in 1919 with the Potsdam chamber of commerce and in 1920 with the "Aelteste der Kaufmannschaft," Berlin, which, as stated above, dated from 1820. Its membership amounts to 93. The income amounted in the financial year 1926–27 to approximately 6,616,000 Reichsmarks and the expenditure to approximately 6,177,000 Reichsmarks. The chamber has a retail trade committee and 48 special committees It conducts the Berlin exchange, a commercial high school and various commercial schools.

(2) *Hamburg, Bremen and Lubeck Chambers of Industry and Commerce.*—The chambers of commerce of the Hansa towns possess a special status, both on account of their historical development and on account of their legal status in general. Here by a process of continuous development the chambers of commerce grew out of the early existing corporations.

Thus in Hamburg, the chamber of commerce, instituted in 1867 represents the long established Union of Merchants engaged in land and sea borne trade, the "Versammlung eines Ehrbaren Kaufmanns." At the same time it absorbed the former representative body the "Kommerz-Deputation," which had existed from 1665 to 1867. The chamber was re-organized by a law of 1909 It consists of 34 members, elected by the above-mentioned *Versammlung*. All wholesale merchants established in Hamburg who, on application, are entered on a register kept by the chamber of commerce are members of this union. An "Industrie Kommission" is annexed to the chamber, consisting of 10 members of the chamber and 22 representatives of industry, and deals with industrial questions. The Hamburg chamber of industry and commerce administers the local stock and produce exchange It is officially represented by three members in the "Deputation" for commerce, shipping and industry, annexed to the "Burgerschaft" (lower house of representatives), in the "Deputation" for indirect taxes and duties and in the emigration authority. Its income is derived partly from fees levied for the use of the exchange and its institutions, and from a special tax levied on all firms entered in the commercial register. Its budget closed in 1927 with receipts at 1,673,000 marks and expenditure of 1,197,000 marks The yearly budget must be laid before the Deputation for trade, shipping and industry for information.

The Hamburg retail trade is also legally represented by a "Detaillistenkammer."

The Bremen chamber of commerce (established in 1849 and reorganized by the law of July 1921) consists of 30 members elected by the members of the "Kaufmanns-Konvent" The chamber is officially represented in a mixed committee of members

of the senate and the chamber for the consideration of questions affecting trade and shipping. It is also represented in certain municipal committees including one for promoting trade.

The Lübeck chamber of commerce consists of 21 members who are elected by the "Kaufmannschaft von Lubeck"; it was established in 1867 and its composition and functions regulated afresh by the Merchants Ordinance of 1898 The Lubeck "Kaufmannschaft" is one of the oldest merchant bodies in Germany. Its duties were practically the same as those of the other Hansa chambers of commerce. The chamber carries on its duties in close touch with the senate through various committees consisting of members of the senate and of the chamber, in respect of all questions of trade and shipping The retail trade is also officially represented in Lübeck by a "Detaillistenkammer"

German Chambers of Commerce Abroad.—Especially in the decade 1919–29, German chambers of commerce abroad have been greatly extended Although they are unofficial associations, they are generally officially recognized At the present time (1928) there are about 26 German chambers or mixed chambers consisting of an equal number of German and foreign members. Among these may be specially mentioned those for Switzerland, Spain and Italy and that in Vienna; there are several German chambers of commerce in China and Japan (Shanghai, Tientsin, Canton, Mukden, Tokio, etc) and in South America (Brazil, Uruguay, Argentina)

Voluntary Associations.—A great development has taken place since the war in regard to such associations, both industry and commerce forming numerous societies and unions for the furtherance of their interests The chief organization for the whole of German industry is the Federation of German Industries ("Reichsverband der Deutschen Industrie"), which was established in Feb 1919, and embraces all branches of German industry It is divided into numerous branch groups, each of which is composed of numerous special or technical associations Either individual firms or associations may be members of the federation. Wholesale trade and retail trade are united in a central association, the Central Association of German Wholesale and Retail Trade ("Zentral Verband des Deutschen Gross- und Einzelhandels") with local branch associations all over Germany.

The "Aussenhandelsverband" must also be mentioned as the association for export trade and export industry

German Government and State Authorities and Trade Organisation.—The Ministry for Economic Affairs (Reichswirtschaftministerium) is the competent body for dealing with commercial and industrial questions affecting the whole country Questions of foreign trade, especially commercial treaty negotiations, and consular affairs, are dealt with by the Ministry for Foreign Affairs (Reichsministerium des Aeussern) in conjunction with the Ministry for Economic Affairs

An advisory body also exists, in virtue of Art 165 of the German constitution, in the economic council of the Reich (Reichswirtschaftsrat) It consists of 326 members, but under a bill to regulate its composition it is proposed (1928) to reduce the membership to about 140 to 170. It is divided into 11 committees, the most important being the political-economic committee, the social-economic committee and the financial committee. It approves all important bills on economic and social questions, and the Government is bound to submit such bills to the council before they are laid before the Reichstag The council may also make proposals on its own initiative

In addition each State has a Board of Trade ("Handels-ministerium") for matters affecting trade, industry and production and, like the Government of the Reich, they have a State economic council as an advisory economic body.

Consular and Foreign Trade Service.—All German legations, embassies, consulates-general and the more important consulates have commercial departments attached to them for the promotion and assistance of trade and industry A central information bureau has been set up, to give information to German trade and industry on general economic conditions abroad, on customs and transport questions, import conditions and other subjects. This bureau has branches all over Germany, notably in the more important chambers of commerce.

VI. TRADE ORGANIZATION IN ITALY

Chambers of Commerce.—The Italian chambers of commerce which were regulated by the law of 1862 and performed functions similar to those of the French chambers of commerce, were replaced by Laws Nos. 1045/731 of April 18, 1926, and Nos. 1363/1071 of June 16, 1927, which set up in their place economic provincial councils, "Consigli Provinciali dell' Economia" These councils which commenced their functions as from Dec. 1, 1927, are consultative bodies of the State and local administrations as well as organs for decentralization and for the local execution of Government policy. They are under the general control of the minister of national economy at Rome They formulate proposals for economic development in their province (including agricultural and technical education). They compile and review commercial usages and exercise a general supervision over public institutions concerned with economic matters

They administer the commercial bourses, and through a board which is established in the chief town of the province exercise specific administrative or executive functions in regard to the following matters:—(*a*) representation of the minister of national economy in actions for fraud in trade, (*b*) the laws relating to factory plans and trade marks; (*c*) the registration and winding up of companies, (*d*) the issue of certificates of origin and identity papers for commercial travellers, (*e*) the compilation of bulletins and lists of prices as required under article 38 of the Italian commercial code.

These councils consist of not less than 12 and not more than 28 members, some of whom are *ex officio* members representing Government and public institutions, and others are appointed by the minister of national economy or by royal decree to represent economic associations and institutes of agriculture, manufacturers, traders and employees The chairman is the prefect of the province. All industrial and commercial firms have to register with the economic provincial council and the funds of these bodies are derived from charges on the income of these firms and taxes on land and buildings and social insurance premiums

Government Action.—A Law No. 1129/800 dated April 18, 1926, created the Italian national institute for exportation (Instituto Nazionale per l'Esportazione) which was inaugurated on July 18, 1926, with Dr Pirelli as president This institute, which is controlled and financed by the Italian Government but not a part of the regular Italian civil service, consists of a chairman chosen by the ministers for national economy and foreign affairs, and a general council containing representatives of Government departments, Fascist corporations, commercial and industrial bodies and other economic and financial institutions There is also a technical committee appointed by the general council and consisting of 8 of its members. The function of the institute is to develop export trade, to collect and distribute commercial intelligence and to undertake propaganda work abroad It also arranges for Italian participation in foreign exhibitions and fairs, and assists in the obtaining of credits and proper transport facilities for export trade; in addition it sees to the juridical protection of Italian exporters abroad. It receives a Government contribution of 4,000,000 lire per annum It replaces the commercial information bureau and *Bulletin* of commercial information which had been set up by royal decree No 2125 of Sept 6, 1923.

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Russia.—Trade organization in Soviet Russia naturally differs substantially from that of other countries. Centralization in State hands of the ownership of the greater part of industry and of transport of course makes much of the usual commercial machinery inappropriate or unnecessary Of large scale industry 90·7% is owned by the State; 6·8% by the co-operators; and only 2·5%, including concession enterprises, is in private hands. The percentage of production from private industries rises to

26% if the small scale industries and small workshops are included

In the nationalized industries the unit of organization is the Trust which is responsible for a single factory or a group of factories conveniently situated, geographically or commercially, for economical management Each Trust is an independent financial and commercial enterprise with a responsible Board of Directors, with its own capital and credit resources and its own responsibility and incentive for successful commercial operations The State holds the ordinary capital, but the Trusts make their own arrangements for loans and credits with the banks and those with whom they trade The Directors of each Trust are appointed in consultation with the Council of Trade Unions by the Supreme Council of National Economy—the Government Department responsible for the conduct and control of industry The number of Trusts in industries varies In textiles, for example, there are 22 important Trusts; in oil, the most important are the Azerbaijan, Grozny and Emba Trusts, each of which controls the productive and refining process of a whole oilfield

Whilst each Trust has the right of individual trade, in general the Trusts in each industry are linked together in Syndicates for their main buying and selling operations, particularly where they are operating on foreign markets These syndicates are independent financial and commercial units, their share capital being subscribed by the constituent Trusts Among the best known are the Naphtha Syndicate, which disposes of most of the oil products, and the Textile Syndicate, which sells finished goods and buys raw materials on behalf of the textile industry In some cases syndicates have been formed specially for work on foreign markets, e g, Exportles, which acts as the exporting agency for all the Timber Trusts, and Exportkhleb, which has the monopoly of the sale abroad of grain on behalf of the various Co-operatives and Government organizations concerned

The wholesale and retail distributive trades and the marketing of the peasants' produce together with the bakeries, dairies, elevators, cold stores, etc , necessary thereto are mostly in the hands of the co-operatives (*See* RUSSIAN CO-OPERATIVE ORGANIZATIONS) These buy their supplies of industrial commodities from the Trusts or Syndicates concerned

Internal and Foreign trade is under the administrative control of the People's Commissariat of Trade (Narcomtorg) which deals with the adjustment of relations between producers and consumers, and itself decides on prices and other matters of difficulty when negotiations fail It also administers the monopoly of foreign trade, issuing licences for import and export, and appoints Trade Delegations abroad which control the Government and co-operative foreign buying and selling agencies The Gosplan, or State Planning Department, works in close contact with the Supreme Council of National Economy and Narcomtorg It is a statistical and intelligence bureau, whose task is to collect and correlate statistical data and to work out comprehensive operation plans by which industrial and agricultural production, finance and banking, internal and external trade may be developed and correlated.

In the cities there are Goods Exchanges and in the country towns there are markets and fairs at which State trading organizations, Co-operatives, private traders and individual peasants meet for buying and selling. In August of each year there is also held the historic Nijni-Novgorod Fair to which buyers and sellers come from all parts of Russia as well as from Persia, Mongolia and other Asiatic countries. (E. F. WI.)

TRADE ROUTES. In Mediaeval English the word "trade" meant a path; it was connected with the word "tread" Exchange, which is now of the essence of trade, was not at first implicit in the word, but rather the idea of movement to and fro. In a sense trade routes are older than trade. Many of them probably began as "raid-routes." The Norse pirates, for instance, sallied forth annually in the spring by familiar courses and in the autumn returned with their ships laden with spoil The pathways in Central Africa which guided the European explorers of the 19th century had been organized as a thorough system by the Arab slavers.

Ancient Routes.—The trade routes which now envelop the globe as with a net may be regarded as having grown from the track which at the dawn of recorded history connected Babylonia with Egypt These two lands, while both rich with the agriculture of a river plain, so differed in the details of their civilizations as to offer to each other commodities suitable for exchange The primitive way was, no doubt, north-westward along the bank of the Euphrates and then south-westward along the fertile foot of the Syrian mountains, but that way was early "short circuited" by a direct route across the Syrian desert. The change was effected by the Semitic nomads of the desert, whose wealth was of horses, camels, asses, sheep and goats Periodically they made descents on the borders of the cultivated land, robbing the tillers of the soil, the cattle owners, and compelling the towns to engird themselves with walls In time the nomads discovered that articles of luxury taken as booty from one side of the desert commanded a high price on the other side, and gradually a lucrative system of transport and exchange was substituted for the dangerous practice of raiding The nomads knew the whereabouts of the wells and oases, and jealously guarded their secret. Ultimately, because they held the central position and could concentrate quickly for attack, they conquered and ruled the settled peoples of the encompassing fertile plains, and the desert tracks became the links of empire. Rich cities, taking a toll of the passing traffic in return for sending it forward, arose in the oases, as at Tadmor and the later Palmyra, or where the caravan routes ended at the edge of the cultivated land, as at Damascus.

From the Mesopotamian and Syrian ends of this "desert-ferry" there gradually extended ramifications into Europe and into Asia, in each case with alternative routes by land and by sea Towards Europe a traffic grew up through the country of the Hittites, by the Taurus passes and the upland of Asia Minor, to the Balkan peninsula and the Danube basin, and on into Northern Italy. Troy may have risen to wealth and power on this traffic, and by interfering with a local Greek trade through the Dardanelles may have brought upon herself the war sung by Homer On the other hand a Semitic tribe, the Phoenicians, took to the sea and, with transhipment at Tyre, prolonged the desert route over the waters of the Mediterranean to Carthage and Spain In the opposite direction, towards Asia, a trade was organized through the passes in the Persian Mountains and round the north of the Persian deserts into Turkestan and Hindustan, while shipping from the Indies came up the Persian Gulf

The first great change of routes resulted from the conquest of Egypt by the Greeks under Alexander the Great From the newly-founded Alexandria, which took the place of Tyre, ruined by the war, a water-way led up the Nile to Koptos, which is distant by caravan across the desert only 100 miles from the Red Sea—no more than the breadth of the Isthmus of Suez. According to Herodotus the Egyptians had long before joined the western to the eastern waters by a canal through the Isthmus, but in the time of Alexander this had been abandoned, probably for the reason that the homeward voyage of sailing ships up the northern part of the Red Sea was rendered difficult by a persistent contrary north wind, the local equivalent of the trade wind of the same latitudes in the Atlantic Ocean The Koptos route came out at the coast some 300 miles from the northern end of the Red Sea.

The Greeks celebrated under the name of Hippalus the pilot who first among their mariners made use of the seasonal monsoon winds for the direct passage from the mouth of the Red Sea to the coast of India opposite instead of following the shoreline of Arabia and Baluchistan By the second century after Christ the ocean route to southern China was vaguely known to the Greeks of Alexandria Meanwhile the land route through the heart of Asia had penetrated to Northern China, and silk from that source was finding its way to the Mediterranean through Tyre

Silk was a commodity typical of the then traffic by land, for the cost of animal transport was great and could only be borne by goods occupying little space in proportion to their value, such as gold, silver, precious stones, fine linen, and incense. Within the Mediterranean, however, cargoes of grain to such places as Rome constituted a beginning of sea carriage in bulk. Fragile wares such as the art pottery of Athens were transported to every shore.

Mediaeval Routes.—The greatness of Constantinople during the early middle ages was in part based on a continuance of the land traffic through the Balkan Peninsula and Asia Minor. The Saracen and Moorish fleets had rendered the Mediterranean unsafe, and piracy, which had been suppressed while the Roman empire was efficient, had again become rife. Gradually the sea traffic recovered, being organized afresh by the Italian maritime cities, and the later crusaders, in the 12th and 13th centuries, were carried eastward by the ships of Venice. The fact that at this time a single race, the Arabs, dominated the caravan tracks of the Near East and also the sea ways of the Indian Ocean undoubtedly favoured the development of the trade with the Middle and Far East, although Christendom was excluded from the Eastern seas and had to buy silks and spices of the Muslims at Alexandria and Aleppo. Thus the principal trade of the world in the Middle Ages came to be conducted in two separate compartments, Eastern and Western; the goods went through, but not the men

In Europe the Italian cities, especially Venice and Genoa, undertook the forwarding into the West of the wares of the East The lie of the Italian peninsula south eastward towards the Egyptian and Syrian ends of the desert routes was such as to favour sea transport along the Italian coasts into the heart of the Western world From Northern Italy trains of pack animals carried the goods over the Alpine passes to the Rhine, down which river they were transported in boats to Cologne and the cities of Flanders for distribution over Northern France, England, Northern Germany, and Scandinavia On the return journey furs from the northern forests were a principal article of traffic Important banking houses rose to wealth in the cities of South Germany as well as in Venice by financing merchants along this trade route.

At certain times, and notably under the short-lived Mongol Empire in the 13th and 14th centuries, there were notable revivals of the traffic from the Far East through the heart of Asia, although normally the turmoil of barbarous peoples rendered the passage unsafe and costly. The trans-continental caravan route came out either at Aleppo or at the head of the Sea of Azof. The Venetian traveller, Marco Polo, went in at Acre during the Mongol epoch and travelled safely to Cathay or Northern China. The Genoese, from Constantinople, for a couple of generations in the 14th century did a considerable trade with the East through the Black Sea

Growing Predominance of Sea Routes.—In the 15th century a change in the course of European trade took place which must have appeared even to contemporaries as of the first importance. Venice began to send forward the wares received from the East no longer over the Alps and by the Rhine, but by an annual fleet through the Straits of Gibraltar to Flanders, with a call of some of the ships at Southampton The overland traffic soon yielded to the new competition, and the financial houses of the south German towns transferred themselves to the Netherlands. There had long been a local trade of English wine ships to Bordeaux and the advent of the Italian pilots, now equipped with the mariner's compass, into the outer seas with the valuable wares of the East must have stimulated ideas of bolder venture in the northern ports The exploration of the West coast of Africa, organized from Portugal by the half-English Prince Henry the Navigator, was contemporary with, and no doubt incidental to, this development If sea venture round the West of Europe was cutting out the continental traffic across Europe, why should not a greater venture round the South of Africa cut out the traffic across Egypt and Syria? The spices of the Orient would then reach London by an unbroken voyage with only terminal handling of goods, whereas by Egypt and the Rhine there was a chain of three sea voyages, with two expensive land sections intercalated, and handling of the goods at least six and more often eight or ten times.

During the early 16th century Venice struggled tenaciously to maintain her trade long after Da Gama had rounded the Cape, and the last voyage of the Venetian fleet to England and Flanders did not occur until 1532. The 17th and 18th centuries saw a virtual monopoly of the carriage of the world's trade by the sailing ship on the ocean. Strictly speaking there are no trade routes on the sea. Once the mariner had learnt to go boldly out of sight of land, he was free of all the ocean, and might descend upon any coast. Practically, however, the greater part of the water surface of the globe is left to-day as in the past to the undisturbed possession of the albatross and the flying fish, for merchant craft are compelled for economic reasons to keep to the courses which on a balance of considerations are likely to yield the best net results to their owners. In the great sailing days, however, ship-masters took other courses from those followed in the later days of steam, and courses, moreover, which varied in most cases on the outward and homeward voyages. In the Atlantic the trade winds, north-east and south-east, determined the sailing tracks, and the Gambia became a place of refreshment on the outward voyage and St. Helena on the homeward voyage. Algoa and Delagoa are names which record corresponding facts with reference to the voyages of the Portuguese to and from Goa on the seasonal monsoon winds. Thus the new ocean routes to the Indies came to be punctuated with victualling and watering stations and these stations were the property of the "East India Companies" of the several nations

At first the Portuguese claimed an exclusive use of the new route which they had discovered to the East, and "stapled" the goods which their ships brought home at Lisbon, and other peoples had to come and buy there. This "pride of the wholesaler" brought its retribution, for the Dutch built up a distributing trade from Lisbon throughout northern Europe, and when Portugal was conquered by Spain, the Dutch rebels against Spain steered past Lisbon and sought their own wares in the East. Amsterdam now became the seat of the depôt trade in spices, a term which covered many more articles than in modern parlance It would exceed the limits of this article to enter into the history of the English and French competition with the Dutch on the trade route to the Indies. Suffice it to say that England ended by defeating all her rivals, in no small measure because her motive was to sell even more than to buy.

Europe and the Indies.—The history of human civilization might be written round the story of the trade routes between Europe and the Indies The facts of physical geography are such that it was inevitable that the main trade of the world, apart from local exchanges, should be between the northwest and the south-east of the Euro-Asiatic continent Those two regions are alike characterized by ample rainfall, lowland soils, and navigable rivers and arms of the sea. They are separated by a belt of great deserts through which lie narrow natural ways, such as the Red Sea and the Nile and Euphrates rivers. Neither the north of Asia nor the centre and south of Africa offered comparable facilities for early human development. To-day, on an area of some three million square miles in Europe are three hundred million people, and on an area of some five million square miles between Ceylon and Japan are eight hundred million people

Europe and America.—The second great trade of the world, that between Europe and America, was inaugurated by the voyages of Columbus. He set out to reach the East by way of the West, and as a fact his immediate successors succeeded in accomplishing that feat. The Philippine Islands were approached by the Spaniards, not by the Portuguese route round the Cape, but across the Pacific The track of their galleons was from Spain to Vera Cruz in Mexico, and thence the way led over the Mexican table-land to Acapulco on the Pacific shore, and then by ship across the Pacific. Thus at the very time when trade was abandoning the overland routes in Europe and the Near East, a new overland route was established in America. The reason, apart from the opposition of the Portuguese, was that America projects 20° of latitude farther south than does Africa, and the passage into the Pacific by doubling Cape Horn is a far more serious venture than the rounding of the Cape of Good Hope into the Indian Ocean.

The sailing track from Europe to America was on the north-east trade wind to the tropical West Indies, whence shipping turned northward to Virginia and so homeward on the prevalent west winds of the higher latitudes—a great triangle of trade. Only Canada and New England were reached laboriously by tacking against the west winds. In no trade in the world has the advent of steamships been of greater assistance than in the North Atlantic. Elsewhere on favouring winds a sailing ship would often

make nearly as quick a passage as a steamer

The Advent of Steam Power.—The Industrial Revolution of the later 18th and early 19th centuries, though it transformed manufacturing, wrought comparatively little change in commerce. The commercial revolution began only about 1870. In that year only about 10% of the world's shipping was moved by steam; today not 10% is moved by sails. The newly-made roads and canals, and at first even the railways, remained subsidiary to ocean traffic. There was, however, one freshwater canal the construction of which effected changes on a world scale The opening of the Erie Canal in 1825 from the great lakes of North America to the Hudson River and the Atlantic brought the harvests of the west into relation with the industrial coastland of New England New York, which had hitherto been a smaller place than either Boston or Philadelphia, shot forward in development to become as is now inevitable the largest city in the world Today 130 million highly civilized people in the United States and Canada offer as great a basis for international trade as the 800 millions of the Orient, and the North Atlantic trade route balances in importance the ways of the east.

The first transcontinental railway from Atlantic to Pacific was completed through the United States in 1867, but the day of transcontinental carriage of goods in bulk did not begin until about 1878, when for the first time the grain of the prairies was brought to England

Modern Developments.—Much more immediately significant was the opening in 1869 of the Suez Canal (*q v*) A large part of the ocean-borne commerce to the East was almost at once diverted to the new route The approach to India, which round the Cape was as easy to Calcutta as to Bombay, was now more direct to Bombay, and thence the railways of India were constructed southeastward, eastward and north-eastward, radially from the terminus of the new ocean-ferry from Europe Simultaneously the piercing of the Alps by railway tunnels, of which the first, the Mont Cenis, was completed during the Franco-Prussian War in 1870, facilitated the transfer of the European points of departure for India to the Mediterranean ports Italian Genoa became the principal southern exit for German commerce, and even British liners had to call at Marseilles

Towards the end of the 19th century the railway net began to cover wide areas on the continents, and for some purposes land transport seemed likely to rival sea transport. Transcontinental railways now traverse Asia, Australia and South America, and it is only a question of time before the Cape to Cairo line, the dream of Cecil Rhodes, will be realized None the less for the carriage of bulk the sea holds its own The tonnage through Panama already exceeds that through Suez, although the completion of the second interoceanic canal has not affected a change in trade routes at all comparable with that which so quickly ensued on the opening of the first.

Air Routes.—To-day, 1929, the commerce of the world is on the verge of yet another change. Air routes are being added to land routes and sea routes At first sight it would appear that there can be even less of a route in the air than on the sea. In fact, air craft are very closely dependent on their prepared landing places. One of the most interesting services of aeroplanes as yet in operation is that from Egypt to 'Iraq, along the most ancient of all routes. Great airships are building, 700 feet long, which will float in the wind when tethered to mooring towers like sea ships anchored in a current; these are expected to make the voyage from Great Britain to Karachi, the airport at the entry to India, in 4 days with a call at the mooring tower on the Suez Canal.

Two things are clear. Air traffic will supplement and not supplant the older means of carriage, for the lifting capacity of an airship of 5 million cubic feet gas capacity is only 150 tons; and the capital which is being sunk at the new airports will tend to fix the more important air routes. In regard, also, to the lie of those routes there are two things which may be said with some certainty. The first is that the courses followed by aircraft will for economic reasons have regard to the prevalent winds and will approximate rather to the sailing than to the steaming tracks of surface vessels It is not improbable that, when experience has brought courage, the airship track from Great Britain to Australia will run southward to South Africa and then eastward on the great west winds of the "Roaring Forties" of the Indian Ocean The second is that similar economic considerations must limit the height at which commercial aircraft will fly; there will be an "economic height" just as steamers and motor vessels have an "economic speed." That height will be such as to retain the maximum lifting capacity compatible with a safe margin for manoeuvring. Thus aircraft will respect the major elevations of the land, just as surface vessels seek to avoid rocks and shoals It is probable, for instance, that airships from Great Britain will commonly pass southward through the gap at Marseilles between the Alps and the Pyrenees.

The tendency of the trade routes of to-day—by land, sea, and air—is to exhibit on the map the appearance of a net Within the limits set by the consideration that goods are carried most cheaply in reasonable bulk, transport now seeks the direct line from the place of production to the place of consumption Thus the "depot" trade, associated in the past with such "nodal" centres as Alexandria, Venice, Lisbon and Amsterdam, and of late with London, is not increasing. But the brain centres, the centres of the higher control of exchange, are if anything becoming fewer

BIBLIOGRAPHY —Information in regard to the trade routes of the past is to be found scattered through books on general and commercial history; there are very few works specially devoted to the subject *See* O. Noel, *Histoire du Commerce du Monde*, 2 vols (1891 etc), with a useful bibliography, H de B Gibbins, *History of Commerce in Europe* (1891); E Speck, Handelsgeschichte des Alterthums, 3 vol (1901–06); E H Warmington, *The Commerce between the Roman Empire and India* (1928). The history of trade routes is closely involved in that of geographical discovery; *see* E H. Bunbury, *History of Ancient Geography* (1879) and H Yule, *Marco Polo* (3rd ed 1903) *See* also Russell Smith, *The Ocean Carrier* (1908); A. J. Sargent, *Seaways of the Empire* (1918). (H. J. MA.)

TRADES UNION CONGRESS, THE. The Trades Union congress came into existence in Great Britain when the Manchester and Salford trades council convened a trades union conference in Manchester in Whit-week 1868 There were earlier national conferences, but the Trades Union congress itself dates its birth from the gathering at Manchester of 34 delegates representing 118,367 members of unions In 1869 a parliamentary committee was appointed to carry out the decisions of the congress. In its early days, the congress was concerned largely with trade union legislation It was not long before it was considering political questions, though for years the "economist" or *laissez faire* school held their own against the more advanced school In 1882 the congress adopted by 71 to 31 votes a resolution in favour of land nationalisation, but in later years a similar resolution was rejected. In 1888, however, the principle was decisively endorsed by 66 to 5 votes It was not until 1885 that the principle of the legal regulation of hours of labour was adopted by the Trades Union congress, and in 1890 it carried a resolution in favour of an Eight Hours Bill By this time, it may be said, the congress had finally repudiated economic individualism and embraced the Socialist philosophy, and before many years passed it had created the Labour Party. As early as 1869 a paper dealing with direct labour representation in parliament was read at the T U C. In 1886 it appointed a labour electoral committee which, however, came under Liberal influence, and in 1893 it ceased to operate. In 1899 a resolution was carried for a special congress of trade unions and Socialist organizations. The result was the inauguration of the Labour Representation Committee, and the birth of an independent political labour movement.

The influence of the congress grew with the increase in trade union membership. But it was the World War which laid the foundations of its present prestige. The decision of the congress to take part in the war-time administration of the nation marks an important stage in its history. The congress emerged from the war with greatly increased membership and authority

General Council Organization.—In 1919, therefore, proposals were submitted to a special Trades Union congress for the replacement of the old parliamentary committee of the congress by an enlarged executive body, for the creation of a machinery of co-operation between the congress and the Labour Party, and for

the establishment of joint administrative departments under the auspices of the congress and the Labour Party. The parliamentary committee was superseded by the general council, a body composed of 32 members representing the 17 groups of trades and industries into which the affiliated membership of the congress was divided, including two women representing the woman membership of the Trades Union congress

The following table shows the organization of the council

	Trade group	No of unions	Membership (1928)
1.	Mining and quarrying	8	759,611
2	Railways	3	423,806
3.	Transport (other than railways)	8	389,571
4	Shipbuilding	3	77,911
5	Engineering, founding and vehicle building	25	329,499
6	Iron and steel and minor metal trades	21	127,626
7.	Building, woodworking and furnishing	17	344,773
8.	Printing and paper	12	135,072
9.	Cotton	37	227,562
10	Textiles (other than cotton)	18	166,923
11.	Clothing	8	88,477
12.	Leather and boot and shoe	5	88,654
13	Glass, pottery, chemicals, food, etc.	16	193,204
14.	Agriculture	1	30,000
15.	Public employees	4	24,651
16.	Non manual workers	6	58,106
17	General workers	4	409,896
	Totals	196	3,874,842

This organization is carried further by the establishment of group committees For administrative purposes the 17 trade groups were formed into six group committees as follows: (a) mining and quarrying, railways, transport, (b) shipbuilding, engineering, iron and steel, building, (c) cotton, other textiles, clothing, leather, (d) glass, pottery, etc, agriculture, general workers; (e) printing, public employees, non-manual workers; (f) the two women members and three members appointed by the general council from organizations with women members.

The congress also accepted in 1920 as did the Labour Party conference of 1921, proposals for the establishment of four joint departments: (*a*) research and information, (*b*) press and publicity; (*c*) international, and (*d*) legal. This new central machinery resulted in a great expansion of activities by the general council of the T U C itself and by the council in conjunction with the political labour movement In 1925 the general council reported to the congress that the rapid expansion of work necessitated separate machinery, and on March 31, 1926 the joint departments ceased to exist The administrative side of the T U C. has now departments dealing with organization, trade boards, research, publicity, social insurance and international matters.

Council Activities.—The general council of the T U C. deals with a wide range of questions and its authority continues to increase. It has instituted a standing trade boards advisory council, composed of representatives of organizations catering for workers covered by the Trade Boards Acts. It has its education committee which has concerned itself with the problem of adult education, whose proposals, approved by the Trades Union congress in 1925, were designed to assist in the promotion of educational facilities for trade unionists, and had been arrived at in agreement with Ruskin college, the education department of the Co-operative Union, the Labour college, the Workers' Educational Association, and the National Council of Labour colleges. The object of the proposals was "to provide working-class education in order to enable the workers to develop their capacities and to equip them for their trade union, labour and co-operative activities generally, in the work of securing social and industrial emancipation." Early in 1926, the countess of Warwick handed over her estate, Easton lodge, Dunmow, in Essex to the general council of the Trades Union congress for use as a labour college and as a labour centre generally, but owing to the financial obligations involved the scheme did not materialise In 1927 the general council inaugurated a scholarship scheme, which provides three scholarships a year tenable at the Labour college and Ruskin college respectively.

The general council has taken an increasingly important part in large industrial disputes. At the Hull congress of 1924, its hands were strengthened in this matter. In the event of a breakdown of negotiations in a dispute, "the deadlock being of such a character as to directly or indirectly involve other bodies of work-people affiliated to the Trades Union congress in a stoppage of work or to imperil standard wages and hours and conditions of employment, the council may take the initiative by calling representatives of the unions into consultation, and use its influence to effect a just settlement of the difference." Before this resolution was carried, the general council had, in fact, intervened by mediation or the granting of moral and financial support, in disputes in which affiliated societies were concerned In the prolonged boilermakers' dispute in 1924, in the dock workers' dispute, the tramway dispute in the London area, the Southampton shipyard dispute, and the building trade dispute in the same year, the general council used its good offices But the adoption of the resolution of Sept., 1924, placed greater authority in the hands of the council On the occasion of the dispute in the coal industry in July 1925, the general council appointed a special industrial committee and took a very prominent part in the negotiations which led to the temporary settlement The industrial committee in Aug 1925, intervened in the dispute in the wool textile industry which had culminated in a stoppage of work In 1927 it took a hand in the settlement of the packing-case makers' dispute in Leicester, and in 1928 it assisted in the settlement of a dispute between the National Amalgamated Union of Life Assurance Workers and the Wesleyan and General Assurance Society The year 1928 also saw the intervention of the General Council in the dispute on the Nottinghamshire coalfield

In conjunction with the Labour Party and the Miners' Federation of Great Britain the general council established a committee early in 1925 to prepare a policy for the coal industry, and the proposals of this joint committee were submitted to the royal commission on the coal industry set up by the Government after the coal settlement in July 1925 After the publication of the royal commission's report, the general council, through its industrial committee resumed its consultations with the Miners' Federation and was associated closely with the federation during the course of negotiations Finally, it declared a large scale sympathetic strike (commonly called the "general strike" [*q.v*]) and for the first time in its history tried to stop all industry

An important and developing side of the activities of the general council is the forging of closer bonds with the trades and labour councils which exist in large numbers up and down the country Before 1895 trades councils were represented at the annual Trades Union congress But from that date until 1924 there was no direct contact between these local representative bodies of trade union branches and the T U C, though the trades councils (many of which are local Labour Parties) were affiliated to the Labour Party and sent delegates to its annual conferences

After the establishment of the general council, efforts were made to remedy this defect in organization, and in 1925 a model form of constitution for trades councils was worked out, arrangements made for the publication and circulation of special literature on trade unionism, and a regular monthly statement from the general council to the trades councils was inaugurated At the end of 1924, there were 476 trades councils known to be in existence in Britain, including industrial sections of local Labour Parties In 1913 the number was 328. From 1913 to 1924 the aggregate affiliated membership rose from 1,481,000 to 2,219,000, the latter figure representing about two-fifths of the total membership of trade unions. The general council has taken an active part in promoting federations of trades councils Since 1927, it has refused to recognise councils which are affiliated to the National Minority Movement.

Perhaps the most significant amongst the activities of the general council, is its efforts under the instructions of the Trades Union congress to promote and assist trade union amalgamation on the lines of organization by industry. Though the general council has from time to time brought together unions for discussion

of the possibilities of amalgamation, it has realised that much more is needed than empirical action of this kind. Judged by results the efforts to bring about amalgamations the general council cannot be regarded as successful, though it is still too early, having regard to the real difficulties of amalgamation, to pronounce this work as a failure. Its real importance, however, lies in the persistent and painstaking labour to reach an ideal, and the certainty that, if need be, larger powers will ultimately be given to the general council to deal with the problem.

Finance.—Up to 1923, the affiliation fee of each union affiliated to the T.U.C. was 1d per member per year. In that year the fee was raised to 3d, payable quarterly on the full membership, including probationary and free members. The increased fees were required principally for publicity purposes and to maintain the *Daily Herald,* the organ of the British labour movement In addition to the ordinary affiliation fees, each union contributes £1 per thousand members towards the fee payable to the International Federation of Trade Unions Congress affiliation fees in 1926–27 amounted to £27,550. The affiliation fee to the International Federation of Trade Unions was £4,392

The Industrial and the Political Movements.—As the Trades Union congress really gave birth to the Labour Party, it is natural that close relations should always have existed between the industrial and political sides of the labour movement From 1905 onward there existed a joint board representing the parliamentary committee of the T U C, the executive committee of the Labour Party and the management committee of the General Federation of Trades Unions (which like the Labour Party owed its existence to the T U C) The members of the board were the secretary and three members from each of the three bodies. But in 1914 the congress decided to dissolve the tripartite joint board and to establish a new one representing the parliamentary committee of the Trades Union congress and the executive committee of the Labour Party At the congress of 1917 steps were taken to ensure close co-operation between the two committees. Joint meetings take place, and joint action has often been taken

The conference accepted in 1920, as did the Labour Party conference of 1921, proposals for the establishment of a national joint council consisting of the chairman and secretary and three members of the general council of the Trades Union congress, the national executive committee of the Labour Party and the executive committee of the parliamentary party, 15 members in all

Membership of Trade Unions Affiliated to the Trades Union Congress

Year	No. of unions	Total membership*	Year	No. of unions	Total membership
1868		118,367	1898	188	1,184,241
1869	40	250,000	1899	181	1,200,000
1870	49	289,430	1900	184	1,250,000
1871	63	255,710	1901	191	1 200,000
1872	140	750,000	1902	198	1,400,000
1873	153	1,191,822	1903	204	1,500,000
1874	107	818,032	1904	212	1,422,518
1875	109	539,823	1905	205	1,541,000
1876	113	557,823	1906	226	1,555,000
1877	112	691,089	1907	236	1,700,000
1878	114	623,957	1908	214	1,777,000
1879	92	541,892	1909	219	1,705,000
1880	105	494,222	1910	212	1,647,715
1881	122	463,899	1911	202	1,662,133
1882	126	509,307	1912	201	2,001,633
1883	134	520,091	1913	207	2,232,446
1884	126	598,033	1915†	215	2,682,357
1885	136	580,976	1916	227	2,850,547
1886	122	635,580	1917	235	3,082,352
1887	131	674,034	1918	262	4,532,085
1888	138	816,944	1919	266	5,283,676
1889	171	885,055	1920	215	6,505,482
1890	211	1,470,191	1921	213	6,417,910
1891	213	1,302,855	1922	206	5,128,648
1892	225	1,219,934	1923	195	4,369,268
1893	226	900,000	1924	203	4,328,235
1894	179	1,100,000	1925	203	4,342,982
1895	170	1,000,000	1926	207	4,365,619
1896	178	1,076,000	1927	204	4,163,994
1897	180	1,093,191	1928**	196	3,874,842

*From 1868 to 1894 inclusive the figures for total membership were duplicated by the inclusion of Trades Councils.

†There was no Congress in 1914.

**The decrease is almost wholly due to the forcible separation from Congress of the Civil Service Unions under the operation of the Trade Disputes and Trade Unions Act, 1927.

Membership.—The growth which has taken place in the affiliated membership of the congress since its inception may be seen in the table in the preceding column. (A. Gr)

TRADE UNIONS. Efforts have been made to trace the lineal descent of the trade union movement of the 19th and 20th centuries from the gilds of the middle ages But trade unionism as we know it, was the creation of modern industrial conditions It owes its birth to the capitalist system. Viewed after more than a century of growth it is seen in its first phase of development as an instinctive method of self-protection against the reactions of complex economic changes, which the workers, in common with the rest of the nation, failed to understand In its later phase of growth, the trade union movement is seen as a more conscious organisation of labour concerned with the status of the worker and his place in the economic system Trade unionism is a defensive and offensive instrument for maintaining or improving labour standards But it is more than this It is becoming increasingly a constructive agency, aiming at influencing and changing the world of industry in accordance with labour ideals. This constructive purpose of trade unionism is promoted in two main ways,—through the assumption by the organised workers of increasing "control" over working conditions and the conduct of industry, and through the extension of public ownership in the essential industries and services In its activities in the latter direction, British trade unionism is political and is allied with the Labour Party, which it brought into existence

The trade union movement has within the space of a century become an integral part of the machinery of industrial life Since the days when under the repressive legislation of the time, local trade unions existed as secret and illegal bodies, trade unionism has secured for itself well nigh universal recognition from employers and the public But whilst it is generally accepted that the conduct of industrial relations in Great Britain must be on a basis of negotiations between organised workers and organised employers, there is by no means the same degree of unanimity as regards either the part which trade unions should play in the future in the direction of the policy of industry, or the lines on which industry should develop Nevertheless, far-sighted employers realise that trade union organisations must be accorded the fullest possible information as to the economic position of industry and be brought into the discussion of questions of high policy in industry Already, therefore, the door is being opened to the claim of the unions for greater "control" The problem of ownership, however, remains a purely political problem to be solved by political methods

The Combination Laws.—The history of such a movement could not be uneventful. Time was when by the common law of England combinations of workpeople were, with minor exceptions, regarded as illegal They were deemed to be contrary to public policy, and fell into the category of conspiracies in restraint of trade Membership in such a body was punishable by fine and imprisonment, and though strictly the common law applied to combinations of both masters and men, it was against the latter that the law was developed and directed From the time of Edward I to the end of the first quarter of the 19th century there were a series of legal enactments—between 30 and 40 in all—which enforced and extended the common law All these measures were designed to prohibit and prevent labour organization.

The far-reaching industrial changes which marked the second half of the 18th and the beginning of the 19th centuries created a situation which gave a new impetus to the establishment of combinations of workers Notwithstanding the existence of repressive legislation, secret trade societies became more numerous The laws against combinations were made more stringent and more general by the Acts of 1799–1800 which remained unaltered until 1824. In spite of this legislation, which made all combinations illegal, trade clubs seem to have continued to exist and were tolerated in many trades and in many areas during the first quar-

ter of the 19th century, though they were always subject to the fear of prosecution if they took hostile action against employers; and in many cases strikes were suppressed by the conviction of their leaders under these Acts or the common law of conspiracy

In 1824 a select committee of the House of Commons was appointed to enquire, among other matters, into the "combination laws" This committee reported that "those laws had not only not been efficient to prevent combinations either of masters or workmen, but on the contrary had, in the opinion of many of both parties, had a tendency to produce mutual irritation and distrust, and to give a violent character to the combinations, and to render them highly dangerous to the peace of the community" They further reported that in their judgment "masters and workmen should be freed from such restrictions as regards the rate of wages and the hours of working, and be left at perfect liberty to make such agreements as they mutually think proper." They therefore recommended that "the statute laws which interfered in these particulars between masters and workmen should be repealed,' and also that "the common law under which a peaceable meeting of masters or workmen might be prosecuted should be altered" In pursuance of their report, an Act, 5 Geo IV. c. 95, was at once brought in and passed. But the immediate results of the change which it effected were regarded as so inconvenient, formidable and alarming, that in the session of 1825 the House of Commons appointed another select committee to re-examine the various problems, and review and reconsider the evidence submitted to their predecessors They reported without delay in favour of the total repeal of the Act of 1824, and the restoration of those provisions of the combination laws, whether statutory or customary, which it had been more particularly intended to abrogate The consequence was an act passed in 1825 of which the preamble declares that the Act of 1824 had not been found effectual, and that combinations such as it had legalised were "injurious to trade and commerce, dangerous to the tranquility of the country, and especially prejudicial to the interests of all who were concerned in them" The effect of this act was to leave the common law of conspiracy in full force against all combinations in restraint of trade, except such as it expressly exempted from its operation, as it had been before the Act of 1824 was passed. It comprised, however, within itself the whole of the statute law relating to the subject, and under it no persons were liable to punishment for meeting together for the sole purpose of consulting upon and determining the rate of wages or prices which they, being present, would require for their work or pay to their workmen, or the hours for which they would work or require work in any trade or business, or for entering into any agreement, verbal or written, for the purpose of fixing the rate of wages or prices which the parties to it should so receive or pay But all persons were subjected to a maximum punishment of three months' imprisonment with hard labour who should by violence, threats or intimidation, molestation or obstruction, do, or endeavour to do, or aid, abet or assist in doing or endeavouring to do, any of a series of things inconsistent with freedom of contract which the act defined.

Growth of Trade Unionism.—The partial protection accorded to societies for the purpose of regulating wages and hours of labour by the law of 1825 led to a rapid multiplication and expansion of trade unions, and to an outburst of strikes, in which, however, partly owing to the widespread commercial depression, the workmen were mostly unsuccessful Thus the first impetus given to trade unions by the modification of the combination laws was followed by a collapse, which in its turn was followed (in the third decade of the century) by a succession of attempts on the part of workmen to establish a federal or universal combination, to embrace members not of one but of several trades. To this new form of combination which excited a good deal of alarm among employers, the term "trades union" as distinct from trade union, was applied. All these general movements, however, proved shortlived, and the most extensive of them, the "Grand National Consolidated Trades Union," which was formed in 1834 and claimed half a million adherents, only had an active existence for a few months, its break-up being hastened by the conviction and transportation of six Dorchester labourers for the administration of unlawful oaths. In the years of depressed trade which followed, trade unionism once more declined, and the interest of workmen was largely diverted from trade combinations to more general political movements, *e.g.*, Chartism, the Anti-Corn-Law agitation and Robert Owen's or other schemes of co-operation.

From 1845 we trace another revival of trade unions, the characteristic tendency of this period being the amalgamation of local trade clubs to form societies, national in scope, but confined to single or kindred trades High rates of contribution, and the provision of friendly as well as trade benefits, were among the features of the new type of union, of which the Amalgamated Society of Engineers, formed in 1851, was the most important example The growth of unions of the new type was followed by a development of employers' associations in the 'sixties, and by a number of widespread strikes and lock-outs, and also by various efforts to promote arbitration and conciliation by the establishment of joint boards of employers and employed.

A series of outrages at Sheffield and Manchester in 1865–1866, in which officials of some local trade societies were implicated, led to the appointment in 1867 of a royal commission on trade unions, whose report was followed by the passage of the Trade Union Act of 1871, which as amended by subsequent legislation governs the legal position of trade unions.

Trade Union Legislation 1871–6.—In the meantime, legislation was passed in 1859 to remove doubts as to the meaning of "molestation" and "obstruction" The outcome of the royal commission was, first, a temporary measure for the more effectual protection of the funds of trade unions, passed in 1869, and secondly, the two Trade Union Acts of 1871 and 1876

Under these statutes, construed with the Conspiracy and Protection of Property Act, 1875, the law relating to combinations, whether of workmen or of masters, entered upon a new phase

The Act of 1871 laid it down that the purposes of any trade union shall not, by reason merely that they are in restraint of trade, (*a*) be deemed to be unlawful, so as to render any member of such trade union liable to criminal prosecution for conspiracy or otherwise, and (*b*) be unlawful so as to render void or voidable any agreement or trust It further enacted that certain trade union contracts shall not be enforceable by the courts, *e.g.*, any agreement for the payment by any person of a subscription or penalty to a trade union, and any agreement to provide benefits to members The act also made provision for the registration of trade unions, and for the purchase or lease of buildings by trade unions The Trade Union Act of 1876 amended the law of 1871 on matters of minor administration, and provided for the amalgamation of unions It altered the definition of trade union

The Conspiracy and Protection of Property Act, 1875 superseded the Criminal Law Amendment Act of 1871 which had been opposed by the trade unions and which had proved to be an instrument of coercion It laid down that an agreement or combination by two or more persons to do or procure to be done any act in contemplation or furtherance of a trade dispute should not be indictable as a conspiracy if such act committed by one person would not be punishable as a crime. The act legalised peaceful picketing and cases of intimidation or violence were to be left to the courts of summary jurisdiction.

The "New Unionism."—The period of inflated trade which began in 1871 caused as usual, another rapid growth of trade unions, of which the most characteristic feature was their extension to agricultural and general labourers. The years of depression, 1875–1880, were marked by a series of unsuccessful strikes against reductions of wages, and by a general decline of trade unions, which did not again revive until nearly ten years later, when the new wave of prosperous trade brought with it an outburst of strikes, chiefly among unskilled labourers, for improved conditions, of which the most notable was the strike of the London dock labourers in 1889. These trade movements were accompanied by the formation of a large number of unions of a type more akin to those of 1830–1834 than to the more modern trade-friendly society with its high contributions and benefits

The nineties also saw the spread of trade unionism to the black-coated workers. The National Union of Clerks came into

existence in 1890, followed shortly by the Shop Assistants' Union and the Amalgamated Union of Co-operative Employees

Trade Union Membership, 1892-1913

Year	Number of trade unions at end of year	Membership at end of year			Percentage increase (+) or decrease (−) on total membership of previous year
		Males	Females	Total	
		Thousands	Thousands	Thousands	Per cent
1892	1,233	Not available		1,576	
1893	1,279			1,550	− 1·1
1894	1,314			1,530	− 1·9
1895	1,340			1,504	− 1·7
1896	1,358	1,466	142	1,608	+ 7·0
1897	1,353	1,584	147	1,731	+ 7·6
1898	1,326	1,608	144	1,752	+ 1·2
1899	1,325	1,761	150	1,911	+ 9·1
1900	1,323	1,868	154	2,022	+ 5·8
1901	1,322	1,873	152	2,025	+ 0·1
1902	1,297	1,857	156	2,013	− 0·6
1903	1,285	1,838	156	1,994	− 1·0
1904	1,256	1,802	165	1,967	− 1·3
1905	1,244	1,817	180	1,997	+ 1·6
1906	1,282	1,999	211	2,210	+10·7
1907	1,283	2,263	250	2,513	+13·7
1908	1,268	2,230	255	2,485	− 1·1
1909	1,260	2,214	263	2,477	− 0·3
1910	1,269	2,287	278	2,565	+ 3·5
1911	1,290	2,804	335	3,139	+22·4
1912	1,252	3,026	390	3,416	+ 8·8
1913	1,269	3,702	433	4,135	+21·0

From 1892 onwards the progress of trade unionism can be traced statistically (*see* the table) The depression of trade, 1892–1895, brought with it, as usual, some decline in trade unionism; but though many of the "new unions" collapsed, some of the more important have survived to the present time. The revival of trade which began in 1896 was naturally accompanied by an increase in the strength of trade unions; but the most marked characteristic of this period was the extension and consolidation of employers' associations, of which perhaps the most notable is the Engineering Employers' Federation, which was originally formed on the Clyde, but gradually extended to other districts and became a national organisation of great strength during its successful struggle with the Amalgamated Society of Engineers in 1897–1898 Among the other more important Employers' Associations and federations of a national character may be mentioned the Shipping Federation, the Mining Association, the Shipbuilding Federation, the Federation of Master Cotton-Spinners' Associations, the National Federation of Building Trade Employers, and the Incorporated Federated Associations of Boot and Shoe Manufacturers

At the beginning of the 20th century the trade union movement was fairly established The local trade clubs had given way to national organisations of considerable size and unions existed for practically every type of worker. The opening years of the century prior to the outbreak of the World War saw a considerable expansion of trade unionism. The number of trade unionists doubled between 1900 and 1913

The Taff Vale Decision.—During the last quarter of the 19th century there were many cases in the law courts affecting trade unionism, but by far the most important was the Taff Vale case. This famous case which was largely responsible for the rapid growth of the Labour Party arose out of a local dispute, when in 1900 railway workers employed by the Taff Vale Railway Company in South Wales came out on strike without any authority from their union—the Amalgamated Society of Railway Servants. The introduction of blacklegs by the management brought the A.S R.S. officially into the arena. The society granted strike pay to the strikers, and did its best to dissuade the blacklegs from continuing at work The strikers undertook picketing, and there was some violence, for which, however, the society was in no way responsible. It neither instigated nor authorised violence. The company, besides prosecuting individual employees, took legal action against the A.S.R.S. itself. In the first place, it brought an action for damages against the society, and in the second place it sought an injunction to restrain the union and its officers from committing acts calculated to damage the company in its business. Both actions were successful. The A S.R S paid out damages amounting to £23,000 and the injunction was granted The case ultimately reached the House of Lords, and in 1901 the Lords upheld the original decision of the court. The decision descended like a thunderbolt on the whole trade union movement.

The trade unions and the Labour Party, which the Trades Union congress had brought into existence in 1899, vigorously protested against the result as a decision of judges making a practically new law against trade unions and nullifying the settlement of their status made by the legislature in 1871, and in June 1903 a royal commission was appointed to inquire into the subject of trade disputes and trade combinations

The majority of the commission reported in Jan. 1906, in favour of an alteration in the law relating to picketing and conspiracy, but against any alteration of the law as laid down in the Taff Vale judgment Under pressure from the Labour Party, the Government of the day did not accept this conclusion, and a different view was embodied in the Trade Disputes Act passed in the same year. It was enacted with reference to trade union funds that "an action against a trade union, whether of workmen or masters, or against any members or officials thereof on behalf of themselves and all other members of the trade union in respect of any tortious act alleged to have been committed by or on behalf of the trade union, shall not be entertained by any court," although "nothing in this section shall affect the liability of the trustees of a trade union to be sued in the events provided for by the Trades Union Act, 1871, section 9, except in respect of any tortious act committed by or on behalf of the union in contemplation or in furtherance of a trade dispute "

The Osborne Judgment.—This victory for the trade unions was speedily followed by another attack The Amalgamated Society of Railway Servants again bore the brunt of the struggle In 1908 W. V Osborne, a branch Secretary of the A S R S., sued the society to have it declared that one of its current rules, which provided, amongst other things, for parliamentary representation and the enforced levy of contributions from him and other members of the society, towards the payment of salaries or maintenance allowance to members of parliament pledged to observe and fulfil the conditions imposed by the Labour Party, was *ultra vires* and void. The case was decided in the King's Bench against Osborne, but the judgment was reversed by the court of appeal, whose decision was upheld by the House of Lords on Dec 21, 1909. This meant that the Labour Party in the House of Commons would have to find other ways and means than contributions from trade unionists.

The labour movement turned its energies to the reversal of the Osborne judgment The Labour Party abolished the pledge referred to above, and when the payment of members was introduced—a measure which was largely a direct result of the Osborne judgment—it discontinued the payment of allowances to elected Labour candidates. After the elections of 1910 the Labour Party demanded legislation, but it was not until 1913 that compromise was reached in the Trade Union Act of that year. This measure permitted political action and enabled unions to carry on any lawful activity which was authorized by its rules But the law imposed certain restrictions on the political activities of the unions. A trade union which wished to engage in political activities was required to take a ballot of its members and to obtain a majority of those voting in favour of such action The union, after a successful ballot, had then to draw up political rules, in a form approved by the chief registrar of friendly societies. A separate political fund was to be established from which all expenditure on political purposes as defined by the Act was to be met. Lastly, any member of the union who objected to the political levy was, on signing an approved statement, to be exempted from all political contributions without forfeiting his rights as a member of the organisation.

Industrial Unrest.—In the meantime, whilst the mind of the trade union movement was exercised by the Taff Vale and Osborne decisions, there was a growing volume of industrial unrest. Prices had for some time been rising, and real wages were falling Trade unionism was stronger than ever it had been, but it held back from action in view of the Taff Vale decision After the passage of the Act of 1906, however, many strikes broke out There was in 1907 a prolonged dispute on the railways In 1909 and 1910 there were frequent strikes in the mining areas The boilermakers and the cotton operatives were involved in disputes Broadly speaking, these disputes were unsuccessful, and rising prices swallowed up such wage increases as had been obtained But through disappointment with the results of parliamentary action, the banner of "direct action" was raised The propaganda of the Social Democratic Federation and the Independent Labour Party was for the time, at any rate, overwhelmed by the propaganda of Industrial Unionism and Syndicalism, and a little later of Guild Socialism The trade union, in the eyes of those under the influence of the new intellectual ferment, was not merely a means of defence and a method of collective bargaining, it was a weapon with which to destroy capitalism Militant Industrial Unionism, as preached by the Industrial Workers of the World (*q v*), found few adherents Syndicalism found no home in Britain except in South Wales At the same time, it is undoubtedly true that these gospels influenced the outlook of the trade union movement, stimulated the movement towards federation and amalgamation, and prepared the way for the doctrines of Guild Socialism

The active agitation of the theorists and the rapid growth in trade union membership in the years immediately prior to the war, brought the general labour problem into greater prominence than ever it had enjoyed. The World War broke out and Trade Unionism was faced with new problems

The War and After.—From the period immediately prior to the outbreak of the World War down to the present time, the chief features of British trade unionism have been —

(1) The improved organization of and extension of trade unionism amongst "general workers" and women, in agriculture and on the railways, and in the public services and professions,

(2) The increasing importance of the trade unions in the community, and in the administration of legislation,

(3) The consolidation of trade union forces through the processes of amalgamation and federation;

(4). The growing authority of the executive body of the Trades Union congress

(5). The "General Strike" and the Trade Union and Trade Dispute Act 1927

Growth of Membership.—Trade union membership increased before and during the World War, especially among women, the curve rising rapidly during its later years, and culminating in the peak period of 1920, after which it progressively declined during the years of depression, recovering a little during 1924, but falling away again especially after the "general strike" in 1926

The highest degree of organisation amongst women is to be found in the cotton industry, where about 62% of the women workers are in the unions In the bleaching and dyeing trades, which are closely associated with the cotton industry, 50% of the women are organised; in the boot and shoe trade 48%; in printing, paper and bookbinding 36%; in the wool textile trades 32%; in linen and jute 28½ per cent Amongst shop assistants and clerks, and in the food, drink and tobacco trades, on the other hand, which employ in all over 750,000 women workers, the degree of organisation is very small Only 8% of the women shop assistants and clerks are members of unions and 2% of the female employees in the food, drink and tobacco trades.

Before the war the battle for the recognition of trade unionism was really won and the principles of trade unionism, which had been laid down primarily by the craft unions, were applied on the one hand by the larger body of semi-skilled and unskilled workers, and on the other hand by the "black-coated proletariat"—the salaried employees and professional people, such as public servants, draughtsmen, actors, salesmen, teachers and journalists

After 1914 new organisations arose and others which existed precariously before the war were put upon a firm foundation. Some of the new bodies, such as the Bank Officers' Guild, have not as yet affiliated with the Trades Union Congress, but they nevertheless exist for avowed trade union objects The National Federation of Professional, Technical, Administrative and Supervisory Workers was established in order to bring together the various organizations of non-manual workers.

Trade Union Membership

(All trade unions, registered and unregistered, in Great Britain and Northern Ireland)

The following table shows the total number of unions known to have been in existence in Great Britain and Northern Ireland in each year from 1913 to 1926, and their aggregate membership to the nearest thousand. (The figures of membership include members in overseas branches and in Irish Free State branches of such unions, but wholly exclude unions having their head offices in the Irish Free State).

Year	Number of trade unions at end of year	Membership at end of year			Percentage increase (+) or decrease (−) on total membership of previous year
		Males	Females	Total	
		Thousands	Thousands	Thousands	
1913	1,269	3,702	433	4,135	+21·0
1914	1,260	3,708	437	4,145	+ 0·3
1915	1,229	3,868	491	4,359	+ 5·2
1916	1,225	4,018	626	4,644	+ 6·5
1917	1,241	4,621	878	5,499	+18 4
1918	1,264	5,324	1,209	6,533	+18·8
1919	1,360	6,000	1,326	7,926	+21·3
1920	1,362	6,995	1,342	8,337	+ 5 2
1921	1,250	5,617	1,005	6,622	−20·6
1922	1,204	4,745	871	5,616	−15 2
1923	1,163	4,597	816	5,413	− 3 6
1924	1,159	4,721	813	5,534	+ 2·2
1925	1,144	4,666	831	5,497	− 0·7
1926	1,129	4,401	807	5,208	− 5·2

The steady growth in trade unionism immediately prior to the war may be attributed partly to a trade prosperity and partly to a recognition amongst all grades and types of workers of the need for effective organisation Certain legislation, such as the Trade Boards Act, 1909, and the National Insurance Act, 1911, strengthened the position of the trade union movement.

The increased membership during the World War was partly due to the influence of higher wages—which invariably result in enlarged trade union membership As the war went on high hopes were held out of a brighter future for the workers, the workers themselves, whose services, the community had realised, were essential to the prosecution of the war and to the satisfaction of the nation's needs, visualised more clearly their power in the State and saw in trade unionism a weapon to enable them to maintain in the time of peace the place their services had won for them in time of war But there were other factors operating Particularly in the munition trades, trade union membership became virtually compulsory. The Government itself, and a large number of employers actually encouraged workers in the larger industries to join a union Towards the end of the war the publication of the reports of the committee on employers and employed (better known as the Whitley committee) and their adoption by the Government, gave a new importance to the organisations of employers and workers, and in their desire to promote the establishment of joint industrial councils (and interim industrial reconstruction committees when the joint industrial council was not possible), members of the Government emphasised the value of effective organization (*see* INDUSTRIAL RELATIONS)

As a consequence of these various influences, between the early days of the war and the year 1920, the membership of trade unions doubled, reaching the figure of 8,337,000, of whom 6,995,000 were men and 1,342,000 were women During this time the number of women trade unionists was actually trebled Similarly, there had been phenomenal increases in the membership of unions catering for the less skilled workers. Before the war, what are known as the general labour unions had already become factors of some importance in the trade union movement. During the war period, their strength increased rapidly. The number of organised non-manual employees also rose much above the pre-war level.

Trade Union Membership (All Unions) Great Britain and Northern Ireland

Group of unions	No. of trade unions at end of 1926	Membership at end of 1926[1] Males	1926[1] Females	1926[1] Total	1925 Males	1925 Females	1925 Total	Percentage increase (+) or decrease (−) in membership at end of 1926 compared with end of 1925: Males	Females	Total
Agriculture, horticulture, etc[2]	2	38,341	992	39,333	46,140	1,113	47,262	−16·9	−10·9	−16·8
Mining and quarrying	121	783,418	3,533	786,951	909,535	3,767	913,302	−13·9	− 6·2	−13·8
Pottery and glass	21	16,392	11,874	28,266	17,329	12,366	29,695	− 5·4	− 4·0	− 4·8
Metals, machines, conveyances, etc[2].										
Iron, steel, tinplate, etc., manufacture	7	83,552	1,052	84,604	86,611	1,042	87,653	− 3·5	+ 1·0	− 3·5
Engineering, ironfounding, shipbuilding, other metal working and vehicle building[3]	109	566,891	6,336	573,227	587,989	6,760	594,749	− 3·6	− 6·3	− 3·6
Textile										
Cotton	172	140,874	225,718	366,592	140,424	229,945	370,369	+ 0·3	− 1·8	− 1·0
Wool, worsted and shoddy	28	51,353	42,534	93,887	50,505	41,095	91,600	+ 1·7	+ 3·5	+ 2·5
Flax and jute	23	10,274	25,672	35,946	10,451	25,215	35,669	− 1·7	+ 1·8	+ 0·8
Hosiery	6	4,736	14,584	19,320	4,577	16,689	21,266	+ 3·5	−12·6	− 9·2
Bleaching, dyeing, finishing, etc	33	58,755	17,845	76,600	61,086	18,962	80,048	− 3·8	− 5·9	− 4·3
Other textile	25	11,124	15,188	26,312	11,472	16,177	27,649	− 3·0	− 6·1	− 4·8
Clothing										
Boot and shoe	9	61,749	28,942	90,691	63,186	27,942	91,128	− 2·3	+ 3·6	− 0·5
Tailoring and other clothing	70	30,429	44,895	75,324	30,796	45,754	76,550	− 1·2	− 1·9	− 1·6
Food, drink and tobacco	7	24,239	5,314	29,553	23,843	5,205	29,048	+ 1·7	+ 2·1	+ 1·7
Woodworking and furnishing										
Furnishing	8	26,084	3,399	29,483	29,533	3,858	33,391	−11·7	−11·9	−11·7
Other	26	33,015	909	33,924	32,578	1,094	33,672	+ 1·3	−16·9	+ 0·7
Paper, printing, etc	27	142,974	44,208	187,182	152,729	54,361	207,090	− 6·4	−18·7	− 9·6
Building, public works, contracting, etc										
Bricklayers and masons	4	66,173		66,173	65,917		65,917	+ 0·4		+ 0·4
Carpenters and joiners	1	114,989		114,989	114,521		114,521	+ 0·4	.	+ 0·4
Painters and decorators	7	48,954		48,954	50,828		50,828	− 3·7	..	− 3·7
Builders' labourers[2]	7	51,461		51,461	59,151		59,151	−13·0	..	−13·0
Other	21	46,566		46,566	43,455		43,455	+ 7·2	.	+ 7·2
Other manufacturing industries[4]	36	17,621	6,776	24,397	19,448	5,799	25,247	− 9·4	+16·8	− 3·4
Transport[5]										
Railway service	9	487,786	4,075	491,861	523,100	5,664	528,764	− 6·8	−28·1	− 7·0
Water transport	15	97,720	180	97,900	86,257	194	86,451	+13·3	− 7·2	+13·2
Other (road transport, dock labour, etc)[6]	17	374,810	12,050	386,860	417,947	12,757	430,704	−10·3	− 5·5	−10·2
Commerce, distribution and finance										
Commerce and distribution	16	100,384	38,819	139,203	101,825	40,938	142,763	− 1·4	− 5·2	− 2·5
Banking and insurance	21	72,177	5,809	77,986	73,780	5,359	79,139	− 2·2	+ 8·4	− 1·5
National and local government[6]	262	272,392	59,678	332,070	271,294	61,953	333,247	+ 0·4	− 3·7	− 0·4
Teaching[3]	17	69,493	130,597	200,090	67,650	128,957	196,607	+ 2·7	+ 1·3	+ 1·8
Entertainments and sport	7	26,995	5,507	32,502	27,374	5,470	32,844	− 1·4	+ 0·7	− 1·0
Miscellaneous[7]	43	42,668	3,978	46,646	44,391	4,102	48,493	− 3·9	− 3·0	− 3·8
General labour[5]	2	426,967	46,578	473,545	440,545	47,805	488,350	− 3·1	− 2·6	− 3·0
Totals[3]	1,129	4,401,356	807,042	5,208,398	4,666,279	830,343	5,496,622	− 5·7	− 2·8	− 5·2

[1] The 1926 figures are subject to slight revision. Some unions cannot give separately exact numbers of male and female members. Estimates have, therefore, been given.

[2] The figures are exclusive of the membership of the general labour unions for which *see* GENERAL LABOUR.

[3] The total membership shown for all trade unions includes members in the Irish Free State and other overseas branches numbering approximately 58,000 in 1926, of whom 30,000 were engineers and other metal workers, and 16,000 were railwaymen and other transport workers. In compiling the figures for teachers, while certain associations, the majority of whose members are also members of the National Union of Teachers, have been omitted, others, which have also some members in this union, have been included, but the extent of this duplication is not ascertainable precisely. When allowance is made for all these factors, the *net* number of trade union members in Great Britain and Northern Ireland is estimated to have been nearly 5,140,000 at the end of 1926, compared with about 5,425,000 at the end of 1925.

[4] Leather, chemicals, rubber, brushes, musical instruments, etc.

[5] The figures for these two groups are affected by an amalgamation, a union with over 20,000 members which was grouped under general labour in 1925, having become merged in a transport union in 1926.

[6] The figures exclude teachers', tramway workers' and general labour unions for which *see* TEACHING, TRANSPORT and GENERAL LABOUR.

[7] Including unions of clerks, chemists, foremen, etc., when not classifiable by industry.

But just as rising wages are closely followed by a rise in the curve of trade union membership, so unemployment and falling wages are accompanied by a decline in it. The onset of the grave trade depression after the temporary post-war boom led to a decline of trade union membership amounting to 20·6% in the first 12 months, and a further 15·2% in 1922, the total roll of trade unionists falling in two years from 8,337,000 to 5,616,000. The net loss on the previous year's figure was less than 4%, whilst during 1924 there was a net increase

The backwash of the trade depression, and the disillusionment which followed the shattered dreams of post-war "reconstruction" had spent themselves. The trade union movement had shed the temporary passengers, and those who entered its ranks through the abnormal influences of the war and early post-war periods, and a definite attempt to stem the tide and re-create a powerful trade union movement had begun to take effect. The established minimum trade union membership may be taken as being about 5½ millions, an increase of over a million on the figures of 1913

From 1924 onward the general council of the Trades Union congress has pursued a policy of propaganda, first by means of a national "back to the unions" campaign and then by special activities with a view to the spread of trade unionism amongst women and agricultural workers respectively, whilst individual unions, though impoverished as the result of the long depression, renewed their efforts to secure an increasing membership But the efforts which were made to increase trade union membership met with a rebuff as a consequence of the National Strike of 1926, which led to a shrinkage of membership Since then, however, organising activities have been resumed with the result that members are being recovered. After 1926, the trade unions were far more concerned with rehabilitating their membership and finances than with the formulation of new demands. Indeed, their negotiations were primarily directed towards defending existing standards. The weak negotiating position of the unions was

Trade Disputes
(Great Britain and Northern Ireland)

Year	Number of disputes beginning in the year	Number of workpeople involved in disputes *beginning* in the year		Aggregate duration in working days of *all* disputes in *progress* during the year
		Directly	Indirectly	
1919	1,352	2,401,000	190,000	34,970,000
1920	1,607	1,779,000	153,000	26,570,000
1921	763	1,770,000	31,000	85,870,000
1922	576	512,000	40,000	19,850,000
1923	628	343,000	62,000	10,670,000
1924	710	558,000	55,000	8,420,000
1925	603	401,000	40,000	7,950,000
1926	323	2,724,000	10,000	162,230,000
1927	308	90,000	18,000	1,170,000*
1928	302	80,000	44,000	1,410,000

*In 1927 there were fewer disputes with a smaller number of people involved than in any year during the 40 years for which statistics are available

Membership (Male, Female and Total) at the End of Each of the Years 1913, 1920, 1924, 1925, and 1926

Group of unions	1913	1920	Males 1924	1925	1926[1]	1913	1920	Females 1924	1925	1926[1]	1913	1920	Total 1924	1925	1926[1]
	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands
Agriculture, horticulture, etc[2]	20	207	60	46	38	1	3	1	1	1	21	210	61	47	39
Mining and quarrying	919	1,150	967	910	783	1	8	4	4	4	920	1,158	971	914	787
Metals, machines, conveyances, etc.[2,3]	559	1,155	697	675	651	1	18	7	8	7	560	1,173	704	683	658
Textile:															
Cotton	158	165	142	140	141	214	295	228	230	226	372	460	370	370	367
Bleaching, dyeing, finishing, etc.	58	86	61	61	59	9	31	19	19	18	67	117	80	80	77
Other textile	48	81	76	77	77	36	174	91	99	98	84	255	167	176	175
Clothing	83	110	93	94	92	25	126	72	74	74	108	236	165	168	166
Woodworking and furnishing	45	81	61	62	59	1	6	5	5	4	46	87	66	67	63
Paper, printing, etc	84	155	143	153	143	7	72	51	54	44	91	227	194	207	187
Building, public works contracting, etc[2]	243	563	332	334	328						243	563	332	334	328
Other manufacturing industries[4,7,8]	53	93	62	61	58	4	47	22	23	24	57	140	84	84	82
Transport[5]:															
Railway service	327	606	502	523	488		12	5	6	4	327	618	507	529	492
Other	366	638	510	504	473	1	12	13	13	12	367	650	523	517	485
Commerce, distribution and finance	100	279	174	176	173	20	121	45	46	44	120	400	219	222	217
National and local government[6]	211	367	262	271	272	23	95	59	62	60	234	462	321	333	332
Teaching[3]	49	63	62	68	69	64	135	133	129	131	113	198	195	197	200
Miscellaneous[9]	57	130	71	71	70	3	24	11	10	9	60	154	82	81	79
General labour[5]	322	1,067	447	440	427	23	162	46	48	47	345	1,220	493	488	474
Totals[3]	3,702	6,996	4,722	4,666	4,401	433	1,341	812	831	807	4,135	8,337	5,534	5,497	5,208

[1] The 1926 figures are subject to slight revision. Some unions cannot give separately exact numbers of male and female members. Estimates have, therefore, been given.

[2] The figures are exclusive of the membership of the general labour unions for which see "General Labour."

[3] The total membership shown for all trade unions includes members in the Irish Free State and other overseas branches numbering approximately 58,000 in 1926, of whom 30,000 were engineers and other metal workers, and 16,000 were railwaymen and other transport workers. In compiling the figures for teachers, while certain associations, the majority of whose members are also members of the National Union of Teachers, have been omitted, others, which have also some members in this union, have been included, but the extent of this duplication is not ascertainable precisely. When allowance is made for all these factors, the *net* number of trade union members in Great Britain and Northern Ireland is estimated to have been nearly 5,140,000 at the end of 1926, compared with about 5,425,000 at the end of 1925.

[4] Leather, chemicals, rubber, brushes, musical instruments, etc.

[5] The figures for these two groups are affected by an amalgamation, a union with over 20,000 members which was grouped under general labour in 1925, having become merged in a transport union in 1926.

[6] The figures exclude teachers', tramway workers', and general labour unions for which see "Teaching," "Transport" and "General Labour."

[7] Including unions of clerks, chemists, foremen, etc. when not classifiable by industry.

[8] Comprising pottery and glass, food, drink and tobacco, and other manufacturing industries shown in table on p. 377.

[9] Comprising the entertainments and miscellaneous groups shown in table on p. 377.

one of the reasons for the lull in industrial stoppages after the settlement of the miners' dispute in 1926, whilst it was a contributing factor in the acceptance of the idea of the "Mond-Turner" discussions. The ebb and flow of direct action since the war is reflected in the table above (p. 378).

The broad distribution of trade union membership amongst the various industries is shown in the table on page 381.

The post-war period has been one of mixed gains and losses The unions in many industries secured the eight hour day, and apart from the increase of hours in the mines in 1926, the reduction in working hours is the most solid achievement standing to the credit of the trade union movement In some industries the unions have succeeded in maintaining real wages, in others they have had to make concessions. A feature of the disputes since the war has been what many people regard as their political character. It is certainly true that there has been more Government intervention and even participation in disputes than ever before The coal problem, which has dominated the post-war industrial situation was the direct cause of the so-called "general strike"

In July 1925, the T.U.C. general council promised its full support to the Miners' Federation even to the extent of a sympathetic strike. This step, however, was averted only to be implemented in the following year. The strike called by the T.U.C. general council, on the decision of a conference of trade union executives was the first occasion when the general council actually directed a stoppage, and it was the largest strike ever waged in British history The "general strike" and the defeat of the Miners' Federation was followed by the Trade Disputes and Trade Unions Act of 1927

The Trade Disputes and Trade Unions Act.—The history of Trade Union legislation prior to 1927 had been a history of liberation for the trade unions Adverse decisions of the law courts were rectified by Parliament The Act of 1927 definitely restricts trade union rights.

The principal changes which it makes in the law may be summarised as follows —

(1) Sympathetic strike action (whether on a national or local scale) if designed or calculated to coerce the Government, either directly or by inflicting hardship upon the community, is illegal, provided it is not within the trade or industry in which the original dispute arose (Section 1 [1])

(2). Lockouts are also similarly illegal.

(3). All primary strikes not connected with disputes over hours, wages or other conditions of employment are illegal, if they are designed or calculated to coerce the Government either directly or by inflicting hardship upon the community, *e.g*, a national coal strike to secure a statutory minimum wage. (Section 1 [1].)

(4). Any strike declared to be illegal by the Act will be none the less illegal, even though the workmen may have lawfully terminated their contracts of employment by due notice (Section 1 [1])

(5). A criminal liability is imposed on all union officials, which would include branch officials, shop stewards, members of strike committees, whether national, district or branch, and all other persons (excepting the workmen themselves) who in any way take part in or act in furtherance of any strike which is made illegal by the Act, even though they may be unaware of the facts or circumstances which render the strike illegal. Moreover, the individual workman who, in addition to ceasing work, acts as a strike picket or in any other way renders active support will be criminally liable. (Section 1 [2])

(6). In the case of strikes made illegal by the Act, the liability of union funds in respect of damages which may be awarded to employers and others, as imposed in the Taff Vale case, is restored. (Section 1 [4].)

(7). In the case of strikes made illegal by the Act, members expelled by their trade unions for breach of rule, *e g.*, members who remain at work after a strike has been called in accordance with the rules of the union, are given the right to claim damages, which will be payable out of the union fund. This right is made retrospective so as to cover the 1926 general strike. (Section 2)

(8). The statutory rights of trade unions to use their funds for political purposes are taken away, and the Act gives trade unions little in return which they do not possess under the present law, namely, the right which any group of individuals enjoys voluntarily to subscribe to a common fund. The 1927 Act, therefore, takes away the substantive legal rights conferred on trade unions by the 1913 Act, and, accordingly, is more than a mere change of machinery from "contracting-out" to "contracting in." (Section 4)

(9). Civil servants are prohibited from joining any trade union which is not confined to employees of the Crown, or which has political objects, or which is affiliated to any outside industrial or political organisations, *e g.*, the Trades Union Congress or the Labour Party. Any civil servant who fails to observe the above provision is liable to be dismissed from his employment, together with the loss of his pension (Section 5)

(10). Liability of municipal employees, or employees of any public authority, *e.g*, Port of London Authority, for breaches of their contracts of employment, to be a criminal as well as a civil liability, and so renders them liable to criminal prosecution, as well as the civil liability to pay damages (Section 6)

(11) The attorney general is given the right to interfere in union affairs by means of an application to the court to restrain the expenditure of union funds in support of strike action, declared illegal under Section 1 of this Act In this connection, it should be noted that under the present law, costs cannot always be obtained against the Crown, even when it loses the action. (Section 7)

Trade Unions and the Community.—The growth of trade unionism has meant that the trade unions have become an integral part of British social machinery This development has taken two main lines. In the first place, the trade union is now regarded as the normal machinery for the prevention and settlement of disputes. The State itself regards trade unions as responsible representative bodies They are called into consultation by the Government in times of dispute, and their leaders are invariably the spokesmen and advocates of the workers before courts of enquiry set up under the Industrial Courts Act. They express the workers' point of view before royal commissions and Government Committees, and the labour members of such investigating bodies are drawn from the ranks of organised labour On the Whitley councils in the Government services, the staff side is conducted by the representatives of the civil service unions The joint industrial councils concerned with services in which local authorities are interested are, like all other such councils, composed on the workers' side of trade unionists. The trade unions have won for themselves a definite place in the system of "industrial government," and they are parties to the industrial agreements which govern the relations between employers and employed, lay down the methods of consultation and negotiation, and determine wages and working conditions.

Share in State Administration.—In the second place, the trade unions play an important part in the administration of certain legislation. When the Trade Boards Act, 1909, was passed it was applied to four trades in which trade unionism was weak, and at the outset the interests of the workers were in large measure in the hands of the National Anti-Sweating League and the Women's Trade Union League. But trade unions have since been extended to almost every industry The Trade Boards Act of 1918, which amended and broadened the original Act, extended the minimum wage to trades to which hitherto the Act of 1909 had not been applied (*See* TRADE BOARDS.)

The Corn Production Act, 1917, set up agricultural wages boards on which the representatives of the unions catering for agricultural workers sat. The boards were, under the law, engaged in establishing binding rates of wages. The unions obtained a new status, and the Corn Production Act gave a new impetus to the difficult task of organising these workers When the act was repealed in 1921 the trade unions had nearly 300,000 members employed in agriculture. In 1924 the Labour Government re-established the system of wages boards, and the unions concerned are represented on the boards

The National Insurance Act of 1911 opened the door to trade union participation in its administration. Part I. of the act dealt with health insurance and provided, in general, for the payment of State benefit under the scheme by approved societies. Many trade unions formed trade union approved societies to administer the health insurance scheme, and these have become important agencies in the conduct of this vast system of social insurance A National Association of Trade Union Approved Societies exists to protect the interests of the constituent societies, and it played a prominent part in the opposition to Part I. of the Economy Act of 1926, which reduced the State contribution to health insurance. The insurance activities of the unions have not only associated them with the working of an important piece of legislation, but have consolidated, and in some cases strengthened, the position of the unions with their own members.

Part II of the National Insurance Act, 1911, dealt with unemployment insurance, but the scheme was a limited one. Compulsory insurance against unemployment was widely extended by the Unemployment Act of 1920 to cover nearly 12,000,000 workers. Provision was made whereby trade unions which ordinarily distributed out-of-work pay to their members should, subject to certain conditions, be allowed to administer the State Scheme, and pay the State benefit to their members, for which service the unions received an allowance. Many unions applied this provision of the act, but the reduction of the administration allowance from 1s per week benefit paid to sixpence led to some unions ceasing to administer the act. At the end of 1928, however, unions with a membership of 962,370 were still operating under Section 17 of the Act of 1920. and in order to secure a common policy on matters affecting their position under the Unemployment Insurance Acts, the unions concerned set up a standing committee, which acts with the Trades Union congress general council.

On the local employment committees and juvenile advisory committees attached to the employment exchanges and on the juvenile choice of employment committees of local authorities, the trade unions are represented, whilst when "uncovenanted" or "extended" benefit was introduced, they were actively associated with the employment exchange rota committees for the administration of this form of benefit.

During the progress of the war the trade unions were intimately connected with the conduct of certain phases of national affairs. In March, 1915, the Government came to an agreement (known as the Treasury agreement) regarding the production of munitions, which included compulsory arbitration, the relaxation where necessary of trade union rules, and the limitation of profits in munitions industries. From then onwards, the unions were called upon to assist in accelerating the production of munitions, in administering certain of the controls which were instituted (such as those in the cotton and wool textile industries) and in the selection of men for war service. Parts of the Treasury Agreement were embodied in the Munitions Acts, and offences under these Acts, except such as were brought before the ordinary courts, were dealt with by specially appointed munitions tribunals. Each tribunal consisted of a chairman, with either two or four assessors, drawn equally from panels representing employers and workers respectively. These bodies played a great part in the administration of the Munitions of War Acts.

A "national labour advisory committee on war output" was established early in the war, together with local labour advisory boards in each munitions area. The national committee was replaced in 1917 by the Ministry of Munitions trade union advisory committee, which was divided into three sections representing the engineering group, the shipbuilding group and the general labour group. A special women's trade union advisory committee was also appointed in the same year to advise the minister on all questions relating to women's work. Towards the end of the war further steps were taken arising out of unofficial strikes in Coventry and Birmingham, which, though speedily settled by the trade unions concerned, led to the appointment of a Government committee (on which there was trade union representation). This committee, which was critical of the policy of the Ministry of Munitions, recommended the establishment of a joint committee of employers and trade unionists and the closest possible consultation, both nationally and locally, upon changes and developments of policy—a proposal which the Government accepted.

The recruiting of men for the army was in the early stages of the war left entirely to the War Office. But haphazard recruitment led to the crippling of essential industries by the withdrawal of skilled men in considerable numbers, and to industrial unrest. It was therefore found advisable to bring trade unions into consultation on questions of recruiting.

Similarly, when the Government imposed its control over certain industries, the trade unions primarily concerned played an active part. The cotton and wool textile controls may be taken as an illustration. The cotton control board (set up in 1917) determined the amount of machinery which was to be run upon other than Government orders, and imposed a levy upon concerns working full time to pay out of work benefit to workers employed by firms suffering from the operation of the raw cotton order (which prohibited the purchase of cotton except under licence) and the control board. The wool control board, also instituted in 1917, consisted of eleven representatives of the trade unions, the employers and the War Office contracts department.

After the World War, these various forms of organisation came to an end, but they had given a new standing to the trade union movement. Since 1918 the chief administrative activities of the trade unions have been in connection with health insurance, unemployment insurance and trade boards.

The Consolidation of Trade Unions.—The movement towards consolidation of trade union forces which has been a marked feature in recent years was partly the outcome of the theoretical teaching of Syndicalism and Guild Socialism, but it was largely due to experience and the hard facts of economic life.

Federations have changed from loose alliances to negotiating bodies acting on behalf of the constituent unions. This development is seen in the case of the Engineering and Shipbuilding Trades Federation and the Miners' Federation of Great Britain, though the latter under the Coal Agreement of 1926 is no longer a negotiating body. In Nov. 1910, on the initiative of the Dockers' Union, the National Transport Workers' Federation was formed comprising practically all the unions catering for workers employed in waterside transport, including seamen, dockers and carters. This Federation, however, has since gone out of existence.

The Triple Alliance.—The Triple Industrial Alliance which was formed in 1914 was, in effect, a federation consisting of the Miners' Federation of Great Britain, the Transport Workers' Federation and the National Union of Railwaymen; it was thus composed of two bodies which themselves were federations and one large industrial union. The associated bodies were the unions concerned in the key industries of coal and transport, and the formation of the alliance created some consternation. But the only occasion when the Triple Alliance decided to embark upon industrial action was during the coal stoppage of 1921, when the Alliance issued notices calling a strike in support of the miners. The notices, however, were postponed and then withdrawn on April 14 (Black Friday). The result was to destroy the Alliance, but the association of railway, transport and mining unions continued, as they formed one of the "groups" constituted by the general council of the Trades Union congress. In 1925 attempts were made, largely on the initiative of the Miners' Federation, to establish a new alliance on a broader basis than the Triple Alliance; but, as membership of the new alliance involved in some cases an alteration of the rules of certain unions, and as the implications of the proposed association needed careful consideration, the completion of the alliance hung fire, and was abandoned.

Textile Trades.—In June, 1916, the National Association of Unions in the Textile Trade was established. Of the 36 unions of which the association is composed, 20 represent wool textile workers. The association, however, includes, besides workers engaged in manufacturing and finishing processes, those engaged in the textile machinery trade, and the skilled workers engaged in the maintenance of plant. The association appoints the workers' representatives on the joint industrial council of the wool textile industry. But the association also exists to promote trade union amalgamation in the industry, and to secure co-ordination in the case of disputes.

General Workers.—The General Labourers' National Council (established in 1908) developed in 1917 into the National Federation of General Workers, composed of the seven chief unions of general workers with an aggregate membership of over 800.000.

Building Trades.—The National Building Trades Council (representative of the 13 chief unions in the building industry) formed the basis for the National Federation of Building Trades Operatives established in 1918.

Foundry Trades.—Early in 1918 the Federation of Foundry Trades came into existence to promote amalgamation of the Unions in the industry, deal with demarcation disputes, and secure joint action wherever possible. It included about a dozen unions with a total of between 50,000 and 60,000 members. Three of the

unions in the federation—the Friendly Society of Ironfounders, the Associated Ironmoulders of Scotland and the Amalgamated Society of Coremakers, in 1922 merged to form the National Union of Foundry Workers

The G.F.T.U.—The General Federation of Trade Unions has changed its character. It does not now take any active part in trade union disputes and negotiations or in the work of promoting closer industrial organisation The G F T.U. was formerly the medium of communication between the British and foreign trade union movements, but since 1920 the general council of the Trades Union congress has been the representative British organisation in the International Federation of Trade Unions The chief work of the G F T U is in connection with dispute pay. Contributing associations pay contributions to the federation on the basis of their membership, and receive, when involved in a stoppage of work, benefit to be paid to their members In 1925 there were 118 unions affiliated to the federation with a total membership of 830,316 members

The following table gives the number and gross membership of federations in Great Britain and Northern Ireland at the end of each year —

Year	No of federations	Approximate total membership
1913	125	4,370,000
1914	137	4,730,000
1919	134	9,896,000
1920	116	10,749,000
1921	105	8,623,000
1922	95	6,236,000
1923	92	5,580,000
1924	90	4,442,000
1925	83	4,203,000
1926	84	3,909,000

The number of federations has shown a decline at the end of every year since 1917, except 1926, when there was an increase of one In some years the decline was mainly due to the merging of local into national organisations

In many instances trade unions, or branches of trade unions, are affiliated to more than one federation, and therefore a large number of trade union members are counted more than once in the gross membership given above In the following table the actual or estimated federated membership of each federated trade union is counted once only, irrespective of the number of federations to which the trade union is affiliated, and the table shows for the years 1925 and 1926 (*a*) the total membership (to the nearest thousand) of the trade unions in each group, (*b*) the net federated membership (whether of trade unions or of sections of branches of trade unions), and (*c*) the percentage proportion of (*b*) to (*a*).

Group of trade unions	Total membership of trade unions (000's omitted)		Net federated membership of trade unions affiliated to federations (000's omitted)		Percentage proportion of federated membership to total membership	
	1925	1926	1925	1926	1925	1926
Agriculture, horticulture, etc	47	39				
Mining and quarrying	914	787	891	749	98	95
Metals, machines, conveyances, etc.	683	658	333	305	49	46
Textile	626	619	599	573	96	93
Clothing (including boot and shoe)	168	166	65	62	39	37
Woodworking and furnishing	67	63	52	48	77	75
Paper, printing, etc.	207	187	196	174	95	93
Building	334	328	201	188	60	57
Railway service	520	492	71	60	13	12
Other transport	517	485	112	119	22	25
Commerce, finance, etc	222	217	98	97	44	45
National and local government	333	332	101	104	30	31
Teaching	197	200		.		
Miscellaneous	165	161	59	56	36	35
General labour	488	474	111	89	23	19
Totals	5,497	5,208	2,889	2,624	53	50

Amalgamations.—Federation has in many cases proved to be a stepping stone to amalgamation; but in other cases unions have merged without the intermediate step of federation. The reduction which is taking place in the number of trade unions is in part due to amalgamations as may be seen from the following table:—

Year	New unions formed (other than by amalgamations)	Reductions due to		Net reduction (−)
		Dissolutions	Amalgamations	
1921	45	72	85	−112
1922	30	40	36	− 46
1923	17	41	17	− 41
1924	27	17	14	− 4
1925	20	31	7	− 18
1926	27	30	12	− 15

One of the most striking amalgamations which was carried through prior to the Act of 1917 was that which resulted in the establishment of the National Union of Railwaymen. Up to 1913, when it was formed by the merging of three independent unions, the railway unions had not yet won full recognition from the companies. The N U R. shares with the Associated Society of Locomotive Engineers and Firemen, which is a craft union, and the Railway Clerks' Association, the representation of railway employees, and with certain other unions, the representation of the workers in the railway engineering workshops The N.U R. illustrates both the tendency towards larger scale organisation, for its object is "to secure the complete organisation of all workers employed on or in connection with any railway in the United Kingdom", and also the incomplete success it has achieved and the difficulties inherent in this policy. In time, the Associated Society of Locomotive Engineers and Firemen and the Railway Clerks Association may possibly merge into the National Union of Railwaymen; but the organisation of the engineers, boilermakers. carpenters and other railway shopmen, for which other unions cater, is a problem raising a conflict of principle

A new method of consolidation was adopted in the establishment of the British Iron and Steel and Kindred Trades Association and the Iron and Steel Trades Confederation in 1917 The former was, in effect, a new union which the various participating unions influenced their members to join These unions admitted no further members, all new members joining the B I S A K T A., and they transferred their powers to the Iron and Steel Trades Confederation, which conducts the work of organisation and negotiation When all the members of the participating unions have been transferred to the B I S A K.T A it will assume the duties and powers of the Confederation, which will then cease to exist.

The Amalgamated Engineering Union, one of the largest post-war amalgamations, illustrates the consolidation of craft unions. The nucleus of the present union was the Amalgamated Society of Engineers, with which nine other craft unions engaged in engineering coalesced in 1920 The A E U. catered for skilled mechanics, but has now opened its ranks to other grades of workers

January, 1921, saw the establishment of the Amalgamated Society of Woodworkers, the nucleus of the new organisation being the Amalgamated Society of Carpenters and Joiners In the same year, the Amalgamated Union of Co-operative and Commercial Employees and the National Warehouse and General Workers' Union merged to form the National Union of Distributive and Allied Workers The Amalgamated Union of Building Trade Workers formed at the beginning of 1921 was an amalgamation of the Operative Bricklayers' Society, the Manchester Unity of Operative Bricklayers, and the Operative Society of Masons, Quarrymen and Allied Trades. In 1922, the Dock, Wharf, Riverside and General Workers' Union formed the

nucleus of an amalgamation under the name of the Transport and General Workers' Union, uniting the National Union of Dock Labourers, the National Union of Vehicle Workers, the United Vehicle Workers (which was an amalgamation of the Tramway Workers and the Licensed Vehicle Workers) and several other unions. The Gasworkers' and General Labourers' Union, as it was originally called, became the National Union of General and Municipal Workers, when in July 1924 it absorbed the National Amalgamated Union of Labour and the Municipal Employees' Association In 1923, the National Federation of Women Workers was merged in the National Union of General and Municipal Workers Discussions have since taken place with other unions, *e.g*, the Workers' Union and the Transport and General Workers' Union as to the possibility of further amalgamation. A ballot is taking place of the T. & G W. Union and the Workers' Union members on the question of amalgamation of these bodies Other post-war amalgamations include the United Garment Workers (1920) which unified several sectional and local bodies, the Union of Post Office Workers formed (1920) by the combination of three unions, and subsequently enlarged by the absorption of half a dozen other organisations of post office employees, the National Union of Blastfurnacemen (1922) which took the place of the National Federation composed of five local unions of blast furnace workers, and the National Union of Sheet Metal Workers (1921) which combined a number of small federated societies of steel metal workers and braziers

The spontaneous movement towards amalgamation which characterised the first post-war years appears to have come to an end about 1922–3 It was at this time that the matter was taken up by the Trades Union congress Since then, its general council has played an active part in assisting negotiations for amalgamation. It has held conferences of kindred organisations in the metal trades, the textile trades (other than cotton), the printing trades, the post office, the insurance industry, the dyeing, bleaching and finishing trades, the leather trades, the building trades and amongst distributive and clerical workers In some cases the conferences broke down after a time, in others they have continued; but the process is slow and tedious and many practical difficulties have to be overcome The Swansea Trades Union congress (1928) showed quite clearly, however, that the practical difficulties must not be allowed to stand in the way of greater consolidation

General Policy.—During the years preceding the World War there was considerable labour unrest due largely to the steadily rising cost of living but receiving inspiration in some degree from the intellectual ferment in the world of labour Syndicalism, though never a potent force in the British trade union movement, prompted and encouraged the movement towards militant industrial unionism. The persistent propaganda of the Socialist societies had also begun to influence the outlook of the trade unionist. From about 1910 it is clear that the trade union movement, as may be seen from the resolutions of the T.U.C. was Socialist in temper. It was definitely in opposition to capitalism and private ownership of the means of production. The socialism, however, to which trade unionism gave adhesion, was essentially collectivist; but a closer association with the problems of industry, and a widening knowledge of the world of industry led to a sense of dissatisfaction with the arid doctrines of undiluted collectivism, which came indeed to be described as "State capitalism" Syndicalism, whilst it never commanded a large measure of support, did, by its emphasis on the workers' right to control, indicate the possibilities of a policy which whilst providing for public ownership, escaped the charge of "State capitalism" by the adoption of the principle of democratic control.

During the pre-war years these ideas had not clearly emerged. The effects of State regulation during the war, however, powerfully assisted in swinging active trade union opinion round to a sympathetic appreciation of the essential doctrines of Guild Socialism. Moreover, the new importance of the labour element in the community gave birth to new aspirations, and to the claim that the workers should enjoy increasing responsibility and power in the actual conduct of industry One of the most powerful groups of influences which moulded the minds of organised labour were those connected with the conditions of war-time employment. In the chief industries, the unions were parties to arrangements for the increase of output and the avoidance of stoppages of work.

Shop committees sprang up in the munitions industries, and in the engineering trades particularly they became influential organisations. Shop stewards became the real leaders of the rank and file in matters affecting the day to day lives of the workers in industry. This new reorganisation within the industrial labour movement—the creation of the circumstances in which the trade union executives were inevitably placed—proceeded swiftly and to a considerable extent effectively. It was unknown to the general public until it had established itself It was spontaneous —an obvious method of satisfying the need for some rapid local machinery which could deal with grievances in the workshop.

It spent itself during the war. With the end of the war, it lost the passion which had sustained it; but the value of shop committees and shop stewards (*q v*) was recognised, first in the engineering industry, and subsequently in others, the unions adopted this machinery and grafted it on to their organisations.

In the meantime, the policy of self-government in industry had become crystallized, and since the war, the T U.C. has accepted the policy of public ownership combined with the association of workers in the government and control of industry The application of this policy may be seen in the bill prepared by the Railway Clerks' Association for the nationalisation of railways, and subsequently in the scheme for the future of the coal industry placed before the coal commission of 1925–26 by the Miners' Federation, with the full support of the T.U C general council and the Labour Party In the discussions at the Swansea T U.C (1928) on the "Mond-Turner" conferences, it was strongly urged by the secretary of the congress that it offered an avenue to "industrial control," and to the participation of organised labour in the direction of industrial policy

Russia and Communism.—The Bolshevik revolution in Russia had its reaction upon the British trade union movement Some of the leaders of the shop stewards' movement embraced Communist doctrines, and when the Red International of Labour Unions was formed by the Moscow Communist International, attempts were made to secure the adhesion of trade union bodies to the R.I L U. Such British bodies as are affiliated, however, are not national unions, but sectional and local organisations. Under the inspiration of communist doctrines the "National Minority Movement" was organised, as what may be called the communist wing of the trade union movement. It consists of groups and sections of trade unions, and its spokesmen favour an advanced policy supporting also closer relationship between Britain and Russia The general council of the congress has actively supported a policy of friendship between Britain and Russia and has used every effort to bring about an understanding between the International Federation of Trade Unions and the Russian trade unions Its efforts met with no success and even the attempt to reach an understanding between Russian and British trade unionism failed, and in 1927 relations between the two were virtually broken off

The National Unemployment Workers' Committee Movement established during the period of heavy post-war unemployment, is, like the minority movement, directed largely by people of communist sympathies. From 1923 the T.U.C. co-operated with the N.U.W C M., but in 1928 the general council decided that "no useful purpose would be served by the continuance of the joint committee with the N.U W C M.," and declared that it was not satisfied "as to the *bona fides* of the organisation." The congress of 1928 accepted this statement, and moreover, adopted a resolution instructing the general council to institute "an inquiry into the proceedings and disruptive elements within the trade union movement . . . and to submit a report with recommendations to the affiliated organisations." The debate on this motion made it clear that the resolution was directed against the National Minority Movement and the Communist Party.

The militant left wing was in the ascendant during the earlier years of the trade depression. It reached its maximum influ-

ence at the Trades Union congress in 1925. The National Strike and the prolonged coal stoppage in the following year, whilst creating a despair which provided a fertile soil for Communist propaganda particularly in the mining areas, ultimately resulted in a definite swing to the right. On the coalfields a "non-political" form of trade unionism secured a precarious foothold. In other unions Communist influence waned after the events of 1926 and some trade union organisations excluded Communists and members of the National Minority Movement from representative positions. The Trades Union congress of 1927 indicated a clear change of attitude and the trade unions at their congress in 1928 repudiated the policy and tactics of the left wing, condemned its disruptionist activities, and declared by an overwhelming majority in favour of the continuance of the "Mond-Turner" consultations, a series of conversations between the general council and a group of prominent employers, with the object of securing as far as possible peace in industry.

The factors which have led a minority of trade unionists into the ranks of Communism and the National Minority Movement (which it may be said includes a considerable proportion of workers who could not be described as Communists) have led a far greater number to a realisation of the need for a clearly conceived industrial policy for the trade union movement The establishment of the general council of the Trades Union congress, the enlargement of its powers, and the large extension of its activities were an expression of this need. One of the first problems, however, is that of the organisation of trade unionism; for clearly the success of any industrial policy must depend in the last resort on the efficiency of trade union organisation.

Trade Union Organisation and Policy.—So long ago as 1910 and 1911 the Congress committed itself to the principle of organisation by industry, and in 1911 urged the parliamentary committee to call conferences of the different industries "with a view of amalgamating the several trade unions connected with each industry." This somewhat crude principle was interpreted in a reasoned resolution adopted by the congress in 1918, when it was agreed (*a*) that the organisation of an industrial union should allow for the maintenance within the union of each distinct craft combination and for the possibility of federating such combinations with like bodies outside the union for specific purposes; and (*b*) that every craft union and general labour union should allow sectional combinations within the union, on industrial or occupational lines, so as to facilitate inter-union federations, and, if circumstances require, the transfer of a section to any more appropriate union.

In 1922 the Trades Union congress instructed the general council to make an enquiry into the present organisation of the trade union movement as a necessary basis for a policy of closer unification. The Hull congress of 1924 adopted a resolution declaring that "the time has arrived when the number of trade unions should be reduced to an absolute minimum" and that "the aim should be as far as possible organisation by industry with every worker a member of the appropriate organisation." The congress called upon the general council to prepare a scheme, and a committee was appointed A memorandum by W. M Citrine on the subject was published in the annual report of the congress for 1925. The report which was submitted to the T U C. in 1927 boldly admits the defects of the existing trade union structure and method—the prevailing sectionalism, the competition between different unions for workers, varied rates of contributions and benefits, demarcation of work and the lack of a co-ordinated policy. The council, which has taken an active part in promoting conferences of unions with the object of assisting amalgamation, realises that "the real driving force must come from the unions themselves." It sees no value in laying down a hard and fast scheme, but believes that joint working arrangements should be made wherever possible. After the congress of 1927, the general council circularised the affiliated unions on their attitude towards amalgamation and joint working In most cases the unions were in favour of the latter, many were in favour of the former, whilst some were impressed by the difficulties and past failures as regards amalgamation. The Swansea Trades Union congress of 1928 adopted by a large majority a resolution calling upon the general council "to appoint a reorganisation commission to review the situation of the workers in the principal industries in the light of the material which it has at its disposal, and to formulate suggestions for the speedy reorganisation of the trade union movement." It is certain that the conflicting claims of pure and unadulterated industrial unionism, occupational unionism, federal unionism, and craft unionism, will necessitate some composite method which, within the framework of the industry, permits variety of organisation to meet the needs of special crafts and groups, but, at the same time, one which is comprehensive enough to cover as wide a ground as the modern organisations of capital

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THE UNITED STATES

Something more than 3,500,000 American wage-earners were in 1928 members of labour organizations This membership is scattered over all fields of employment—the manufacturing industries, land and water transportation, the building trades, the mining industry, the professions, domestic and personal service and trade. Organized labour is not everywhere equally strong. In the building trades organization is general and dominant. On the railroads it is powerful largely among the skilled train-service employees. In the coal industry the strength of the union, the United Mine Workers, is on the wane, except in the anthracite industry Among the many manufacturing industries of the country, trade unionism can be regarded as strong only in the clothing and printing industries. For the rest union members are to be found in a large variety of occupations such as actors, barbers, street railway employees, teamsters and chauffeurs and in a few branches of public service. The American labour movement is, moreover, a men's movement.

Knights of Labor.—As a continuous, more or less unified movement, with its peculiar philosophy and strategy, trade unionism in the United States cannot be said to have become established before 1880 In the preceding decades several of the large national unions had been organized and occasionally more general uprisings had taken place only to die out after a few years, usually in the wake of business depression By 1880, the Knights of Labor, organized in 1869 and pursuing since then a secret existence, had appeared in the open as a union of all workers, skilled and unskilled, manual, clerical and professional, and even of the small business man During the next ten years there was unfolded one of the most dramatic and significant episodes in the history of American labour. Hardly known at the beginning of the period the Knights achieved by 1886 a membership of close to 1,000,000 and an influence far transcending its size

The Knights had set out first to organize all workers. For this slow and gigantic task, the organization had neither the financial resources nor an adequate staff of organizers It depended on the spontaneous uprisings of men and women Such uprisings occurred often in the few years from 1880 to 1886 But when strikes ended in failure and strikers lost their jobs and when there

was no place to turn for the sinews of war, it became more difficult to arouse enthusiasm and action At the same time much of the attention and energy of the officers of the organization was dissipated in carrying out the ambitious economic programme of the Knights, which ran from simple trade union action over wages to vast co-operative schemes or plans for the reorganization of the currency and banking system of the country. To these sources of weakness, was added the inevitable conflict for jurisdiction between the Knights and the established craft unions The episode of the Haymarket bomb in 1886 brought the Knights of Labor into disrepute but only hastened the end.

Rise of the American Federation of Labor.—Even during the heyday of the Knights, a new central organization of American labour was already forming under the leadership of Samuel Gompers and his associates. This organization, appearing in 1886 as the American Federation of Labor, had as its precursor the Federation of Organized Trades and Labor Unions begun in 1881. The Knights sought to absorb the existing craft unions; to subject them to the loss of autonomy; and to involve them in industrial disputes, in which their own direct interests were apparently not at stake. Against this tendency craft unions revolted, organizing themselves in the loose federation which is still the sole centralizing and unifying agency of the American labour movement.

The principles on which the American Federation of Labor (*q.v.*) was founded originated in the practical experience of the leaders of this new movement and in their reaction against the practices of the times They saw in craft unionism the solidarity and permanence which they found missing in the industrial unions, mixtures of skilled and unskilled, sponsored by the Knights. They observed that the best chances of continuity and strength in a movement of organized labour lay in formulating narrow and attainable economic objectives instead of embracing a large and attractive programme of economic reform which the trade unionists themselves had neither the interest nor the capacity to make effective In view, finally, of the frequent and disastrous failures of independent political action, they abandoned attempts to form a Labour Party and sought to achieve political influence by other means. In its beginnings, then, the American Federation of Labor was dedicated to the principles of craft unionism and autonomy, of the collective bargaining that wins recognition of organized labour and advances in working conditions.

To this plan the Federation has consistently adhered. This undeviating policy has made of it a loose federation of nearly 150 national and international unions, each of which retains full autonomy over all of the affairs that are the concern of a modern labour organization In return each union receives from the Federation protection of its charter or of the workers and industrial territory over which it claims jurisdiction Out of this policy have grown bitter jurisdictional disputes between unions affiliated with the Federation Although the Federation has usually thrown the weight of decision and influence toward the claimant with the clearest title to the disputed jurisdiction, this has not prevented far-reaching changes in the structure of affiliated unions

Economic and Social Policy.—The American Federation of Labor has become the agency for dealing with all matters affecting the general welfare of organized labour The most absorbing of these matters are, of course, political. From the beginning the Federation has concerned itself with measures for ensuring the proper legal status of organized labour and has employed to this end whatever political influence it could muster Just as Samuel Gompers fought in 1890 for the exemption of organized labour from the terms of the Sherman Anti-Trust Act, so the present leaders of the Federation were in 1928 demanding of the major political parties protection against the use of injunctions in labour disputes and the promise of a liberal legal status Similarly throughout the States and municipalities of the country, federations of the local branches of the unions affiliated with the Federation pursue their activities as lobbyists in the interest of labour; agitate for raising wages on public works; mobilize their power for the repeal of unfriendly legislation, or for the defeat of an "anti-labour" candidate for local office

The American Federation of Labor, acting as spokesman for organized labour, frequently states the position of labour on questions of general economic and social policy. Until recently the Federation has been anti-monopolistic in its attitude toward combinations of business. From almost the very beginning the Federation has been "on record" for the restriction of immigration. It urged the recognition by the United States of the labour government of Mexico but has opposed the recognition of the Soviet government of Russia. Through resolutions adopted at its annual conventions or through manifestoes issued by its Executive Council, the Federation constantly expresses the views of organized labour on a great variety of questions.

Independent Unions.—Outside and independent of the American Federation of Labor are a group of national unions that now have a combined membership of about 800,000. This group consists mainly of the railroad brotherhoods, the unions of locomotive engineers, firemen, conductors and trainmen, of the Amalgamated Clothing Workers of America, and of smaller organizations largely in public service and in the textile and metal industries The railroad unions have at no time been affiliated with the Federation, preferring to preserve full control over their own internal affairs. The Amalgamated Clothing Workers started in 1915 out of a split in the United Garment Workers and is consequently known as a secessionist organization. Occasionally unions that have been independent, like the Bricklayers, join the Federation, or affiliated organizations, like the Railway Clerks, lose their charters and become independent But such changes have, in the history of the movement, been rare The Industrial Workers of the World ("I W W") is separately dealt with

Analysis of Growth.—As an effective force in American industry, organized labour hardly began to be felt before 1900 The period following the collapse of the Knights of Labor was one devoted to building the foundations of the labour movement, to strengthening the few established organizations and to extending unionism into new fields The decade 1890–1900 with its severe depression and general unemployment was not favourable to the growth of unions With the recovery of business toward the end of the decade the growth of the labour movement began and continued with only slight recessions until 1920 From 1900 to 1914, as the table shows, the total membership of American

Year	Membership	Year	Membership
1897	447,000	1913	2,753,400
1898	500,700	1914	2,716,900
1899	611,000	1915	2,607,700
1900	868,500	1916	2,808,000
1901	1,124,700	1917	3,104,600
1902	1,375,900	1918	3,508,400
1903	1,913,900	1919	4,169,100
1904	2,072,700	1920	5,110,800
1905	2,022,300	1921	4,815,000
1906	1,958,700	1922	4,059,400
1907	2,122,800	1923	3,747,200
1908	2,130,600	1924	3,746,600
1909	2,047,400	1925	3,817,900
1910	2,184,200	1926	3,900,500
1911	2,382,800	1927	3,903,800
1912	2,483,500		

trade unions increased by nearly 2,000,000 and trade unionism penetrated many unorganized industries, making its most notable advances in the coal industries. Among the manufacturing industries the progress of organization, while substantial, was slow.

This whole situation changed radically after the outbreak of the World War. The rapid improvement in business and rise in productive activity, the steady absorption of the unemployed in face of the cessation of immigration, the further stringency in the labour market after the American entry into the war, the rising levels of prices and of wages, were all factors contributing to the strength of organized labour The membership of trade unions, consequently, nearly doubled from 1915 to 1920 and unionism won a place for the first time in the textile industry, packing houses, in machine shops, among the shop men and unskilled on the railroads, in the clothing industries and among many clerical occupations. Only in the iron and steel industry did the labour

movement fail to make effective progress.

The war gains were not held. The concomitants of ordinary business depression, unemployment, strikes and lockouts and the shrinkage in the purely war industries had an immediate and devastating effect on trade unions By 1923 they had lost nearly 1,500,000 members and were eliminated from many of the industries which they had for the first time entered during the war Strikes on the railroads reduced the unions of the unskilled almost to nothing and left the shopmen in control of only a few roads. The machinists' union lost more than 230,000 members, and the United Mine Workers began that series of engagements with the mine operators which has seriously impaired the strength of this union throughout the bituminous coal industry Only in the clothing, building, transportation, printing, public service and theatrical groups is the trade union larger and stronger in 1927 than it was in 1913 Nearly 60% of all union members were in 1927 in the building, transportation and clothing unions At first blush the failure of trade unions generally to do better than hold their own in these past years is surprising For, since the revival of 1922, American business and industry has had an astounding record of high levels of production and large profits. Under such conditions in the past labour organization has usually grown. In the building trades the unions have clearly profited from the business boom Elsewhere this has not been the case

Handicaps to Growth.—For generations American industry drew a substantial part of its labour from the masses of immigrants that every year came from the countries of Europe into the United States Although there has been drastic restriction of immigration since the war, American industry appears to be still far from a condition of labour shortage There are new sources of labour within the country that are constantly being tapped and that conduce to an easy labour market

All labour movements suffer from the internal dissension that arises out of clash of doctrine Sooner or later the holding of a new view of the purposes of the labour movement grows into an attempt to capture the movement and to convert it to this view Mild beginnings in this direction have usually ended in bitter warfare and in the disruption of one or more unions. Such was the early history of the relations between the labour movement and the socialists, after 1905 between the I W W and the American Federation of Labor, and since the war between the communist movement and the established trade unions In the clothing industry, for instance, the struggle for control waged during the past few years between the communist Workers' Party and the administration of several of the unions in this industry has resulted in nearly destroying organizations that were only a few years back among the most effective in the country.

American unions have always had an uncertain legal status They have been constantly harassed and hindered by the free use of injunctions in labour disputes. Prohibitions against interference with interstate commerce have applied to trade unions as to business combinations The device of the individual or "yellow-dog" contract, by whose terms a worker holds his job as long as he agrees not to join a labour organization, has almost closed certain areas and industries to unionism. Throughout the 48 States of the country, labour unions encounter almost as many different legal conditions as there are separate judicial jurisdictions. Sustained efforts of the movement to clarify and improve its legal status have hardly been successful. It is clear that the great expense of litigation in the United States and the uncertainty of the outcome have been severe handicaps to the growth of labour organization.

In the face of a swiftly changing industry, whose technical processes are being constantly revolutionized, the unions have clung to an antiquated structure. New industries like the automobile industry and even old ones like the shoe and clothing industries have all participated in this metamorphosis. Old categories of skill have disappeared and new ones have not arisen in their place Over these machine tenders and semi-skilled workers the jurisdiction claims of the established labour unions are vague and ineffective. Where the job in hand demands pioneer activities and a bold strategy, the divided counsel of many separate unions has been a source of weakness.

Company Unions.—Organized labour in the United States, finally, has in recent years been forced to meet a new strategy of employers For the moment, at least, many industrial leaders appear to have abandoned the repressive measures of the past and to have engaged in competition with labour unions for the loyalty of their employees In place of the national trade unions, whose members are recruited throughout the whole of an industry, regardless of geographical location or ownership of the business, industry has created company or plant unions (*See* COMPANY UNIONS) These organizations, sometimes described as employee representation plans or works councils, are limited either to a single plant or to several plants under common ownership. Their number has grown so rapidly since the World War that their present membership may run to several millions

To this device many industries have added the so-called welfare features, which have already assumed a great variety of forms The most common are the sale of a company's securities to its workmen at prices and on terms that are generally more favourable than could be obtained in the open market and the wholesale purchase for all of its employees of insurance against death, and occasionally against sickness and old age Both practices have been growing by leaps and bounds and should, if they continue at the present rate, profoundly affect the distribution of income in the United States The leaders of organized labour are critical of this whole development, question the *bona fides* of the employers and point to crucial defects in both the systems of employee representation and in the new insurance and investment features of labour relations

Trade Union Problems.—The most fundamental of the trade union's problems is that of adjusting its policies to changing economic conditions Very often, before the World War as well as since, strong and established trade unions have been reduced in size and strength because they failed to gauge the probable inroads of machinery and business depression Sometimes the struggle between a union and machinery would last for a generation, but in the end the union was beaten This has been largely the history of the cigarmakers' union In general, also, nearly all of the organized industries in this country are partly non-union. Unless the union is able to organize the non-union area, or so to protect the competitive position of the union area that the non-union firms do not grow, the union will find business being diverted to the unorganized area and control of the industry slipping from its hands The failure of the United Mine Workers to organize the non-union coal fields of West Virginia and at the same time to strengthen the competitive position of the union operators in Illinois, Pennsylvania and elsewhere has more than any other single factor led to the disruption of their union

Advances in Economic Policy.—In the past years several trade unions have made notable advances in the direction of a new economic policy One of the best-known of these experiments is that begun in 1923 between the Machinists' Union and the Baltimore and Ohio Railroad Company (often called "B and O Plan"). The essence of the experiment is the assumption by the union of responsibility for production Under this plan officers and members of the union, working in the shops of the railroad company, undertake to contribute to efficiency In turn the company promises the union a share of the gains from increased output. This arrangement has unquestionably strengthened the union and may be expected to lead gradually to a general improvement in working conditions It has already spread to the Canadian National Railways and to other railroads in the United States. Probably the most significant and far-reaching development of this kind has taken place in the men's clothing industry under the initiative of the Amalgamated Clothing Workers, the union of men's clothing workers. This organization began only in 1915 and by 1920 had organized more than three-fourths of the industry. In order to consolidate its position and to retain the high rates of wages and favourable working conditions which it had won during the war, the Amalgamated took it upon itself to discover and reduce the wastes of the industry, to control overhead costs, and to raise the efficiency of its own members. It has

undertaken to assist manufacturers in organizing new shops; it has assumed many of the functions of supervision and management thereby reducing the costs of overhead; and it has even made loans to manufacturers. The test of the success of this policy lies in the growth of the Amalgamated

The widening of the sphere of labour activity has not taken place in the methods of collective bargaining alone Reaction to the economic effects of the World War and to the new ideas current then led organized labour to a much broader conception of its goals and methods Out of this period grew the discussion of workers' control, the actual experiment in the Rock Island Arsenal, and the concrete proposal for labour's participation in the management of the railroads, in the form of the well-known Plumb Plan At the same time organized labour began to show a strong revival of interest in co-operative undertakings, culminating in 1920 in the beginning of the labour banking movement They grew rapidly in number and in resources and by the middle of 1926, 36 labour banks had accumulated resources of more than $127,000,000 Soon thereafter the leaders of the labour banking movement, the Brotherhood of Locomotive Engineers, found that their banks had not been wisely managed and were forced to undertake a drastic reorganization of their financial institutions The general movement suffered from these disclosures By June 1928, the number of labour banks was 28 and their resources $114,000,000 With a few exceptions, the majority of the labour banks no longer retain those features that distinguish them from private banking institutions The exceptions, however, are making a valuable contribution to the development of co-operative banking in the United States.

Unions have meanwhile turned their attention to other economic activities. Both the Electrical Workers' Union and later the American Federation of Labor have organized labour co-operative insurance companies that appear to be growing rapidly. The Amalgamated Clothing Workers completed in 1927 a large project in co-operative housing in New York city. Finally a number of unions in the various branches of the clothing industry have created unemployment insurance funds that are entirely novel to American industry. Most of these plans have been shattered by internal dissension in the unions, but the largest, that in the men's clothing industry, now covers some 70,000 members of the Amalgamated Clothing Workers and seems to be a successful and permanent feature of this union's activities

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IN OTHER COUNTRIES

As Great Britain was the first country to undergo industrialisation and the modern capitalist system first made its home there, it was natural that modern trade unionism should have sprung into existence in Britain Although in some countries trade unionism has departed from the British model, yet the trade union movement in Britain has powerfully influenced developments elsewhere.

In most countries there has been much the same struggle as in Britain, and the process of development has broadly followed the same lines The French Revolution and the Napoleonic legislation which followed it finally destroyed the guild system in Europe. The rise of large scale industry coincided, as in England, with an era of individualism during which combination was held to be a crime, and was severely punished. In time, however, these penal measures became more or less inoperative, and during the second half of the 19th century in most European countries, and in the 20th century in Russia, the laws prohibiting combination for trade purposes were repealed.

In Germany freedom to form associations was not conceded until the latter half of the 19th century. Under the Empire, though trade unions had no status in courts of law, freedom of association was granted. The trade unions increased in power and membership with the establishment of the Republic, the Constitution specifically granted freedom of association to all, including civil servants, and the unions were called upon to co-operate in the economic activities of the State.

In France the story is broadly similar. During the French Revolutionary period association was prohibited. Later there followed a period of *de facto* tolerance of combination Association ceased to be "a penal delict" in 1864, combinations became finally legal in 1884, and in 1901 an Act of wide scope proclaimed general freedom of association. In 1919 and 1920 legislative powers were conferred on industrial associations to conclude collective agreements, to take legal action to secure the enforcement of agreements. and to take proceedings in respect of infringements of labour laws.

The development of the activities of trade unions has pursued broadly the same course in all countries, though the law with regard to strikes, blacklists, the boycott, etc, varies in different States Generally, trade unions have concerned themselves with the organisation of workers within their ranks, and with industrial negotiations. Where the latter fails, they have made themselves responsible for controlling the withdrawal of labour They have provided "friendly benefits" of certain kinds for their members. In course of time the trade unions came to exercise in varying measure an influence on managerial control in industry, and in most countries influence in some degree social and industrial legislation. In Russia, the trade unions occupy a privileged position During the earlier stages of the Soviet rule, they were a constituent part of the State Though the State and the Unions are now independent, the latter still enjoy legal powers which are an effective influence within the State In Italy, since the establishment of the Fascist régime there has been a very close connection between trade combinations and the State through the Ministry of Corporations Certain duties have been devolved upon the unions, which are in effect direct organs of the State (*See* FASCISM) In Spain, where the course of action was inspired by Italian legislation, corporations were set up by order of the authorities to bring together various trades and industries, and the joint commissions of workers and employers which go to form the corporations include members nominated by the State

In many countries there is a tendency to encourage and to recognise the principle of joint representation of workers and employers on State bodies—a tendency seen in the Joint Industrial Councils in Great Britain Organised employees and employers are represented on the International Labour Organisation, and the right of association is guaranteed by the Treaty of Peace

Socialist ideas were in many countries an important factor in giving a constructive purpose to the trade union movement. In France, the influence of Socialist doctrines in developing the aims of trade unionism is clearly seen, though in the opening years of the 20th century, there was a break between the Socialist Party and the Confédération Générale du Travail, and the latter body at its Conference in 1906. whilst affirming that it included "all workers consciously taking part in the struggle to abolish the wage-earning system and the employers," declared that it stood "apart from all political schools of thought."

In Germany, so long ago as 1854 a Federal Council decree was directed towards the dissolution of all unions pursuing Socialist aims. The Anti-Socialist Act of 1878, though not aimed at the trade unions, did as a matter of fact, result in the dissolution of a number of organisations. At the present time however, the great majority of the trade union membership in Germany belongs to the Socialist trade unions.

In Belgium again, the close association of the political and trade union elements has been one of its chief characteristics, and the Trade Union Committee, which was set up by the Socialist

Congress in 1898, controls the bulk of the trade union membership.

One striking difference between what may be called the British type of trade unionism and the continental type is the intrusion of religion into the movement in some European countries. In the three countries referred to, the trade union movement is divided not only by political differences, but by religious differences. For example, in Germany the trade unions fall into clearly defined groups—the General Federation of Trade Unions (comprising the Socialist unions), the three federations of Christian workers (the German Federation of Christian Trade Unions, the Federation of Salaried Employees, and the Federation of Unions of Civil Servants) and the Federation of National Trade Unions (which repudiates Socialism). There is also a Communist Union of Hand and Brain Workers. At the end of 1925 the General Federation of Trade Unions had a membership of 4,182,511; the Christian unions claimed 582,319 members, and the national unions 157,571 members

In France the Confédération Générale du Travail about the same time had a membership of 553,770. The Confédération Générale du Travail Unitaire, which has been a prey to Communist controversy, was credited with 505,000 members, whilst the Confederation of Christian Workers was reported to have a membership of approximately 120,000.

In Belgium in 1925 the Trade Union Committee had a membership of 594,988, the Christian unions about 180,000, whilst the neutral unions contained only a few thousand workers.

World Growth of Trade Unionism.—As regards the general growth of trade union membership in recent years, it may be said that with the opening of the 20th century trade unionism had secured a permanent foothold in all industrialised countries, and made considerable headway even in other countries In the years immediately prior to the World War, trade union membership was on the increase National laws governing trade union activities varied from State to State and, therefore, the protection afforded by the unions to the workers varied to some extent; but in nearly every country for which particulars are available, there was in the pre-war years a steady and substantial advance in strength as the table given below indicates.

The table shows the growth of membership in over 20 countries from 1910 to 1919 and covers all the most important countries in the world except Russia, where figures are not available for the pre-war years, and China, Japan and India, where trade unionism was little developed before the War

Reliable estimates are available for the following 20 countries (United Kingdom, Germany, U S.A , France, Italy, Belgium, Holland, Denmark, Sweden, Norway, Finland, Switzerland, Spain, Austria, Hungary, Czechoslovakia, Canada, Australia, New Zealand and Serbia). The total trade union membership was at the end of 1910, 10,835,000; 1914, 13,222,000, 1919, 32,680,000.

In most countries during the first part of the war the growth of trade unionism was checked. The decline was substantial in Germany, Austria, Hungary, Italy and Czechoslovakia, but in these countries the numbers began to increase in 1917. After the end of the war numbers increased rapidly, especially in the Central European States

In Europe the total membership at the end of 1919 was at least 26,000,000 as against about 8,500,000 at the end of 1910.

In the 30 countries of the world for which information is available the total membership in 1919 was 42,040,000, and in 1920, 48,029,000. If we take the figures for 1919, no less than 80% of the trade union membership belonged to European countries Of the remaining 7,979,000 members outside Europe, 5,985,000 belonged to the North American continent. Six countries—Germany, Britain, the United States, Russia, France and Italy accounted in 1919 for 33,500,000 members, whilst the remaining 24 countries accounted for only 8,750,000. Two-thirds of the total trade union membership was concentrated in four western countries—Great Britain, the United States, France and Germany

Membership of the International Federation.—This, broadly, represents the position up to date. The total figures have, however, fallen practically everywhere, as will be seen from the typical figures given below, showing the membership of the International Federation of Trade Unions in recent years

The history of trade union efforts at international organisation has been a history of struggle against the difficulties inherent in any attempt at international organisation and of conflicts of principle. The conflict between Marxian Socialism and Anarchism which split the First International has had its counterpart since the war in the clash between Social Democracy and Communism Prior to the war there were two international Labour organisations—the Second International which was political in its aims, but which admitted trade unions into affiliation, and the International Federation of Trade Unions which received that title in 1913 superseding the International Trade Union Secretariat founded in 1901 (*See* INTERNATIONAL)

When the World War broke out in 1914, both the Internationals broke under the strain In order to maintain some sort of connection between the trade unions of the belligerent countries a temporary bureau of the International Federation of Trade Unions was established at Amsterdam, and unsuccessful attempts were made to convene international conferences of trade union representatives of all belligerent countries. A conference of trade union representatives from the allied countries was, however, held in Leeds in July 1916. It was decided to open an international correspondence office at Paris for the duration of the

Membership of Trade Unions at the End of the Years 1910–19

Country	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
United Kingdom	2,400,000	2,970,000	3,226,000	4,192,000	4,199,000	4,417,000	4,677,000	5,547,000	6,645,000	8,024,000
Germany	2,960,000	3,336,000	3,566,000	3,572,000	2,271,000	1,524,000	1,496,000	1,937,000	3,801,000	9,000,000
U.S.A.	2,100,000	2,282,000	2,539,000	2,722,000	2,672,000	2,860,000	3,000,000	3,451,000	4,000,000	5,607,000
France	977,000	1,029,000	1,064,000	1,027,000	1,026,000	*	*	1,500,000	2,000,000	2,500,000
Italy	817,000	847,000	861,000	972,000	962,000	806,000	701,000	740,000	*	1,800,000
Belgium	139,000	189,000	231,000	203,000	203,000	*	*	*	450,000	750,000
Netherlands	154,000	169,000	189,000	220,000	227,000	251,000	304,000	369,000	456,000	625,000
Denmark	124,000	128,000	139,000	154,000	156,000	173,000	189,000	224,000	316,000	360,000
Sweden	115,000	111,000	120,000	136,000	141,000	151,000	189,000	244,000	302,000	339,000
Norway	47,000	53,000	61,000	64,000	68,000	78,000	81,000	94,000	180,000	144,000
Finland	15,000	20,000	24,000	28,000	31,000	30,000	42,000	161,000	21,000	[illegible]
Switzerland	75,000	78,000	86,000	89,000	50,000	65,000	89,000	149,000	177,000	224,000
Spain	41,000	80,000	190,000	128,000	121,000	76,000	99,000	90,000	150,000	211,000
Austria	200,000	200,000	257,000	253,000	147,000	112,000	109,000	211,000	295,000	772,000
Hungary	86,000	95,000	102,000	107,000	107,000	43,000	55,000	215,000	500,000	500,000
Czechoslovakia	100,000	100,000	107,000	107,000	55,000	40,000	24,000	43,000	161,000	657,000
Rumania	8,000	6,000	10,000	*	*	17,000	16,000	16,000	*	*
Canada	120,000	133,000	160,000	176,000	166,000	143,000	160,000	205,000	240,000	378,000
Australia	302,000	365,000	433,000	498,000	523,000	528,000	546,000	564,000	582,000	628,000
New Zealand	57,000	66,000	61,000	71,000	74,000	68,000	71,000	*	*	100,000
Serbia (Yugoslavia)	7,000	8,000	5,000	9,000	14,000	12,000	12,000	12,000	15,000	20,000

*Figures not available.

war, and a peace programme was formulated In October 1917, a Conference convened by the Swiss Federation of Trade Unions was held at Berne, which was attended by representatives from the neutral States and the Central Powers.

The International Federation of Trade Unions (the I.F.T.U.) was reconstituted in 1919 following a Congress held at Amsterdam It consists of the various national central trades union organisations affiliated, but the General Council includes three delegates from the "international trade secretariats," (*i e*, representatives of the "trade internationals" such as the International Miners' Federation). The management of the I.F T U. is vested in the executive committee, the General Council and the Congress The Executive Committee (or the Bureau, as it is often called) consists of the officers (*i e*, the president, vice-presidents and secretaries) and meets six times a year. The General Council (often referred to as the Management Committee) is a larger and more representative body. The supreme governing authority is the Congress which consists of the General Council and the representatives of the affiliated national centres (*e g.*, the British Trades Union Congress)

The membership of the International Trade Secretariats is as follows:—

The International Trade Secretariats on December 31st, 1925, and 1926

International trade secretariats	December 31, 1925			December 31, 1926		
	Membership	Number of affiliated		Membership	Number of affiliated	
		Countries	Unions		Countries	Unions
1 Bookbinders	80,603	15	16	79,509	15	16
2 Building workers	775,103	22	26	761,606	20	26
3 Clothing workers	322,510	18	29	306,877	18	30
4. Diamond workers	21,276	7	9	22,696	7	10
5 Employees Clerical, etc	720,201	18	42	691,387	19	43
6. Factory workers	694,272	12	17	562,136	13	19
7 Food and drink trades	692,661	18	27	745,001	18	28
8 Glass workers	92,165	9	10	94,827	9	10
9. Hairdressers	9,155	9	9	9,169	9	9
10. Hatters	57,352	13	13	48,576	13	13
11. Hotel employees	65,843	15	17	62,683	15	17
12. Land workers	373,542	14	16	314,666	14	17
13. Leather workers	351,000	16	26	283,399	14	24
14. Lithographers	47,748	20	22	46,081	20	22
15. Metal workers	1,728,421	19	28	1,582,932	19	27
16. Miners .	1,688,497	15	15	1,878,706	17	17
17. Painters	181,413	11	12	181,375	11	12
18. Postal employees	466,005	19	29	475,304	19	29
19. Pottery workers	80,196	6	6	119,457	6	6
20. Public services	437,310	14	16	498,673	15	17
21. Stone workers	107,240	12	14	103,944	12	14
22. Textile workers	956,999	12	15	941,551	12	15
23. Tobacco workers	105,059	11	11	106,418	12	12
24. Transport workers	2,145,950	35	82	2,224,954	34	82
25. Typographers	184,036	22	22	180,467	22	22
26. Wood workers .	637,197	18	38	999,668	21	41
Total	13,021,754		567	13,322,062		578

In 1924 the I.F.T U. created an International Committee of trade union women which held its first meeting in November, 1925, and international conferences are held on questions specially affecting women workers.

The total affiliated membership of the I F T U is given in the appended table (p 389).

Communist Movement.—It is now necessary to turn to the Communist trade union movement which owes its origin to the Communist International The germ of this International is to be found in the Zimmerwald Conference of 1915 called by the Italian Socialist Party, and attended by Scandinavian, Dutch, Russian and other Socialists from Eastern Europe, and also by representatives of the pacifist sections of the French and German Socialist movements This Conference was inevitably an anti-war gathering, but when it re-assembled in the following year at Kienthal it was less pacifist than revolutionary It was in a sense the forerunner of the Third (Communist) International, and indeed at a Conference in 1917 definitely declared the need for a new International From this time onwards the Bolshevik Revolution provided an inspiration for revolutionary elements in most countries. The first Congress of the Communist International was held in March 1919, and was convened by the Russian Communists, the Hungarian Communists, the Norwegian Labour Party and smaller Communist groups. In the following year a second Congress met at Moscow and adopted a constitution The aim of the Moscow International is "to organise an armed struggle for the overthrow of the International Bourgeoisie and the establishment of an International Soviet Republic "

The Red International of Labour Unions (the R I L U.) was established at this second Congress, at which minority trade union representatives from various countries were present, when it was declared that "it is the duty of the working class to gather together all trade union organised forces with a powerful revolutionary class association, which, working shoulder to shoulder with the political organisation of the Communist International of the proletariat and in closest contact with this organisation, would be able to develop all its forces for the general victory of the social revolution, and the establishment of a world Soviet Republic " It was also laid down that the International Federation of Trade Unions "because of its programme and tactics" could not "secure the victory of the proletarian masses in all countries " The first R I L U congress was held in July, 1921, in Moscow, and has since continued its work in close association with the Communist International. Relations between the I F.T U and the R I L U have been hostile The British Trades Union Congress, however, endeavoured to bring about an understanding, though without success.

It is not easy to ascertain the real strength of the affiliated membership of the R I L U, but Losovsky, the secretary of the Red International, has analysed its membership as follows (*see* "The World's Trade Union Movement," 1925, pp. 244–5):—

"The Red International of Labour Unions has eight types of affiliated organisations —

1. National trade union centres embracing the whole trade union movement of their respective countries, such as Russia, with 6,400,000 trade union members; Bulgaria, 40,000, Greece, Egypt, 50,000; Persia, 20,000; Estonia, 25,000 and so on.

2. National trade union or regional revolutionary centres existing parallel with reformist centres and carrying on a struggle against them, our organisations being stronger than the reformist ones. Such are, France, with 480,000 members; Czechoslovakia, 300,000; Yugoslavia, 100,000; Java, 35,000 and so on

3. National trade union centres playing a small rôle in comparison with the reformist trade union movement of their respective countries as in Holland with 20,000 members; Belgium, 12,000; Germany, 150,000; the United States, 25,000, and so on.

4. National trade union centres identifying themselves with the principles of the R I.L U., but not affiliated thereto, as a result of the 'White Terror,' as is the case in Finland, 50,000; Rumania, 60,000; and so on.

5. Independent unions and unions which have been from time to time formed of expelled members not belonging to the national

Memberships of Constituent National Centres of the I.F.T.U. on December 31st, 1925 and 1926

National Centres	December 31, 1925				December 31, 1926				Increase or decrease of membership in %
	Men	Women	Total	Number of affiliated unions	Men	Women	Total	Number of affiliated unions	
1. Argentine	81,939	635	82,574	14	81,939	635	82,574[9]	14	
2. Austria	621,593	185,922	807,515	53	588,473	167,910	756,392	52	− 6·3
3. Belgium	525,456	26,638	552,094	27	496,062	55,798	551,860	25	
4. Bulgaria	.		14,803	16	2,200	300	2,500	11[4]	−83·1
5. Canada			106,412	68			103,037	68	− 3·2
6. Czechoslovakia	290,732	65,654	356,386	48	432,286	115,945	548,231	71	+53·8
7. Denmark	200,478	39,226	239,704	51	127,033	29,244	156,277	52	−34·8
8. France	.		605,250	36	[9]		605,250[9]	36	.
9. Germany A.D.G.B.	3,342,162	720,825	4,182,511[1]	40	3,181,879	627,451	3,933,931[7]	38	− 5·9
Germany A.F.A	319,551	80,304	399,855	14	311,121	76,988	388,109	14	− 2·9
10. Great Britain	3,903,173	462,446	4,365,619	206	3,784,455	379,539	4,163,994	203	− 4·6
11. Holland	178,794	10,892	189,686	26	185,066	11,248	196,314	27	+ 3 5
12. Hungary	109,278	15,746	125,024	38	108,819	17,441	126,260	40	+ 1·0
13. Italy		..	234,520	38	.	..	[6]		
14. Latvia	12,314	2,241	16,679[2]	17	12,007	3,811	15,818	17	− 5·2
15. Lithuania			.	.			18,486	9	
16. Luxemburg	13,292	106	13,398	12	14,058	121	14,179	12	+ 5·8
17. Memel Territory	1,152	249	1,401	5	943	221	1,164	5	−16·9
18 Palestine			18,663	28[5]		.	22,332	28[5]	+19·7
19. Poland	200,340	24,083	224,423	28	217,233	27,150	244,383	27	+ 8·9
20. Roumania	31,997	1,096	33,093	25			30,468	10	− 7·9
21. Spain			235,007	33			221,000	33	− 6·0
22 Sweden	349,749	34,868	384,617	34	376,703	38,156	414,859	35	+ 7·9
23. Switzerland	137,433	12,564	149,997	19	140,496	13,301	153,797	17	+ 2·5
24 South Africa							60,660	54[8]	
25. Yugoslavia	24,082	2,174	27,156	30	25,115	2,184	27,299	30	+ 0·5
Total	10,344,415	1,685,669	13,366,387[3]	906	10,085,888	1,567,452	12,839,174[10]	928	− 3·9

(1) Including 119,524 young workers, not mentioned under the heading "Men and Women" (2) Including 2,124 members not mentioned under the heading "Men and Women" (3) Including 1,336,303 members not mentioned under the heading "Men and Women" (4) Besides 10 local mixed unions (5) 28 different trades distributed over Tel-Aviv, Haifa, Jerusalem, Tiberias, Afuleh and Akko (6) Membership not to be given (7) Including 124,601 young workers not mentioned under the heading "Men and Women," and 80,216 members for whom affiliation fees were paid to the General German Civil Servants Federation. (8) 54 local unions. (9) Dec. 31, 1925. (10) Including 1,185,834 members not mentioned under the heading "Men and Women"

trade union centres of their respective countries

6. Minorities inside the reformist trade unions organised under the direct leadership of the Communist faction; Germany, Japan, Italy, Sweden, Denmark, etc.

7 Opposition blocs or minority movements co-ordinating the action of all left-wing elements both inside and outside the reformist and the Anarcho-Syndicalist unions of such countries as: the United States, Great Britain, Spain, Austria, the Argentine, Mexico and elsewhere.

8 Finally, there are the left-wing elements belonging to the unemployed committees (Great Britain), shops stewards committees, etc, generally supporting the R.I.L U. policy."

The Fourth Conference of the R I L U held in 1928 was attended by 421 delegates, representing 49 national groups, and according to the leaders of the R.I.L U., the affiliated membership is approximately 19 millions, comprised as follows —

U S S R.	10,200,000	United States	388,000
China	3,000,000	Czechoslovakia	210,000
Germany	1,000,000	Australia	120,000
Great Britain	700,000	Cuba	100,000
France	525,000	Poland	95,000
Mexico	93,000	Canada	10,000
Sweden	80,000	Latvia	9,000
Colombia	60,000	Japan	8,000
Chile	50,000	Argentina	7,000
Brazil	40,000	Mongolia	7,000
Norway	33,000	Hungary	5,000
Korea	30,000	Uruguay	4,500
Dutch East Indies	25,000	Portugal	4,000
Serb, Croat, Slovene		Estonia	3,000
Kingdom	21,000	Denmark	2,000
Peru	20,000	Venezuela	1,200
Italy	12,000	Guadeloupe	800

These figures include the membership of minority groups within trade unions which are affiliated to the I.F.T.U.

It will be seen that no national trade union body representing the whole of the organised workers of any country, apart from Russia and certain small countries where trade unionism is an ineffective force, has associated itself with the R I L U, and that outside Russia its chief support comes entirely from individual trade unions and minority groups, though Losovsky is at pains to point out that the figures of membership of the I F.T.U are swollen by the adherents of the R I L U

BIBLIOGRAPHY.—The International Federation of Trade Unions publishes Reports, a Year Book, and serial publications ("The International Trade Union Review" [Quarterly], and "The International Trade Union Movement" [Monthly]) It also publishes a series of volumes on trade unionism, *e g*, C Mesten's "The Trade Union Movement in Belgium" (1925). For the Communist side of the Movement, *see* A. Losovsky, "Trade Unions in Soviet Russia" (1920), and "The World's Trade Union Movement" (1925) Other special studies are S Sanders, "Trade Unions in Germany" (1916) and W P Ryan, "The Irish Labour Movement" (1920) The most important work, however, is the Report on "Freedom of Association" published by the International Labour Office Three volumes have appeared Vol I (1927), Comparative Analysis, Vol. II (1927), Great Britain, Irish Free State, France, Belgium, Luxemburg, the Netherlands, Switzerland, Vol. III (1928), Germany, Former Dual Monarchy of Austria-Hungary, Austria, Hungary, Czechoslovak Republic, Poland, Baltic States, Denmark, Norway, Sweden, Finland Each section contains a bibliography (A. GR)

TRADE WINDS, the name given to the regular north-easterly and south-easterly winds which blow from the tropical belts of high pressure towards the equatorial belt of low pressure. Their regularity, especially over the oceans, explains their name, the term "trade" being used in the otherwise obsolete sense of "course" (*cf.* "tread"). Their distribution may be considered broadly as being between 3° to 35° N, and from the equator to 28° S, but at any particular period their influence is felt over a narrower area on account of their seasonal swing into higher latitudes during the respective summer seasons of the two hemispheres. The best area for the study of these winds is the Atlantic ocean. (See *Met. Office Publication*, No. 203, also METEOROLOGY.)

TRAFALGAR (trah-făl-gahr′; popularly tră-făl′gar), **THE BATTLE OF.** The British naval victory over the French and Spanish fleets off Cape Trafalgar, on Oct. 21, 1805, was a sequel

to the breakdown of Napoleon's scheme for invading England, and an account of the movements leading up to it, known as the Trafalgar Campaign, will be found under the heading NAPOLEONIC CAMPAIGNS.

Admiral Villeneuve, returning from the West Indies, succeeded in making the port of Ferrol; thence he should have sailed for the Channel and effected a junction with the Brest fleet, but, judging that Napoleon's schemes were already defeated, he made for Cadiz instead Nelson, after his arrival at Gibraltar from the West Indies, had fallen back on the English Channel fleet, but Collingwood was watching Cadiz with three ships. On Villeneuve's arrival, he retreated slowly towards the Straits, and the French pursued him; but they had no wish to be drawn into the Mediterranean, and after a time retreated to Cadiz, and Collingwood was able to resume his station; he was joined at the end of August by reinforcements amounting to 22 ships. The importance of defeating or effectively blockading this allied force which now numbered 33—15 of them Spaniards—was fully realised by the Admiralty, and in September they decided to send Nelson to take command of the blockading force

Nelson in Command at Cadiz.—Nelson left Portsmouth on Sept. 15 with three sail of the line, arriving off Cadiz on the 29th of the same month—his forty-seventh birthday. He had sent ahead a frigate to forbid any hoisting of colours or firing of guns, in order not to draw the attention of the Allies to the arrival of British reinforcements But the unofficial welcome he received was such as to put heart into any commander of a fleet. During the first fortnight of October he was reinforced by a further six ships, so that his strength was at one time 34, but at the time the battle was actually fought he had only 27 ships at his disposal, six had been sent to Gibraltar to revictual, and Admiral Calder, who was going home to face court-martial for his unsatisfactory action off Finisterre, was magnanimously allowed to return in his flagship. Nelson did not keep the bulk of his fleet close to Cadiz; only the frigates were inshore, most of the ships being some 30 to 40 miles to sea, connection being maintained by a line of signal ships.

Villeneuve Ordered to Mediterranean.—Nelson's first task was to induce Villeneuve to put to sea, and this was performed for him by Napoleon himself A new coalition of European powers had just been formed against Imperial France, and Napoleon, unable to use his troops against England owing to the breakdown of his schemes, had marched them against Austria He thus required naval support in the Mediterranean, and Villeneuve was ordered to leave Cadiz and enter that sea, furthermore, should he encounter an enemy fleet to which he was not inferior, he was not to hesitate to attack them These commands reached the French Admiral at the end of September. He knew, however, that they could never be acted on successfully, and a council of war held at the beginning of October decided that, though a sortie might be possible, to give battle to the British fleet would be suicidal At this time, too, it appears that the Allies were under-estimating the strength of the British Later in the month Villeneuve heard that Napoleon was sending Admiral Rosily to supersede him This he regarded as a reflection on his honour, and he decided to put to sea before his successor arrived He did not intend to give battle to Nelson if he could get into the Mediterranean without doing so, but he fully realised that he would probably be forced into action; and he thought that, in such a case, Nelson's probable plan would be to obtain local superiority over part of his fleet. To guard against this he formed a reserve squadron of 12 ships under the Spanish Admiral Gravina, which was to keep to windward of the rest of the fleet, and thus be able to come to the assistance of any part of it that was in difficulties.

Nelson's Battle Orders.—Nelson had also drawn up orders for the guidance of his officers, and had explained to them how he intended to fight the battle His instructions are embodied in the "Nelson Memorandum," which was drawn up at a time when he expected to have a larger force than 27. None the less the principles it contained are applicable with equal force to a smaller fleet. They were that the attack was to be made in two bodies; the larger, under Collingwood, was to obtain local superiority over the enemy's rear, while Nelson, with the smaller body, was to preserve him from the interference of the van and centre, should they attempt to go about to the assistance of the rear, as they normally would. On the day of battle Collingwood's squadron consisted of 15 ships and Nelson's of 12.

Villeneuve Puts to Sea.—It was on Saturday, Oct. 19, that the first of the Allies got to sea. Nelson knew of their movements immediately, and made sail for the south-east so as to cut them off from passing through the Straits. Only part of the allied fleet got to sea on the Saturday, and on Sunday the 20th the weather was so bad that they returned to the neighbourhood of Cadiz. Nelson, throughout, kept his main fleet out of sight, but followed them, move for move, receiving all the information on which he based his decisions from his frigates. Monday the 21st was a fine day, the wind was light and blowing from the north-west, and at dawn the two fleets were in sight of one another The Allies were sailing south, making for the Straits again, and the British were some 12 miles to the west of them Nelson at once ordered his fleet to form two lines of sailing, in accordance with his plan outlined above His own squadron was the more northerly of the two, and each admiral was leading his own squadron, Nelson in the *Victory*, and Collingwood in the *Royal Sovereign* In this formation, they approached the allied fleet, and as they came more clearly into view, Villeneuve, for the first time, saw that he had underestimated their strength He at once sacrificed the originality of his dispositions by ordering Gravina, with the reserve squadron, to come into the line, and, shortly afterwards, partly with a view to keeping Cadiz open as a refuge on his lee, and partly to counter what he thought was designed as an attack on his rear as he was sailing south, he ordered his whole fleet to wear and sail roughly north

Collingwood's Attack.—Villeneuve's order to his fleet to wear was made about 8 o'clock, and it was not properly finished when Collingwood, who was to initiate the attack, ordered his squadron to change its formation from an irregular line ahead to an irregular line of bearing This was about 8 50, some two hours after Nelson had first ordered the advance Collingwood's object was to bring his force into a line as nearly parallel as possible with the part of the enemy line that he was to engage, and the concavity in their line was such that this manoeuvre would virtually produce that result Nelson had given his second-in-command a free hand in deciding how to carry his line into battle, so that the credit for this movement, admirably suited as it was to the circumstances and designed to enable the British ships to use their broadsides as they got into action, must be given to Collingwood For the rest, he carried out brilliantly the part assigned to him—namely to break through the enemy and engage the rear 12 ships. His own vessel, the *Royal Sovereign*, being a very fast sailer, was in close action just after 12 o'clock, and to her fell the duty of selecting the gap which would enable him to cut off 12 ships. Actually he cut off 15 and became engaged with 16

Nelson's Attack.—It now remains to consider the movements of Nelson's line The commander-in-chief it will be remembered had kept for himself the duty of preserving Collingwood from any interference from the allied centre or van. For this purpose he continued his advance in the order he had first assumed, that is to say, irregular line ahead With the object he had before him, he naturally wished to disguise the point at which his attack was finally to be directed, and line ahead was the most flexible and easily-managed formation he could adopt It had the drawback of exposing the head of the line, as it approached, to the concentrated fire of the enemy, but Nelson was prepared to regard this as a justifiable risk in view of the advantage of flexibility which the formation conferred, and which was peculiarly valuable in the particular circumstances The event proved him right. He began by aiming at the van rather than the centre of the allies, whose leading ships, nervous of having their T crossed, crowded on sail to prevent this manoeuvre being executed, thus taking themselves further from that part of their line which was now being attacked by Colling-

wood, and which Nelson did not intend should be assisted by them. Indeed, the whole of the allied van and centre, mystified by Nelson's movements and uncertain of his aims, could do nothing but wait for him to declare his intentions, while they left the rear to look after itself. Nelson was himself leading his line, and as the *Victory* approached the allied van, he turned to starboard, followed in succession by the ships in his squadron and sailed down the allied line, looking for a suitable place at which to break through. This turn enabled him to open fire, but he preferred to hold it. Finally he found a gap astern of the *Bucentaure*, twelfth ship in the line and Villeneuve's flagship, and, passing through, he opened fire, raking the ships on either side with terrible effect. The majority of his line deployed to starboard and broke through the Allies at various places between the points pierced by Nelson and Collingwood, but two more ships ahead of the *Bucentaure* were engaged, the leading ten ships finally being left without attention Six of these, under Dumanoir, at length made some attempt to go about to the help of those behind them, but their arrival was too late to be of any use, and they made off; for, in the meantime, Nelson's 12 had been matched with 7, with the inevitable result. By this time, too, victory had declared itself for Collingwood, who had been left without interference, as Nelson had designed, to complete the destruction of the rear

Completeness of the Victory.—In all, 20 prizes were taken—about 60% of the allied fleet A larger percentage was taken or destroyed at the Nile, but the comparison is not a sound one, for at the latter battle the enemy were caught in a confined space At Trafalgar they had plenty of room to manoeuvre and a friendly port on their lee; yet they could not escape, such was the paralysing effect of Nelson's tactics—an inspired mixture of the traditional and original. Nelson had solved a problem that had puzzled British admirals for a century—namely, how to prevent the French making off while most of their fleet was still more or less intact. For this reason Trafalgar is regarded as the greatest of naval battles, and Nelson as the greatest of Admirals.

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TRAFFIC AND TRAFFIC REGULATIONS. Throughout the civilized world the countryman is being irresistibly drawn towards the great cities, which spread outwards, ring by ring, over the open fields, while the ancient core of the city on which millions of workers now converge retains the shape imprinted on it in mediaeval times when a small compact area amply sufficed

IN GREAT BRITAIN

London.—Although the difficulties thus created are by no means restricted to Greater London, where the population had risen from 7¼ millions in 1911 to 7¾ millions in 1925, yet it is probably within this area that the typical problems present themselves in the most aggravated form In 1923 the registrar-general published, for the first time, a report on the work-places of residents in London and the five home counties. The preface reminds us that in a less highly organized and industrialized society localities may be self-sufficient, every residential group being supplied with its needs by members of the same groups in their working capacity Such conditions were due to the dispersion of necessary service and production, which in the absence of transport facilities had to be located in proximity to the population served The subsequent development of transport and communications fostered a concentration which has changed the whole face of industry.

To gauge the magnitude of the traffic problem the following data may be of service. In 1912 a census was taken of vehicles of all classes passing 39 of the more congested points in London between the hours of 8 A.M. and 8 P.M. on a selected day The total reached was 825,445. In 1927 a count taken at the same 39 points gave a total of 1,139,434, an increase of 38%. The outstanding feature on the London streets is the motor-omnibus, of which in 1913 the number licensed was 3,664 In July 1927 the number of motor-omnibuses scheduled for regular operation in the Metropolitan Police District was 4,709. In 1913 the passengers carried by omnibuses numbered 736,000,000; in 1924, 1,485,000,000; while in 1926 a total of 1,700,000,000 was computed to have been reached. The important part played by the London County Council's tramways can be estimated from the statement that their tramcars carry more than 1,000,000 passengers during the six busiest hours of the day. On the Victoria Embankment 400 tramcars pass every hour.

Expressed in millions the numbers of passengers carried by the various forms of transport in London have been estimated as follows —

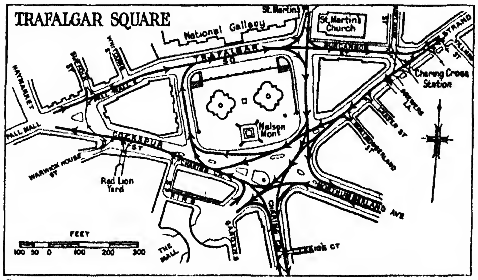
Year	Suburban trunk railways (estimated)	Underground	Tramways	Omnibuses	Total
1913	450	298	812	736	2,296
1919	505	480	1,064	861	2,910
1923	488	367	1,001	1,214	3,070
1924	474	369	983	1,485	3,311
1925	.	289	984	1,687	2,960
1926		281	965	1,700	2,946
1927	478	315	1,011	1,842	3,646

In 1927 a grand total of 3,646,000,000 was reached The increase in the volume of traffic is out of all proportion to the growth of population A principal factor in the increase of congestion on the streets is the growth and spread of the travel habit. It has been estimated that whereas in 1900 every Londoner, man, woman and child, travelled 158 times a year, that figure had risen in 1925 to 460 The burden thus thrown upon the transport agencies is even greater than these figures would indicate, owing to the fact that the "peak" periods of the day are now more compressed

Remedies.—The remedies for traffic congestion on the streets are easier to enumerate than to apply First and foremost, all wanton obstruction should be removed; fountains, clock-towers, refuges, obelisks, horse-troughs and such like structures erected in the leisurely days of an earlier century must justify their existence in the light of changed circumstances Street traders and stalls must be relegated to side streets, slow and heavy vehicles must be prohibited from using, during the busy hours of the day, certain routes in which rapid movement is indispensable; the position of the great markets must be reconsidered in order that the streams of ponderous traffic to which they give rise may not choke all-important adjacent arteries By extending railway sidings into markets, now served by road, much of the congestion on the latter might be relieved The provision of adequate parking places or stances will prevent the wasteful occupation of valuable space in busy thoroughfares by stationary vehicles Within the London Traffic Area it is probable that upwards of eighty parking places will eventually be in use under regulations made by the Minister of Transport.

Parallel Routes.—A useful purpose may be served by the judicious sign-posting of parallel routes, so that inexperienced drivers may be induced to leave the overcrowded roads and make use of less familiar thoroughfares A glance at the map of our great cities will show how many such alternatives are already available and how many more might be rendered feasible by the demolition of a few buildings which interrupt the continuity of a line of streets In many instances greater advantage would accrue from the completion of an alternative route by the acquisition of such obstructive buildings than from the customary widening at enormous cost of the principal thoroughfare by the demolition of one entire frontage. Two roads are better than one, seeing that an accident may at any time have the effect of closing a single thoroughfare, however wide. Unavoidable traffic stoppages due to road repairs can be shortened in many cases by the use of quick-setting cements and the introduction of pneumatic

tools for breaking up old foundations. In the busiest thoroughfares repairs should proceed uninterruptedly day and night. Co-ordination between adjoining highway authorities would prevent the annoyance of parallel routes being simultaneously closed for repair The extreme need of some co-ordinating body for London led to the creation in 1924 of the London and Home Counties Traffic Advisory Committee, which reports to the Minister of Transport upon all matters affecting transit in that populous area.



PLAN OF TRAFALGAR SQUARE, LONDON, SHOWING SYSTEM OF "ROUNDABOUT" TRAFFIC INTRODUCED TO RELIEVE CONGESTION

High-level Roads.—To relieve the congestion at the ground-level of great cities the construction of high-level roads may before long be forced upon civic authorities

Single-way Traffic.—Narrow streets which are so situated as to form useful lines of communication can often be advantageously utilized as single-way routes, a practice which has been widely adopted in Paris, where no less than 105 streets are reserved for one-way traffic In London this restriction has been applied to 45 streets Obviously the facilities for establishing alternative routes and single-way routes are greatest in cities which have been methodically laid out on a fairly rectangular plan In cities of haphazard growth more formidable difficulties arise. The delay inflicted upon traffic at busy cross roads can be eliminated by the enforcement of gyratory movement in the rare cases where space permits, or by the construction of a bridge or tunnel enabling one stream of traffic to pass over the other—a device that is only rendered feasible by a convenient configuration of the ground The ample dimensions of the "places" of Paris have enabled gyratory movement to be instituted at 19 traffic centres, whereas in London the experiment was tried in Jan 1926, for the first time, in Aldwych and Parliament Square where its success has led to its extension to 10 other traffic centres (*See* figure illustrating the arrangement prescribed for Trafalgar Square) At 14 important road intersections where space for gyratory movement is lacking the regulation is imposed that vehicles shall not turn to the right By this means the steady flow of traffic is promoted

White lines formed by metal plates sunk into the pavement or by similar devices play an invaluable part in directing traffic into its proper channels The acceleration of vehicular traffic due to the adoption of these various methods of control renders it necessary to indicate special crossing places for pedestrians In great cities the construction of subways or bridges for foot-passengers is likely to be increasingly favoured where funds permit

Traffic Signs.—An experimental installation of light signals was brought into use in London at the junction of St. James's Street and Piccadilly in 1926 These signals, eight in number, are electrically operated from a central control at the junction of the two streets They are of the three-aspect colour-light type, fitted with red, amber, and green lenses, with the necessary transformers, and are mounted on tubular steel posts on cast iron bases. Five of the signals are fitted with a small lens which serves as an indication to the constable on point duty that the signal is showing red The central control cabin is equipped with an illuminated diagram which repeats all signal aspects and with a miniature frame of eight levers, space being provided for the addition of a king lever, if necessary Each of the levers has three positions—normal, mid-stroke and reverse—providing red, amber and green indications, respectively.

Circumferential Roads.—Whatever efforts may be made to take full advantage of the roads already in use, the vast increase in vehicular traffic will in most of our growing cities call for the provision of additional thoroughfares While the radial roads may be tolerably adequate it will usually be found that suitable circumferential roads are wanting, save in the case of towns whose fortifications have given place to a ring road Relief to the congested centre of a city can often be most readily afforded by the building of circular roads which enable traffic to pass round the outskirts. By suitable regulations it should then be possible to limit the passage through the crowded centre to vehicles whose business legitimately requires their presence there. Little hardship is inflicted upon drivers who are relegated to the circular road, seeing that, although their journey may be longer, the time occupied is less, owing to the absence of congestion. As a good example of this type of route may be cited the circular road, 26 m. long, round the north of London

Co-ordination.—At the root of the traffic problem in great centres of population lies the difficulty that the present local government boundaries usually have no relation whatever to the wider traffic region upon which the welfare, the work and the very existence of the city depend. Concerted action for the common good is defeated by the multiplicity and divergent interests of the small administrative units which encircle the city In the aggregate the resources of the greater community forming the traffic region are amply sufficient to provide the remedies which are admitted to be necessary, but the application of these resources to the desired purpose is difficult in the absence of some public body empowered to determine the best means of promoting improvement schemes and to apportion the cost over the traffic region which ultimately benefits Until this power of apportionment can be exercised there are insurmountable obstacles to the execution of vital improvements in poverty-stricken administrative areas, where local conditions often generate traffic delays reacting injuriously upon the whole traffic region An authority exercising control over such a traffic region would naturally be charged with the duty of co-ordinating the different traffic agencies and means of transit, so as to eliminate wasteful competition and the congestion to which it gives rise Certain routes would be reserved for trams or trolley vehicles, others for motor-buses, others for underground railways The number of vehicles plying on various routes would be restricted to the needs of the travelling public instead of being dependent upon the varying fortunes of the struggle between rival undertakings It is indeed questionable how much longer the interests of the citizen can tolerate the use of the public highway as the arena for unrestricted traffic-competition The London and Home Counties Traffic Advisory Committee in their report for 1926–27 reiterate their view "that the co-ordination of passenger transport services with a common fund and common management with the elimination of unnecessary, wasteful and uneconomic competition is essential before any substantial improvements in travelling facilities can be effected "

The need for additional resources is acutely felt by congested suburban railways constructed in the days of steam traction Electrification of such lines is often the only means of increasing their carrying capacity and great activity prevails in the application of this remedy. As an instance may be quoted the electrification of the London suburban lines of the Southern Railway, involving the conversion of 650 m of track, at a cost of nearly £8,000,000. The traffic flow of a railway being governed in large measure by its terminal capacity, the aim must be to enable the largest number of trains to enter and leave the terminal It has been claimed that thanks to electrification the capacity of terminals can be increased by 150% so that five trains would run where two ran formerly (*see* RAILWAYS. *Electrification*).

Future Developments.—Casting a prophetic glance forward one can discern certain directions in which the development of civic, social and industrial life may be fundamentally affected

by the pressure of the traffic problem There is already a tendency towards the creation of self-contained satellite towns of moderate size where the citizen can live within an easy walk of his work and yet within sight of the green fields Such development will be fostered by the North Orbital Road which is being planned to sweep in a curve 75 miles long through the counties of Essex, Hertfordshire and Buckinghamshire, at a distance of about 20 miles from Charing Cross. The administrative centres of capital cities can be relieved by moving to the open outskirts of towns certain offices and departments which do not require an absolutely central position As open spaces in central districts become rarer and rarer we may see legislation promoted to safeguard such squares and gardens as have escaped the builder

It is conceivable that the high rental value of office accommodation in the heart of great cities and the increasing closeness of business contact between countries of every latitude may lead to the continuous use of offices throughout the day and night, with the result that the volume of passenger traffic to and from the suburbs would be better distributed It is perhaps significant that several London restaurants should remain open throughout the 24 hours A time may indeed be in sight when the problem of transport will be the dominating influence in moulding the life of the citizen in every highly developed industrial community

(H My)

THE UNITED STATES

The increase in numbers of motor cars has created very serious traffic problems that demand drastic treatment for their solution. They attain their maximum of seriousness in cities, where owing to the narrow thoroughfares, variable speeds and necessity for frequent and long stops, the resulting congestion has already reached a point where traffic movement is greatly hindered This condition is found at present most emphasized in American cities on account of the vastly larger number of automobiles in proportion to population than is found in other countries Taking the two largest American cities as examples of congestion the following table of motor car registration shows how rapid has been the growth, and how much more rapid than the corresponding increase in population

New York				
Type of vehicle	1915	1920	1925	1927
Passenger	59,850	152,036	365,894	464,180
Commercial	12,148	83,746	114,022	148,363
Total	71,998	235,782	479,916	612,543
Population (in millions)	4 3	5·0	5 00	6
Cars per 1,000	17	47	81	102
Chicago				
Passenger	36,419	86,709	290,956	388,622
Commercial	7,384	22,900	48,262	54,194
Total	43,803	109,609	339,218	442,816
Population (in millions)	1·9	2·4	3·0	3·1
Cars per 1,000	23	50	113	127

Traffic Towers.—In 1918 the congestion on Fifth Avenue, the busiest thoroughfare in New York, had become so great that some means, other than traffic policemen stationed at intervals, were seen to be necessary if a reasonable speed of movement was to be maintained The local situation of Fifth avenue was peculiarly difficult as the nearest parallel street is 920 ft. distant on one side and 420 ft. on the other, thereby forbidding any large diversion of vehicles In that year there was erected a series of signal towers placed in the centre of the street with red, green and white lights operated by hand at each tower, the several operators turning the lights to correspond with those at 42nd street. The towers were taken down in 1929, as occupying too much space

The controlling of vehicular traffic by a system of mechanical signals was extended in New York and has since been adopted with various modifications by every city in the United States and on a growing scale in other countries. As installations were erected and large areas of cities were put under control, traffic engineers found that there were at least three methods under which automatic signals could be operated, (1) the isolated clock, (2) the synchronous and (3) the progressive systems

In the synchronous system all signal colours are changed simultaneously and are the same in a given direction, that is, green or clear lights are shown permitting all north and south traffic to move throughout the controlled area while the red or stop signal is set against the cross, or east and west movement. Then after a fixed interval, the signals and the corresponding traffic movements are reversed The synchronous system is simple in installation and is used in the great majority of cities

The progressive operation undertakes to keep all traffic moving continuously in all directions To accomplish this the street to be controlled is divided into blocks of approximately equal lengths which may be the ordinary city blocks or arbitrary traffic blocks comprising several city blocks according to the intervals between cross streets Instead of having all signals in one street change to the same colour at the same instant as in synchronous operation, in the progressive they alternate That is, when a green light is seen at the beginning of one traffic block a red is shown at the next The block lengths and signal time intervals are so fixed that a driver proceeding at any predetermined speed which is usually set at from 15 to 20 m per hour, will find the next signal turn green giving a clear way as he reaches it

The progressive system can be successfully operated only when the longitudinal and cross timing intervals are equal and it works best on wide thoroughfares with long traffic blocks Narrow streets, particularly those with only one lane of moving vehicles, do not respond well, since the entering of parked cars into the moving lane or other similar irregularities are apt to throw the traffic out of running schedule Under this system all signals are connected to the same set of bus wires and are operated simultaneously. Control apparatus is the same for the progressive and synchronous systems

To obviate some of the disadvantages of the progressive system the flexible progressive or co-ordinated system has been devised, in which the clear signals can be given at irregular intervals on both the through and cross streets and so permit a variation in length of traffic blocks according to relative densities of traffic. Mechanically this system is the most expensive to install and the most complicated in operation A separate electric cable must be run from each intersection to the central station and the signals at each intersection be turned by its individual timing switch. No general rule can be laid down to govern all cities There are many factors that must be taken into consideration among which the following may be mentioned total volume of traffic, relative density of travel in the two directions, widths of streets, street intervals, character of traffic, presence of tramways and control of extraneous retarding causes.

In March 1929 a centralized system installed at one point was put in operation in the city of New York It controlled all of the traffic lights in the center of the city by means of seven machines, one for each of the principal north and south avenues With the addition of about six more it was planned that all of the lights in the island of Manhattan would be controlled One of these machines could do all the work; however flexibility is obtained by the use of one for every avenue Each machine consists of a synchronous motor driving gears and cams making the necessary contacts to operate the relays that in turn control the switches in the circuits to the lamps The cycle of operation adopted is 3 minutes, 115 seconds for north and south movement of traffic, 55 seconds for east and west traffic with two 5 second dark intervals To change the cycle it is only required to replace the motor For any cycle, however, the time interval of red or green light and of darkness can be adjusted at will

Interference with Traffic Flow.—The most important of the last class are left hand turns (in America all traffic is right hand), presence of horse-drawn vehicles and parking Of these the first two are serious interferences with a continuous or progressive flow. A left hand turn involves the crossing of the opposite traffic lane, while the slow speed of horses and heavy trucks will

defeat, unless there be plenty of passing space, a general platoon or group movement at an established speed that approximates one as great as 15 m. per hour. In some cities left hand turns in congested districts are forbidden, but this can be done conveniently only when there are parallel streets sufficiently near so as not to involve too great a loss of time for the diverted vehicles.

Parking.—Parking, however, presents a great problem because it is opposed and supported equally strongly by opponents and proponents. To forbid parking is opposed by some merchants who fear that their customers would be driven away if they were prevented from standing their cars in the street while actually shopping Unless streets be widened at great expense, or some heroic remedy adopted, it is evident that free parking must be radically limited. Already in some cities a time limit is set in many streets, while in very busy streets it is expressly forbidden during hours of maximum congestion to stop a car except to deposit or pick up passengers.

One-way Rules.—The regulation of traffic and the need for full facilities to keep it moving has led to the adoption of one-way traffic. This has worked well and will be more widely introduced as the problem becomes more acute. The installation of traffic signals was expected to reduce the number of policemen engaged in traffic regulation The pressure has however increased more rapidly than the relief so that the demand for men is steadily growing. In New York 581 policemen were so detailed in 1907, 775 in 1917 and 2,511 in 1927 (W. B. PA)

TRAHERNE, THOMAS (1637?–1674), English writer, was, according to Anthony à Wood, a "shoemaker's son of Hereford." He entered Brasenose college, Oxford, in 1652, and after receiving his degree in 1656 took holy orders. In the following year he was appointed rector of Credenhill, near Hereford, and in 1661 received his M.A. degree. He found a good patron in Sir Orlando Bridgeman, lord keeper of the seals from 1667 to 1672 Traherne became his domestic chaplain and also "minister" of Teddington He died at Bridgeman's house at Teddington on or about Sept. 27, 1674. He led, we are told, a simple and devout life and was well read in primitive antiquity and the fathers. His prose works are *Roman Forgeries* (1673), *Christian Ethics* (1675), and *A Serious and Patheticall Contemplation of the Mercies of God* (1699). His poems have a curious history. They were left in ms and presumably passed with the rest of his library into the hands of his brother Philip They then became apparently the possession of the Skipps of Ledbury, Herefordshire.

In 1896 or 1897 they were discovered by W T. Brooke in a street bookstall. Dr Grosart bought them, and proposed to include them in his edition of the works of Henry Vaughan, to whom he was disposed to assign them He left this task uncompleted, and Bertram Dobell (*q.v*), who eventually secured the mss., was able to establish the authorship of Thomas Traherne. The discovery included, beside the poems, four complete "Centuries of Meditation," short paragraphs embodying reflections on religion and morals. Some of these, evidently autobiographical in character, describe a childhood from which the "glory and the dream" was slow to depart The poems on childhood may well have been inspired by Vaughan's lines entitled *The Retreat.* His poetry is essentially metaphysical and his workmanship is uneven, but the collection contains passages of great beauty.

See Bertram Dobell's editions of the *Poetical Works* (1906), and the *Centuries of Meditation* (1908 and 1927); H I. Bell's edition of the *Poems of Felicity* (Oxford, 1910); and G E. Willett, *Traherne: an essay* (Cambridge, 1919).

TRAILL, HENRY DUFF (1842–1900), British author and journalist, was born at Blackheath, London, on Aug 14, 1842, and died in London on Feb 21, 1900. Traill was one of the best known journalists of his day; he was connected with the *Pall Mall Gazette,* the *Saturday Review,* and other papers, and was the first editor of *Literature.* He wrote some important biographical and critical studies, and in 1893–97 directed the production of a vast work on *Social England.* But he is now remembered for his witty parodies and *jeu d'esprit.* His best known work is *The New Lucian* (1884; new and enl. ed., 1900) Traill also wrote one or two plays Nellie Farren made a noteworthy success in his *Glaucus, a Tale of a Fish* at the Olympic theatre in 1865. In collaboration with Robert Hichens he wrote *The Medicine Man,* which was produced in 1898 at the Lyceum.

TRAIN BANDS. In the early part of the 17th century the commissions of musters directed the county officials to muster all persons liable for service and organize them into bands for training. The bands so organized became known as trained bands or train bands, a phrase which by the end of Charles I.'s reign was superseded by the term militia

TRAINING CAMPS. A movement for the military training of youth in the United States through the means of summer camps conducted under the supervision of regular army officers was inaugurated by Maj-Gen. Leonard Wood in the summer of 1913. Two camps, at Gettysburg, Pa., and at Monterey, Calif., were attended by 244 men, most of them college students. The following year (1914) camps were established at Fort Ethan Allen, Burlington, Vt.; Asheville, N.C; Ludington, Mich.; and Monterey, California. The total number in the different camps was 667. These aroused a gradually growing interest, reinforced by considerations growing out of the outbreak of the World War, and the Department of War determined that four such camps should be established during the summer of 1915, at Chickamauga Park, Ga.; Plattsburg, NY. (three camps); Ludington, Mich; and at the Presidio, San Francisco, California. The total number of men who passed through the camps during this year was 3,406. The camps were no longer limited to students from colleges and high schools, but were open to men from all walks of life who had the necessary physical qualifications and showed sound qualities of leadership. As Plattsburg was the largest training centre, the camps, wherever held, began to be called "Plattsburg Camps" In 1916 a series of four camps, each for a month, was held at Plattsburg, NY; a camp of one month's duration for boys at Fort Terry, NY; a series of six camps of two weeks' intensive training at Wadsworth, N.Y., for the police of New York city; and a series of three camps, each for a month, at Oglethorpe, Georgia. Over 16,000 men were passed through the camps. In 1917, applicants for the camps numbered 130,000, and had the United States not gone into the War in the spring well over 100,000 men would have been trained in these volunteer training camps. During the winters of 1915–6 and 1916–7 courses were opened in Boston, New York, Providence, Detroit, Pittsburgh, Philadelphia, and other cities for the instruction and examination of applicants for reserve commissions, and through them were developed a large number of officers who played a vital part in the training of the great War levies.

When the United States entered the World War these hastily but intensively trained, enthusiastic men were invaluable. They formed the nucleus of civilian officers with which to begin the great work of developing 200,000 officers, and added a valuable and indispensable force to the scanty number of regular officers and national guard officers available for the training of men. In the spring of 1917 the Federal Government took over the whole task and established a series of camps for the training of officers for the War. The Secretary of War directed the establishment of 16 Citizens' Training Camps at the following points: Plattsburg Barracks, N.Y. (two camps); Madison Barracks, NY.; Fort Niagara, NY.; Fort Myer, Va.; Fort Oglethorpe, Ga; Fort McPherson, Ga.; Fort Benjamin Harrison, Ind. (two camps); Fort Sheridan, Ill. (two camps); Fort Logan H. Roots, Ark.; Fort Snelling, Minn.; Fort Riley, Kans.; Leon Springs, Tex.; Presidio of San Francisco, California. The training camps for officers were ordered to be ready for the reception of reserve officers about May 8, for candidates for commission May 14, and the course of instruction was to begin on May 15 1917. The minimum age for attendance was 20 years and nine months; the maximum age, 44 years. In addition to the foregoing, General Order 119, War Department 1917, established a training camp at Fort Winfield Scott, Calif, for the training of members of the coast artillery section of the Officers' Reserve Corps residing within the territorial limits of the western department, and a similar camp at Fort Monroe, Va., for the balance of the coast artillery reserve corps officers. These training camps began opera-

tion on Sept. 22, 1917. A medical officers' training camp was also established in 1917 at Camp Greenleaf, Fort Oglethorpe, Georgia. Other camps for officers were established at the headquarters of the various divisions, the courses being essentially the same as those at the former officers' camps. The period allotted for the development of an officer at the government training camps was three months. The work was intensive and hard. It was an attempt, in the rush and confusion of war, to produce officers in the minimum period of time. The purpose was to turn out the largest possible number of platoon leaders and a limited number of company commanders and officers of field grade. The same general plan was carried out at the training camps for officers in the quartermaster corps, medical corps and other staff corps. The courses turned out many tens of thousands of officers with elementary training supplemented later by work with the divisional organisations to which they were assigned.

Congress, recognizing the value of the training camps established prior to and during the World War, provided in its 1920 revision of the National Defence Act for their retention. In 1921 ten Citizens' Military Training camps were held and 10,000 men were given training. Since 1921 camps held annually have been increasing in numbers and in attendance; in 1928 approximately 50 camps were conducted in the United States and Porto Rico at which about 35,000 men were enrolled The type of training given in the post-war camps differs materially, however, from that given in previous camps The present camps are attended by younger men and the courses conducted emphasize equally citizenship training, military training and physical development. While the minimum age for attendance is 17 years and the maximum 31 years, the majority attending are under 21 years of age The Government bears all the expenses of attendance and instruction. The complete course extends over a period of four years, occupying one month each year Graduation from the complete course is a material step towards a commission in the Officers' Reserve Corps.

TRAINING CORPS, OFFICERS'. The creation of the Officers' Training Corps (Junior and Senior divisions) dates from 1908. Its aim was twofold: (1) to provide students at schools and universities with a standardized measure of elementary military training to enable them eventually to become special reserve or territorial officers, (2) to create a potential reserve of junior officers to meet a national emergency.

The Junior Division is composed of boys of 13 years of age and upwards in public secondary schools and is officered by the masters in those schools. The former incur no military obligation when they leave school, but the latter as they are commissioned officers of the Territorial Army are under the same obligations and enjoy the same privileges as other officers of that Army. Though equipment is supplied from army funds and training is supervised by the War Office, each contingent is definitely under the control of the school authorities by whom the training is highly valued as a means of character building. The cadets are prepared for the written and practical examination for "Certificate A," which qualifies for a commission in the territorial army or special reserve. In Nov. 1928 out of 3,450 candidates, 2,803 obtained the certificate.

In 1909, the Junior Division comprised 123 contingents containing 311 officers and 13,814 cadets. By 1928 there were 171 contingents with 618 officers and 34,805 cadets. (Two new ones just recognized are not included)

Grants are paid by the War Office in respect of efficient cadets and for holders of "Certificate A" taking commissions in the Territorial Army, but parents bear 50% to 90% of the total expenses. There are 173 contingents of the Junior Division and 176 contingents on the waiting list, belonging largely to the schools which have Cadet Corps The latter are under the control of the County Territorial Associations and, except for a very small grant per head, have to find the whole cost of the training and equipment of both the cadets and the officers.

The Senior Division contains 20 university contingents consisting of 177 officers and 4,469 cadets. The cadets are prepared for "Certificate A" and for "Certificate B," the latter certificate carrying certain privileges in connection with candidates for commissions in the Regular and Territorial armies. In May 1928 111 candidates entered for "Certificate B" and 105 were successful. The contingents include cavalry, artillery, medical, surveying, sound ranging, engineers, signal, veterinary, infantry, air units, etc., whereas the Junior contingents are, with the exception of 3 engineering units, all infantry.

To qualify for grant a cadet in the Senior Division must do the requisite number of drills and the musketry course, and attend camp for 10 days. Cadets are eligible by nomination for commissions in the Regular Army, Territorial Force, Reserve of Officers and for regular and short service commissions in the Royal Air Force They thus furnish a valuable source of supply of officers for the Territorial Army—which needs 1,600 new officers each year—for the Special Reserve, and for the Regular Army, whose needs are not fully met by the Royal Military College and the Royal Military Academy During the World War no less than 35,000 officers were supplied by the Officers' Training Corps. (F. R H.-J.)

TRAJAN (Marcus Ulpius Traianus) (A D. 53–117), Roman emperor, was born at Italica, in Spain, on Sept 18, 53. The family to which he belonged was probably Italian by blood. His father began as a common legionary soldier. and fought his way up to the consulship and the governorship of Asia The younger Trajan was a soldier born and bred

For ten years he was a military tribune, serving all over the empire; then he held important posts in Syria and Spain. By 89 he had a considerable military reputation In that year he was ordered from Further Spain to the Rhine to deal with the revolt of Saturninus. He covered the distance very quickly, but the rebellion had been crushed before his arrival He was consul in 91. Nerva on his accession made him consular legate of Upper Germany, and on the advice of L Licinius Sura adopted him as his son and successor on Oct 27, 97. The senate confirmed the choice and acknowledged him as the successor Trajan at the time was in Germany Shortly afterwards, at Cologne, he received news of the emperor's death (Jan 25, 98). Trajan's authority was at once acknowledged all over the empire He gave the senate an assurance like that given by Nerva, that he would neither kill nor degrade any senator, and ordered the foundation of a temple and cult in honour of his adoptive father, but he did not come to Rome till he had inspected the Rhine-Danube frontier. The praetorians, who had been a menace to Nerva, were quickly overawed, and he proceeded to make his long-awaited entry into Rome Here he at once made himself popular with both senate and people Soon afterwards he left for his first Dacian campaign It would appear that Trajan himself wrote an account of this war, but only one sentence has survived We are left with the evidence of Trajan's column and the monuments at Adamklissi.

This much may be said Roman prestige and security were threatened by the terms of peace exacted by Decebalus from Domitian Trajan took the initiative in 101; his advance, more or less unopposed at first, ended in an indecisive battle at Tapae, at the entrance to the Iron Gate pass Trajan retired to winter on the Danube. The winter seems to have been disturbed by a raid by Dacians and Roxolani into Moesia The next spring Trajan invaded Dacia again His advance ended in an attack on a stronghold (identified as Muncel Cetate), and a complete victory near Koztesd. Decebalus surrendered, a garrison was left in Sarmizegetusa, and Trajan withdrew In 105 Decebalus revolted, and again (probably) invaded Moesia Trajan started at once from Ancona, and seems to have spent the first season in Moesia, making his way to his bridge at Pontes and wintering there. The next year (106), after prolonged and desperate fighting, Sarmizegetusa was taken, and Decebalus committed suicide. Dacia was annexed, the capital became a colony, *Ulpia Traiana,* and the new province was gradually Romanised in the usual way.

There followed seven years of peace, broken at last by war with Parthia The *casus belli* was the appointment by the new king of Parthia, Chosroes, of a nephew to the throne of Armenia without the customary application to Rome, but there must have been something behind that, for Chosroes' instant apology failed to placate Trajan There were three campaigns. The first (114)

resulted in the annexation of Armenia almost without opposition.

The next year, still without much fighting, Trajan occupied Mesopotamia up to the Tigris. There he halted, and went to Antioch for the winter. In 116 he first marched through Edessa and Nisibis, forced the passage of the Tigris without difficulty, and annexed Adiabene, which became the province of Assyria. Then he turned down the Tigris to Ctesiphon Chosroes fled, and Trajan went on down stream to the shores of the Persian gulf, where he looked over the waters to India, and said sadly, "If only I were younger." The captured territory became the province of Parthia

Then, on the way back, the trouble started Before the end of the year a serious rising in the north had to be crushed, and the Parthians were threatening a counter-attack. Trajan decided to abandon lower Mesopotamia, installed the young prince Parthamaspates as king in Ctesiphon, and withdrew, not without trouble on the way Meanwhile the Jews all over the East had risen and massacred everyone they could find, Greeks and Romans alike Trajan, alarmed by this and other signs of trouble all over the empire, set out for Rome He died on the way, at Selinus in Cilicia, on Aug 8, 117 His reign closes ominously; while he had been in the East trouble had started in Africa, Egypt, Libya, Palestine, Sarmatia, Britain He was deified, of course, and his triumph was celebrated after his death Trajan's reign takes one more long step towards complete despotism, which we shall see when we consider the provinces For Italy Trajan did much His new forum was the glory of Rome, there are columns and triumphal arches to commemorate his victories, he reclaimed the Campagna, built new harbours at Ostia, Centumcellae and Ancona, built roads and aqueducts, and tried to arrest the decline of Italy in agriculture and man-power, by extending the *alimenta* system of Nerva, forbidding emigration, encouraging settlements on the imperial lands, making senators invest in real estate in Italy, and so on.

His provincial administration is a little less easy to summarise In intention it was excellent, but his long absence in the East led to difficulties Numerous prosecutions for extortion show the extent of the evil and the emperor's efforts to stop it. This reign sees also a new phenomenon, the breakdown of local government on the financial side Various municipalities have to receive curators, and the province of Bithynia and the "free cities" of Achaea had their financial administration taken over by imperial *correctores* Pliny was sent to Bithynia, and his letters to Trajan and the replies are preserved In the enormous mass of detail referred to the emperor we can see foreshadowed the complete centralisation that was to come under Diocletian Mention must also be made of the view (Rostovtzeff, see *inf*) that Trajan's wars were completely disastrous to the empire, overstraining its man-power and economic strength irrevocably

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TRALEE, a seaport and county town of co. Kerry, Ireland, on the Ballymullen or Leigh river, and on the Great Southern railway Pop (1926) 10,536 Tralee, anciently Traleigh, the "strand of the Leigh," owes its origin to the foundation in 1213 of a Dominican monastery It was incorporated by James I A ship canal, permitting the passage of ships of 200 tons' burden, connects it with Tralee bay Large vessels discharge at Fenit, 8 m. westward, where there is a pier connected with Tralee by rail Coal, iron and timber are imported, and there is a considerable export of grain. There is a large trade in butter Railways serve the neighbouring seaside watering-places of Ballybunnion and Castlegregory. Ardfert cathedral, 4 m N W of Tralee and now united to the see of Limerick, was founded by St Brendan and had once a university. A neighbouring round tower fell in 1870.

TRALLES (mod. *Güzel Hissar*), an ancient town of Caria, Asia Minor, situated on the Eudon, a tributary of the Maeander. It was reputed an Argive and Thracian colony, and was long under Persian rule, of which we hear in the history of Dercyllidas' raid from Ephesus in 397 B.C Fortified and increased by the Seleucids and Pergamenians, who renamed it successively Seleucia and Antiochia, it passed to Rome in 133 Rebuilt by Andronicus II. about 1280, it was superseded a few years later, after the Seljuk conquest, by a new town, founded by the amir Aidin in a lower situation. (*See* Aidin.)

TRAMWAY. A track or line of rails laid down in the public roads or streets (hence the United States equivalent "street railway") along which wheeled vehicles are run for the conveyance of passengers and, occasionally, of goods; also a light roughly-laid railway used in coal mining and for carrying out public works.

Construction.—The earliest form of construction consisted of primitive lines or trams of wood or flat stones Later, in 1676, the longitudinal timbers forming the rails were laid on transverse logs and provided with a stout capping of beech or sycamore to facilitate easy renewal of worn sections without undue disturbance of the understructure In 1767 iron plates were substituted for the wood capping; and early in the 19th century iron rails were used

The first tramway or street railway intended for public passenger traffic was the New York-Harlem line opened in 1832 The rails had a deep wide groove which proved so dangerous to the ordinary light narrow-tyred vehicles of the period that they had soon to be removed Twenty years later Loubat, a French engineer, devised and used a wrought iron rail with a narrower groove and with a clearance suitable for wheel flanges In 1855–6 Charles L Light, an English engineer, designed a rail with a groove limited to $\frac{7}{8}$ in in depth and carried up to the surface with a slight slope for a tramway in Boston, U S A No form of grooved rail, however, seemed to suit the conditions of local traffic in the United States, and an entirely different kind of rail was introduced and used in the construction of a tramway in Philadelphia. This consisted of a flat rail 5 in wide, with a step at one side raised $\frac{7}{8}$ in above the surface It was made of wrought iron and weighed 50 lb per yard

Loubat in 1855 laid down a tramway in Paris—the first of its kind in Europe It was a replica, in most respects, of his New York form of construction. The rail was 3 in wide on the surface and had a groove $1\frac{1}{4}$ in wide and $\frac{7}{8}$ in deep, with a tread $1\frac{1}{8}$ in wide It was of a semi-hexagonal section at the lower side, to rest upon a timber sleeper which was chamfered to receive it, and upon which it was spiked diagonally through the sides A fishplate of iron, 6 in long and $\frac{3}{8}$ in thick, was laid under each joint The rail weighed 19 kg per metre or 38 lb per yard The tramways first constructed by G F Train in England in 1860–3 had a step rail of the Philadelphia pattern This rail was manufactured of wrought iron and weighed 50 lb per yard It was 6 in. wide and had a step $\frac{3}{4}$ in above the sole The rails were spiked to longitudinal timbers laid on transverse sleepers English people, unlike the American, would not however tolerate the danger and obstruction caused by the step rail, and the tramways in London had to be removed after a brief period of working, while those initiated by Train at Birkenhead and in North Staffordshire were preserved by the timely substitution of a flat grooved rail.

The adaptation of the steam locomotive for street tramway purposes necessitated tracks of greater strength and rigidity than were sufficient for horse traction The older methods of supporting the rails were inadequate for stability, and many attempts were made to overcome the difficulty Finally recourse was had to the girder rail which soon proved its superiority to the built-up rail, and it eventually became predominant in tramway construction. A form of girder rail was patented in 1860 by Charles Burn; reinvented and patented in 1877 by Achille Legrand of Paris; and with modifications again patented in 1878 by J. Gowans, who succeeded in establishing its greater merits after the lapse of 20 years from the time of its original inception.

The method of construction of modern street tramways follows the same general principle in all countries; variations depending upon local conditions which govern the depth of the con-

crete foundations, weight and composition of the rail, and the class of paving. In cities the foundation consists of six or more inches of concrete The rails weigh about 110 lb. per lineal yard, and are of 45 ft or 60 ft. in length, according to requirements. Heavy fishplates are used for the joints of the rails or the rail ends are electrically welded together. Steel tie-bars are interposed at short intervals and, where electric traction is the motive power, the rails are bonded together by copper rods to provide a continuous path for the return current (and to prevent leakage and consequent possible electrolysis of contiguous pipes). The surface of the rail is laid flush with the paving which may be of wood blocks or granite or basalt setts, grouted with cement

FORMS OF TRAMWAY TRACTION

Animal.—The original street tramways were worked solely by animal traction, the cars being drawn by one to four animals, according to the contour of the routes and traffic necessities An average speed of six to seven miles per hour was customary, and the cost of horse maintenance and renewals averaged 40% to 45% of the total working expenses

Steam.—The need for higher speeds, quicker acceleration and larger and more comfortable cars than were practicable with animal traction, led to the evolution of a type of steam locomotive suitable for street tramway purposes Some extraordinary designs were produced, not only for the engines themselves but for their position in the car One inventor placed his engine at the front; another in the centre, and a third provided an engine at each end of the car Between 1871 and 1883 many experiments on other forms of locomotives were carried out, including fireless locomotives in which well-insulated cylinders (filled with water which was heated from a stationary boiler at the end of each journey) together with the machinery were placed under the floor of the car Ammoniacal gas and compressed air also found devotees but after many trials an enclosed steam engine coupled to the car became standardized, and rendered on the whole quite efficient service until displaced by electric traction. It was employed on most of the tramways in the manufacturing areas of England Locomotive power and repairs and renewals of engines approximated 42% of the total working costs.

Gas.—The development of the gas engine for industrial purposes seemed to offer possibilities for its introduction for street traction Accordingly trials were made, principally in Germany, of small gas engines placed on the outside platform of the car, with the gas receivers accommodated under the floor, the gas being taken from the town mains and then put through a compressing engine before being admitted into the cylinders

Cable.—The principle of cable haulage was first applied to street tramways in 1873 in San Francisco by Andrew S Holliday. It was introduced in England in 1884 on Highgate Hill, London, and installations followed subsequently at Brixton Hill and at Edinburgh, Birmingham, and Matlock. All these have since been discontinued, but there is still a small cable undertaking in operation at Douglas, Isle of Man In cable systems haulage is effected by an endless wire rope continuously moving in one direction, supported on pulleys within a slotted conduit laid below the surface of the street or roadway, or between the rails of a surface or elevated railway The rope is driven by means of a steam engine or motor situated at a convenient place near the line, the motion of the cable being intermittently communicated to the cars for starting and stopping by means of a gripper attached to the car. The tube is formed of concrete with cast iron yokes spaced at intervals of 4 ft to support the slot beams. The slot is usually ¾ in wide and the conduit about 19 in. deep x 9 in. wide

Electric.—The history of the electric tramway is covered under ELECTRIC TRACTION There also will be found a description of the engineering accomplishments that resulted in its superseding all other forms of tramways.

Much controversy used to occur as to whether the overhead or conduit system should be installed. Engineers and financiers advocated the former on grounds of economy of cost of construction as well as of operation. But the general public was loth to sacrifice the amenities of the streets by permitting the erection of poles and overhead wires, and demanded a less obtrusive form of construction In the end the economy and merits of the overhead system prevailed, the exceptions being confined to capital cities such as London, Washington, New York, Paris, Berlin, Brussels and a few other places where financial considerations were subordinated to the aesthetic views In this system the trolley wires are usually hung about 21 ft above the rails The poles are placed not more than 40 yds apart

Surface Contact.—The high cost of conduit construction and the objectionable character of the overhead wires respectively were incentives to the invention of an alternative method of construction Attention was given by engineering specialists to the surface contact systems and a number of designs were patented Among those put into practical use in England were the Lorain system at Wolverhampton, the Dolter system at Torquay, Hastings, and Mexborough, and the G B system at Lincoln On all these systems current is supplied from iron studs laid in the roadway between the rails of the track to a skate carried on the car. The studs were placed every 10 ft to 15 ft, and contained a movable switch or contact which was operated by a magnet carried under the car.

Storage Batteries.—In theory storage batteries afford a simple and convenient form of electric traction, but extended trials have failed to justify their permanent adoption Cars operated by batteries prove costly to work and maintain

TRAMWAY CARS

The car operated on the pioneer lines in New York in 1832 was fashioned after the "voiture omnibus" of Paris, a vehicle designed by an English coachbuilder, George Shillibeer The body had three compartments and was supported on leather springs The four iron wheels, all of the same diameter and flanged, were placed centrally A dickey or elevated seat accommodated the driver and two passengers, and the foot-brake operated on one pair of wheels only The standard horse-car of 1880–90 had seats for 18 inside passengers and 18 outside, the upper deck being approached by a straight staircase

Modern car bodies are mounted either on a single four-wheeled truck with a fixed or rigid base 6 ft to 8 ft long, according to the sharpness of the curves to be negotiated, or on bogies or swivelling trucks The truck may be described as a carriage or frame supported on the axleboxes, and supporting by another set of springs the car body Of bogie trucks two types are used. one the "maximum traction" truck, having a pair of wheels of standard size—about 30 in—with another pair of smaller or "pony" wheels, and the other having four wheels of equal diameter. The single and maximum traction trucks are fitted with two motors, while the equal-wheeled bogies may have four motors. The trolley standard placed on the roof or upper deck of the car carries an arm which through a revolving wheel collects current from the overhead wires; instead of a wheel a frame shaped like a bow is sometimes used for the same purpose Controllers on the platform enable the motorman to stop, start and regulate the speed of the car by means of a handle on the upper surface of the controller frame which has notched divisions The brake equipment comprises a powerful hand brake with a foot ratchet, operating shoes on each side of the wheels, and a magnetic brake forming part of the controller equipment

While the various forms of trucks are common both to British and American practice, car body construction differs in many respects The single-deck car is in general use outside Great Britain where, although many single-deck cars are worked, the greater number are of the double-deck type

In addition to the types here mentioned other designs are to be found. Single-deck open cars of the "toast-rack" type with transverse seats are employed on many holiday lines. and the Californian type of car body, with the control part closed in and one or two double-sided transverse seats at each end, is sometimes used on routes where low bridges preclude the use of double-deck cars The earning value of this type is, however, small when weather conditions are unfavourable.

GREAT BRITAIN

Legislation.—Statutory sanction is necessary for the construction and working of a tramway on public streets or highways. The earlier tramways in England were constructed by private enterprise under powers conferred by special acts of parliament In 1870 parliament passed a general act "to facilitate the construction and to regulate the working of tramways" in Great Britain.

This 1870 Act of Parliament which is still in force, confers upon local authorities powers to construct and alternatively the optional right to purchase, but not to work, a tramway undertaking established by private enterprise upon the expiration of 21 years, and at every subsequent period of 7 years, at the "then value" of the tramway, land, buildings, materials and plant suitable to and used for the purposes of the undertaking, exclusive of any allowance for past or future profits or any compensation for compulsory sale or other consideration whatever In the meantime the undertakers are under the specific obligation to repair and maintain at their own expense the roadway between the rails and 18 in on either side thereof, and are subject to numerous other onerous conditions relating to the method of construction and working non-interference with Post Office, telephone and telegraph wires, gas and water pipes, electric cables, the services of carriages to be run for ordinary and work-people's traffic; and the maximum fares to be charged, including reduced fares to workmen, children, etc. The practical effect of the legislation was to constitute the local and road authorities sole arbiters of the tramway situation in the British isles, and promoters or lessees were frequently under compulsion to accept not only the statutory obligations of the act, but also burdens in regard to expensive street widenings and improvements, and otherwise, which were imposed upon them by local authorities. Promoters of new undertakings were deterred and in course of time lessees were difficult to find, in these circumstances some local authorities sought parliamentary powers to work the tramways in their districts After about 1896 parliament permitted any local authorities that so desired to work tramways as well as own them

The general tendency for British tramways to partake of a local, even parochial, character was thus accentuated Within even small but populous areas having several local authorities, horse, steam, and cable tramways were worked as segregated undertakings under separate management Moreover, there was no uniformity of gauge in the country, gauges of 4 ft 8½ in, 4 ft. and 3 ft. 6 in were adopted without regard to the needs of the travelling public for interconnecting services between towns The striking example of the adjacent cities of Leeds and Bradford, with gauges of 4 ft 8½ in. and 4 ft respectively, still exists

The advent of electric traction in the nineties opened up new opportunities in Britain. With its dense industrial population in a small area, no country was at that time better suited or riper for electric traction on street tramways on a large scale But this important industrial development suggested and, to some extent, initiated by private enterprise, was to a large extent frustrated by the territorial spirit of local government However, the need for linking up urban tramway systems, the development of intermediate townships, and the consequent better distribution of population and industries in a manner similar to that of large and successful street railway systems in the United States, was strongly urged on the Government by Stephen Sellon, a prominent parliamentary engineer, and others, with the result that the Light Railways Act of 1896, avoiding many of the imperfections of the Tramways Act of 1870, was passed The power given to local authorities to veto the promotion of a light railway or tramway disappeared, and the act did not give any option to the local authorities to purchase the undertaking Section 7 of the act, however, provided that the commissioners who were appointed to administer the act were to satisfy themselves that all reasonable steps had been taken for consulting the local and road authorities affected, and the owners and occupiers of the land proposed to be taken. The commissioners seemed to interpret the Light Railways Act in the terms of the old Tramways Act (which is still in force) rather than in the spirit of the departure from it implied by the new act, and included in most of the orders they made an option to the local authorities to purchase the light railway undertaking within their area at the end of a period of 30 years and at subsequent intervals of 10 years, the terms of purchase generally to be the fair market value of the undertaking as a going concern The more equitable provisions of the 1896 act removed some of the conditions in the Act of 1870 which had deterred capitalists, and the British Electric Traction Company, Ltd, and other companies, were formed with the object of providing and operating urban and interurban systems of tramways and light railways.

COMMERCIAL RESULTS

Tramways as public utility undertakings have undergone more changes than any other service of public utility, *e g*, water, gas, electricity supply, or steam railways For more than 30 years improvements in rail and track design followed one upon another, each accompanied by some loss of capital and dislocation of working routine. Rolling stock, too, was remodelled, and many alternative methods of traction were tried and improved or superseded The greatest change of all—the adoption of electric traction—involved the writing off or replacement of many millions of capital in the abandonment of existing horse and steam plant equipments, as well as in the provision of central generating plant, reconstruction of track, and erection of overhead electric lines

The following table (see *Garcke's Manual,* 1906, vol x) illustrates the relative values of electric, steam, and horse operation in Great Britain —

	Horse period 1879	Steam period 1898	Early electric period 1904-5
Length of route:			
Mileage open	321	1,064	2,117
Total number of passengers carried	150,881,515	858,485,542	2,068,913,226
Capital expenditure per mile of single track open			
Lines and works	£7,840	£7,770	£11,799
All items .	£9,877	£10,469	£15,599
Percentage of net receipts to total capital outlay	3·97	6 38	6 36
Percentage of working costs to gross receipts	84	77	66
Passengers carried per mile of route open .	469,641	806,703	977,386
do. per car mile	7 77	9 48	9·10
Average fare per passenger .	1 84d.	1 23d.	1·10d.

The benefits arising from the adoption of electric traction have inured more to the advantage of the travelling public than to the promoters and owners of the undertakings To some extent the comparatively small return of 6·36% on the capital outlay was owing to the heavy cost of construction, but to a larger extent it was in consequence of the policy of reducing the fares to a non-profit standard of municipal service. In the matter of fares British and American practice has always differed materially British fares are usually based on stages or traffic points The fares are charged at a given rate per mile—pre-war 1 to 1½ miles for a penny; post-war 1 to 1½ miles for 1½d—with a reduction for longer distances; thus producing differential fares according to distances travelled.

The earlier estimates of the cost of construction and working of electric tramways in Great Britain were based largely on the experience of the American and European undertakings then in operation. Some of the pioneer lines were built and worked within the estimates But as time went on the original estimates were largely exceeded. The overall cost of £9,500 per mile rose to £12,500 per mile, due to superior track construction, more elaborate overhead equipment, use of larger cars, street widenings, and higher cost of road paving imposed upon tramway undertakings The operating costs instead of being 5·30d per car mile, began to average over 6½d. per car mile, by reason of increased rates of wages and of greater wear and tear of track and equipment than was contemplated.

Subjoined are financial and statistical data relating to electric tramways and light railways in Great Britain in 1913–14 and 1926–27, taken from official sources.—

	Municipalities		Companies	
	1913–4	1927–8	1913	1927
Number of undertakings	170	167	94	66
Miles of lines open				
Total route length	1,708	1,850	731	664
Equiv single track	3,047	3,240	1,092	1,052
Capital expenditure	£54,298,188	£84,318,151	£22,371,533	£19,601,626
Gross receipts	£11,396,710	£23,860,707	£3,763,766	£3,890,737
Working expenses	£7,436,884	£18,663,222	£2,342,679	£3,279,925
Net profit	£3,959,826	78 2%	£1,421,087	84 3%

Note A number of undertakings belonging to companies were acquired by local authorities between the periods covered by these statistics

TRAMWAYS AND OTHER FORMS OF TRANSPORT

Since the advent of electric tramways—and especially during the past two decades—other forms of road transport, namely, trackless trolley buses, petrol (gasolene) motor omnibuses, and light railways, also the electrification of suburban railways, have been developed to provide increased travelling facilities for the ever-growing requirements of the public In the absence of any comprehensive scheme for the co-ordination of these different forms of services there has been much overlapping and wasteful competition between them, and reference is made below to proposed legislation with the object of co-ordination of the various services Every form of transport possesses special merits for certain conditions and characteristics of traffic

In the case of *tramways*, these were originally established to provide a better track than that offered by the then inadequate or bad state of the roads Legislation authorizing the construction of tramways gave their owners a monopoly in the form of the exclusive right to operate vehicles with flanged wheels over the lines For these rights many onerous obligations were imposed, indicating that electric tramways are expensive to establish and to operate, because they have been saddled with costs and obligations by obsolete legislation passed before the advent of the electric tramway, but in spite of this the operating costs per seat mile are less than those for any other road passenger transport

Light railways are very similar to tramways The procedure in obtaining powers to establish and operate them is different, and the terms on which they can be acquired by the local authorities of the districts served may in some cases be more favourable to the promoters than is the case with tramways They are, like railways, chargeable with only one-fourth of the district rates; but for all practical purposes where they have been constructed along roads as a means of passenger transport, they fall into the same category as tramways In passing the Light Railways Act 1896, parliament clearly indicated tramway lines constructed under this act being built with a cheap form of construction with rails laid on sleepers like railways, and used for urban and interurban work, connecting up hamlets and villages, and to encourage general agricultural, fishing and freer intercourse between neighbouring small towns

Trackless trolley buses were designed to serve specific routes with road transport facilities, and are suitable for dealing with traffic features similar to those which modern tramways are designed to provide, though in less densely populated districts They have the advantage over tramways of costing less to establish and run, and are more flexible in operation inasmuch as they are free to deviate from a fixed path. They cannot, however, be reversed at the termini of routes with the same ease as tramcars. While such services have not been developed much compared with other forms of road transport, they have been established by several municipalities and companies in this country and on the Continent to deal with moderately dense traffic Their sphere of usefulness is in cases where there is a moderate flow of traffic along a specific route having a good road surface Like tramways and light railways they are very suitable for short-distance traffic For the year 1926–27 nineteen local authorities and one company operated trackless trolley undertakings in Great Britain, while twenty-one local authorities did not exercise their statutory powers The following are some particulars of the operating results abstracted from the return issued by the Ministry of Transport —

Miles of route operated	84 13
Capital expenditure	£714,277
Total income	£286,391
Total working expenses	£249,955
Net revenue	£36,436
Car miles run	5,092,956
Passengers carried	50,382,193

Suburban railways also serve local traffic requirements in a very efficient manner, although the class of traffic for which they are pre-eminently designed is somewhat different from that particular kind of local traffic which forms so large a proportion of that served by tramways, light railways and trackless trolley buses The three latter forms of road transport are designed primarily for frequent stops at short intervals—a continual picking up and setting down of passengers along their routes—whereas the passenger traffic on suburban railways consists chiefly of large numbers of passengers conveyed from the centre of one locality to another, with comparatively short journeys to and from the railway stations

Omnibuses—The comparatively rapid development of omnibus services is perhaps the outstanding feature of modern land transport This development is due primarily to (*a*) the provision of good roads at the cost of other industries and the community at large; (*b*) the skill of the automobile engineer in producing so efficient a machine, (*c*) the improvements made in the manufacture of pneumatic tyres, (*d*) the comparatively low cost of establishing and operating an omnibus service, and (*e*) the fact that unlike other forms of transport referred to, parliamentary powers are unnecessary to establish a service except in the case of omnibuses owned by municipalities or statutory companies Motor omnibuses (single- and double-deck types) as at present evolved are now being used to cater for road passenger traffic of practically all classes The single-deck types are used chiefly for urban and interurban services where the density of traffic is not great, and for touring work, and many regular high-speed services for long distances (50 to about 100 miles) have been established between large towns They are also used in districts where the height of bridges precludes the use of the double-deck type Generally speaking the double-deck types are used for town services where the traffic density calls for a vehicle with larger seating capacity than can be given by a single-deck vehicle This is conspicuously so in London where no tramways are laid in the large central area which comprises the chief commercial and shopping districts, the chief amusements, and some important residential districts within the metropolis On this account the London road transport services are quite special The economic competitive aspect of omnibuses compared with other forms of road transport is to some extent influenced by the limitations as to dimensions and weights of vehicles as imposed by the Heavy Motor Car (Amendment) Order, 1927

Comparisons of Systems.—Having briefly indicated the special features of each form of traction referred to, it is not difficult to visualize the character of the traffic which they are especially suited to provide, and generally speaking there is no very great difference of opinion among transport experts on this important question But experience has shown that in cases where omnibuses are permitted to run and ply for hire indiscriminately over tramways, the tramway revenue can be so depleted as to reduce the undertakings to insolvency, although the motor omnibuses themselves would not be the most suitable form of transport for dealing with the traffic, and it is on this point that confusion of thought among non-transport experts exists A motor

omnibus, being a self-contained vehicle, is a comparatively inexpensive vehicle to provide and operate, and is admirably suitable for dealing with many kinds of traffic characteristics It is extremely mobile and can be operated in different districts at different parts of the day, in this manner depleting the tramway revenues just when it was earning a profit.

Apart from the merits of the two forms of traction for dense traffic conditions, the question of the capacity of the roads in large towns is a very important factor to be studied. Another important question—national in its bearing—is the fact that practically the whole of the motor spirit used to propel motor omnibuses is imported It is difficult to realize what the position of road transport in this country would be if there were no electric services and omnibus fuel supplies were for any reason cut off for a prolonged period The French Government is so concerned at the undesirability of having to depend on imported fuel for transport purposes that they have given much encouragement to the discovery and use of petrol substitutes On the other hand, the omnibus has the advantage over tramcars in that it can draw up to the side of the road for the convenience of picking up and setting down its passengers Much confusion of thought on the merits of tramways has been created owing to several tramway systems having been discontinued and superseded by omnibuses or trackless trolley buses These changes were made mainly because the tramways were established to deal with traffic which in these cases never was and probably never would have been sufficiently dense to justify their establishment and continuance Nevertheless these matters do not detract from the value of tramways for dealing with dense city and suburban traffic, where the requirements call for permanent way with double track and large-capacity tramcars operated at frequent intervals at high speeds Many of the managers of large road passenger transport undertakings, some of whom are responsible for both tramways and omnibuses, have recently expressed the view that on their true merits tramways for dealing with dense city traffic have nothing to fear from omnibuses Some figures recently published in connection with the Manchester Corporation tramways and omnibus services give the working costs per seat mile as being 0·21d. for the tramways and 0·46d for the omnibuses In London the cost of operating a double-deck omnibus averages 0·263d per seat mile, and 0·190d for tramways It is obvious that if tramways were relieved of their onerous obligations referred to above, the cost of operation per seat mile would be still more favourable to them

Summary.—Much evidence has recently been given by officials responsible for large combined tramway and omnibus undertakings, to indicate that tramways form an indispensable part of road transport required to cope with the ever-increasing traffic in large cities where, in most cases, by far the greatest proportion of the whole passenger traffic is still carried by tramways. The London and Home Counties advisory committee, which was set up under the London Traffic Act, 1924, to bring about co-ordination of transport systems, confirmed this by expressing similar views They "consider that tramways are an essential part of the passenger transport system in the metropolis" Several large municipal tramways are being extended into the suburbs with special track construction along new and modern thoroughfares

Summarizing the above it may be said generally that.—

(1) Tramways are pre-eminently suitable for main city routes where the traffic is dense

(2) Trackless trolley buses are suitable for traffic of moderate density, cross-town work, and feeders to tramways, where the roads are suitable for their use

(3) Motor omnibuses have a wide range of usefulness for dealing with traffic varying from light to heavy. They are more mobile than other forms of public transport vehicles, but create more congestion than tramways and reduce the capacity of the roads, especially at city termini, when used for dealing with heavy traffic They are dependent on imported fuel There are cases where their use to augment tramway services during the heavy peak loads is well worth consideration

(4) Light railways, as developed for road traffic purposes in Great Britain, are similar to tramways Powers authorizing their construction have not been used to a large extent for the express purpose intended by legislation, although the comparatively cheap form of construction (sleeper track) is being used to extend into the suburbs some large city tramway undertakings

(5) Suburban railways are used in large cities for the transportation between localities as contrasted with pick-up traffic along the routes. The services are frequently superimposed on main line railway services.

Even with the best of co-ordination of the various forms of transport, there is bound to be a certain amount of direct or indirect competition between them, and to organize the best scheme for any particular conditions on their merits as transport agencies, calls for high degree of experience and expert transport knowledge The desirability of the co-ordination of the various forms of transport to enable all to function according to their respective merits was appreciated by the Government, and a royal commission was appointed in 1928 to consider the matter. The evidence given before the joint committee of both houses of parliament in connection with the omnibus powers being sought by the railway companies indicates the urgent necessity of legislation to deal with this important question There is a growing feeling that legislation in this connection is vital to the co-ordination of this country's transport services, and to protect and encourage them in such a way as to ensure healthy expansion and improvements in these services on which England depends for its industrial development and welfare (E. Gar.)

UNITED STATES

As far back as 1746 stage coaches were running in New York carrying passengers on Broadway to the Battery, and other lines of this type were in existence even earlier But the street railway business as such cannot be said to have actually begun until the adaptation of the "railway" principle to transportation in city streets. Apparently the earliest record of a "street railway" in America is that of an omnibus car known as the "John Mason," which in the third decade of the 19th century operated in Fourth street, New York This car was drawn by horses and ran on strap rails laid on stone ties During the two succeeding decades there seems to have been very little new development, though the demands of the fast growing communities gave rise to a vast number of omnibus and stage coach lines Twenty years after the advent of the John Mason the Sixth Avenue railroad of New York was built, and between 1850 and 1855 six new rail lines appeared in different parts of the country

Thereafter the new idea developed rapidly, though not without considerable opposition on the part of the more reactionary element, who saw in these noisy and rapidly moving vehicles only detriment to property values and danger to life and limb The superior comfort of the rail carriages as compared to the old-fashioned omnibus jolting over rough cobblestone pavements was soon demonstrated Between 1855 and 1860, 30 street railway lines were built Between 1860 and 1870, 80 new lines appeared By the year 1890 there were 769 street railways in the principal cities of the country

Early Development.—Most of the new lines met with apparent success from the start Operating data and financial reports of these early days are meagre and unreliable, but it is certain that the rapid industrial development of the period assured a growing demand for local transportation. The ease with which franchises were obtained in most cities also gave encouragement to promoters Each line was usually operated as a separate corporation and under a separate franchise. Runs were comparatively short At first each company charged a separate fare, but before many years in most cities agreements permitted interchange from one line to another, usually upon payment of an "exchange" fare slightly above the regular fare Fares were almost invariably fixed at 5 cents for a single ride of any length Fares rose temporarily in most cities, following the Civil War, to 6, 7 and even 8 cents. The 5 cent fare persisted throughout the latter part of the 19th century and up to the World War.

The use of horses for motive power continued until about 1890. A number of cities, notably San Francisco, where very difficult grades were encountered, had cable systems but the heavy installation cost involved stood in the way of any general abandonment of the horse car systems in favour of cables. This factor also worked against the adoption of electricity as a motive power. Early experiments by Edison, Field, and several others

had shown the practicability of a railway with cars operated by electricity, and F. J. Sprague is generally credited with having built and operated the first actual electric street railway in Richmond, Va, in 1888 with about 12 m of track and 40 cars A further serious obstacle to the growth of electric railways was the excessive cost of producing electric power As soon as new developments in power production and transmission largely overcame this difficulty, a new era began in urban transportation

Combination of Lines.—The late '80s and early '90s brought about the gradual combination of the independent lines, through a series of mergers, so that there emerged one single street railway system in nearly every large city. No cable or horse car systems were proposed after 1890, and by 1902 the electric car was in almost universal use in all principal cities The amalgamation of independent lines into a unified system for each community undoubtedly effected substantial economies in operation and made possible a more satisfactory grade of service. Unfortunately, in keeping with financial and political practises of the time, these amalgamations were often accompanied by flagrant abuses. Many managements shaped their policies with little regard for either the public welfare or the permanent economic good of the community or the transit system Such tactics on the part of the so-called "traction magnates" naturally gave rise to a deep-seated feeling of distrust on the part of the riding public Wages and working conditions of the street car employees during these years were probably as poor as those in any industry. The public's distrust of the owners thus came to be shared by the workers, and street car strikes were frequent and violent in all parts of the country.

Regulation.—It was during the early part of the present century that the condition of the street railways sank to the lowest point in their history After long agitation and political controversy, came the public utility commissions, designed to regulate the conduct of public utility enterprises in the interest of the public and with regard to the rights of investors in the properties. For several decades most of the States had had what were known as railway commissions, which came into existence with the advent of the steam railroads These railway commissions, however, were confined practically to the gathering of information and had little or no authority in matters of rates and service New commission laws were passed in 1905 in Washington, Wisconsin and Indiana, which gave the commissions of those States complete jurisdiction over rates and service of all common carriers, with authority to enforce their rulings

To-day every State in the Union has its utility commission State public utility commission laws have in general followed the form of the Interstate Commerce Commission of the United States. The theory of public utility regulation is briefly and generally that a "business affected with a public interest" is one which should be subject to a certain measure of public control. This applies with special force to undertakings which are in the nature of legal or natural monopolies and which, by virtue of certain privileges extended to them by the commonwealth, assume the obligation of rendering service to the public By virtue of the assumption of such obligations the utility is regarded as having the right to be protected from competition and the right to earn a fair return on the value of its property. Much controversy has arisen as to the legal definition of "fair return" and "fair value." Commissions generally have defined fair return to a public utility as that return which would be realized from any other business where the risks and capital investment are the same In actual practice 7% per annum has been generally indicated Fair value has been harder to define. Arguments have been advanced in favour of original cost of plant and improvements, present capitalization, prudent investment, cost of reproduction and present value as a going concern. The U S. Supreme Court has refused to accept any one of these bases for determining fair value and has indicated that commissions may take into consideration any or all of these factors and give to them "such weight as may be just and right in each case." (*See* PUBLIC UTILITY.)

Competition and Rising Costs.—The serious condition in which the street railways found themselves prior to 1915 was greatly aggravated by the unprecedented conditions brought about during the World War Labour and material costs rose steeply while at the same time the street railways began to encounter serious competition in the form of the taxi, motor-bus and private automobile. Some idea of the acuteness of the situation may be had from the fact that in 1919, 7 8 of the mileage and 9 per cent of the securities invested in the street railway industry were involved in receivership, exceeding by a considerable degree any previous year.

At this juncture President Wilson appointed the Federal Electric Railway Commission to study the situation of the electric railways and suggest measures for their relief The commission attributed the cause of the railways' condition to the high cost of labour and materials, early financial mismanagement, and the inadequacy of the existing fare system It recommended, in general terms, a redoubling of the efforts to effect economies in operation and to improve service It recommended also that some relief be given the companies in the way of elimination of special assessments and taxes, pointing out at the same time that strict regulation of independent motor-bus operators should be undertaken to lift the burden of undue competition Little progress was made in the immediate ensuing years. Later however, many of the recommendations made by the commission were put into effect with the result that public, employees and owners have all benefited materially

Private Automobile.—Prior to the advent of the World War the use of private automobiles in the United States had reached very considerable proportions, but the increase in the manufacture and sale of automobiles following the close of the war was phenomenal.

No factor in the entire situation has been more detrimental to the success of the street railways of the past nor more threatening in the future than this ever-increasing tendency of the public to ride in privately operated vehicles Many studies have been made which have purported to trace the future trend of automobile usage to an ultimate point All such prognostications that have been made in the past have proven fallacious in the light of actual experience

Motor-bus.—Gasolene propelled double-deck motor-buses had been in use on certain streets of New York and Chicago for many years, but throughout the remainder of the country they were practically unknown Starting, however, with the rather small beginning which they had during the World War when many of the street railway companies were unable to supply service adequate to the demands of the vast army of factory workers, the use of motor-buses increased with great rapidity in all sections of the country Street railway managements for several years made the mistake of attempting to regulate and legislate the motor-bus out of existence. It could not be done The motor-bus had several points of superiority over the street car which in the public mind sufficiently offset its obvious drawbacks After fighting a losing battle for several years, street railway managements undertook to co-ordinate rather than outlaw the motor-bus The larger street railway companies at the present are realizing that their business is one of public transportation, not limited to one particular form of vehicle, each vehicle eventually fitting into a co-ordinated whole, so as to obtain the most efficient and economic results for the community

As a rule, double-deck buses have been found most practical in thickly settled sections where traffic is heavy, single-deckers are used for suburban and intercity routes Seating capacity is usually from 45 to 70 in the double-deck buses and from 20 to 35 in the single-deck Many companies prohibit the carrying of standing passengers. The rate of fare on city motor-bus routes is almost universally 10 cents The extent to which street railway revenues and development have suffered through the inroads of motor-bus competition is indicated by the fact that the number of motor-buses in use in the United States has increased from 52,925 in 1924 to over 92,325 in 1928; while the number of passengers carried by motor-buses has reached a total of 1,826,-000,000 in 1928 During recent years the figure for street rail-

way passengers has remained practically stationary and the number of cars in use has decreased Further light is thrown on the more recent tendency of the street railway companies to absorb motor-bus operations as a part of the unified transit systems by the fact that whereas in 1922 street railway companies operated only 355 motor-buses, in 1928 the figure had increased to 8,492

Traffic Congestion.—The remarkable increase in the number of automobiles using the highways has created a situation of traffic congestion in the centres of large cities. a real problem for which no adequate practical remedy has yet been devised It constitutes obviously a serious obstacle to regularity of street railway schedules, adds materially to the cost of operation per car mile, and multiplies accident hazards Hundreds of thousands of dollars have been spent by communities, chambers of commerce and street railway managements in making traffic counts and surveys and laying out elaborate plans for remedial measures

Parking of vehicles on city streets is one phase of the situation which has received considerable attention Regulations have been devised to limit the length of time which an automobile may be left standing on the public highway Parking has been prohibited in some sections in nearly every city on one side of the street or on certain portions of some city blocks Limited parking is in some cases permitted at certain hours of the day and forbidden during the hours of greatest congestion These plans have brought a certain amount of relief, but the major problem remains For the most part American city streets were designed with no knowledge or anticipation of the demands which modern conditions would put upon them Present experience indicates beyond question that even the absolute prohibition of the parking of vehicles on highways in the streets would fall short of completely remedying the situation (*See* TRAFFIC and TRAFFIC REGULATION)

Taxicab.—The same reasoning which eventually forced upon street railways the realization that the street car and motor-bus service must be co-ordinated in one system applies with equal force to taxicab transportation The growth and use of the private automobile was accompanied by a similar growth in public patronage of motor-driven cabs This particularly affected the revenues of the street railway companies, because it was the short rider who had always been the most profitable part of the street railway company's business in America where flat rates rather than zone fares were the universal rule, and which was gradually but surely diverted to the taxicabs One or two pioneer street car companies have always handled the taxicab business as an adjunct to their street railway and motor-bus systems In Philadelphia virtually all of the taxicabs are under the control of the street railway management.

Future Development.—From the foregoing one might be inclined to draw a most pessimistic conclusion as to the future of street railway companies in America Yet the situation is not without many hopeful signs Street railway managements generally have accepted a more comprehensive view of their functions and are realizing the need of extending their facilities in the direction of co-ordinated service They are recognizing the need for an ever-improving grade of service to meet the demands of public taste. At the same time they are everywhere inaugurating more enlightened policies with respect to labour; industrial co-operation is the watchword rather than the violent strike of earlier years. The forces of organized labour in the industry have declared, through an agreement with one of the largest management groups, in favour of co-operation as a substitute for militant opposition A much more intelligent policy of public relations has almost universally replaced the former uncondescending attitude which so antagonized the riders At the same time. spurred on by the evident preference of the public for motor-bus and taxicab riding, even at advanced rates, street railway companies and manufacturers are bending every effort toward more comfortable and more inviting vehicles.

The accompanying statement showing gross and net revenues at five-year intervals is evidence of the decided improvement which has taken place in street railway affairs since 1909

Notable advances also have been made in reducing to the minimum costs of operation Particularly the introduction of the so-

Street Railways in United States

	Gross Passenger Revenue	Net Income
1907	$382,132,000	$40,340,000
1912	502,652,000	68,140,000
1917	603,130,000	56,451,000
1922	854,663,000	57,188,000
1927	860,000,000	66,000,000

called "one-man car" has accomplished much in this direction The earliest types of one-man car were extremely small and limited in their application to sparsely settled districts, but developments of safety devices and more thorough training of operators have made possible the use of larger cars operated by one man even in the densest traffic In some of the largest city systems the newer types of one-man car are shown to be safer than the two-man car by statistics of accidents over a considerable period of time

The increased use of city highways in the near future leads one to the inevitable conclusion that, in order to supply anything approaching an acceptable transportation service, the various types of transportation in city centres must be segregated Widening and double-decking of city streets is too costly to be extensively undertaken High speed subways and elevated lines in the larger cities have been a valuable contribution but the cost of their operation and the carrying charges on the enormous investment involved are far beyond what the passenger revenue can be expected to yield Several cities have already adopted the plan of putting some of their surface street railway lines underground when they approach the city centre It is safe to predict that before many years all surface lines will enter congested city centres underground and that all of the short-riding business in the centres of the cities will be taken care of by the free wheel motor-buses and taxicabs

High Speed Lines.—New York, Chicago, Philadelphia and Boston have high speed (either subway or elevated) lines in addition to the surface street car lines Philadelphia and Boston have both made use of the "surface car subway" principle In both of these cities the operation of high speed surface lines and buses is co-ordinated under one management Philadelphia's system is partly city-owned and all operated by private management Boston's transit system, also partly municipally and partly privately owned, is under the control of a board appointed by the State New York city's high speed system, also partly city-owned, is operated by two separate private corporations while her surface lines are divided into several systems, each operating independently All are subject to the control of the city's transit commission Chicago's system of high speed and surface lines, privately owned and operated, is subject to a large measure of city control The city is also planning early construction of municipally owned subways

Already a very substantial portion of the electric railway mileage in the principal American cities is municipally owned or under a large measure of municipal control In addition, nearly all of the larger cities are giving serious consideration to the construction of high speed subway or elevated lines at the city's expense Future extensions of street railway mileage in larger cities will in all probability take the form of high speed trunk lines in subway tubes operating between the congested centres and the more populous suburban districts Elevated structures are not popular owing to their unsightliness, and in congested sections they constitute a serious interference with vehicular traffic The high speed, subway and trunk lines will be supplemented by present surface rail lines in the outlying sections. Additions to present surface mileage will be practically negligible, all lines into newly developed sections being served by motor-buses. Surface railway lines where they enter congested centres will, as already indicated, be placed in underground tubes.

City Ownership and Co-ordination.—While as previously pointed out the situation of the street railway industry is now showing decided improvement, nevertheless the credit of the companies has been so impaired in the last decade and the riding

habit so definitely shifted from public conveyances to private automobiles, that it is extremely doubtful that any street railway company will in the future be able to finance the construction of underground high speed lines There is no indication anywhere that sufficient patronage can be attracted to such lines with a rate of fare which would yield sufficient income to pay operating costs and carrying charges on the investment involved It therefore appears more or less certain that future construction of high speed lines and construction of tubes in which surface cars will be operated will be at the city's expense Municipalities are able to float bond issues at substantially lower interest rates than private utility corporations The construction of such high speed lines materially enhances the value of abutting real estate, which furnishes ample justification for added real estate tax assessments

It may well be that municipal ownership will not stop with the building by the cities of new high speed lines as required, cities may make arrangements by which ownership of the entire transportation system within their borders will pass to the municipality In such eventuality, it appears obvious that such a city-owned system should include not only high speed and surface railway lines but supplementary motor-bus lines and taxicab systems as well, in order to preserve to the municipality as owner the same advantages from co-ordination as have already been shown to accrue to the private companies There is a distinct sentiment throughout the United States against municipally operated transit lines As a matter of fact, in the few isolated communities where municipal operation has been tried in America, the results have not been encouraging In all probability the ultimate development of large city transportation systems will be toward municipal ownership with operation by responsible and experienced private management agencies, to whom will be offered the incentive of contingent remuneration based upon results secured in attraction of patronage and efficiency of operation (*See* TRANSPORT, ELECTRIC TRACTION) (T E M)

TRANCE, a term used very loosely in popular speech to denote any kind of sleeplike state that seems to present obvious differences from normal sleep, in medical and scientific literature the meaning is but little better defined In its original usage the word no doubt implied that the soul of the entranced person was temporarily withdrawn or passed away from the body, in accordance with the belief almost universally held by uncultured peoples in the possibility of such withdrawal But the word is now commonly applied to a variety of sleeplike states without the implication of this theory, ordinary sleep-walking, extreme cases of melancholic lethargy and of anergic stupor, the deeper stages of hypnosis (*see* HYPNOTISM), the state into which many of the mediums of modern spiritualistic séances seem to fall almost at will, all these are commonly spoken of as trance, or trance-like, states. There are no well-marked and characteristic physical symptoms of the trance state, though in many cases the pulse and respiration are slowed, and the reflexes diminished or abolished The common feature which more than any other determines the application of the name seems to be a relative or complete temporary indifference to impressions made on the sense-organs, while yet the entranced person gives evidence in one way or another, either by the expression of his features, his attitudes and movements, his speech, or by subsequent relation of his experiences, that his condition is not one of simple quiescence or arrest of mental life, such as characterizes the state of normal deep sleep and the coma produced by defective cerebral circulation by toxic substances in the blood or by mechanical violence done to the brain.

If we refuse the name trance to ordinary sleep-walking, to normal dreaming, to catalepsy, to the hypnotic state and to stupor, there remain two different states that seem to have equal claims to the name; these may be called the ecstatic trance and the trance of mediumship respectively

The ecstatic trance is usually characterized by an outward appearance of rapt, generally joyful, contemplation The subject seems to lose touch for the time being with the world of things and persons about him, owing to the extreme concentration of his attention upon some image or train of imagery, which in most cases seems to assume an hallucinatory character (*see* HALLUCINATION) In most cases, though not in all, the subject remembers in returning to his normal state the nature of his ecstatic vision or other experience, of which a curiously frequent character is the radiance or sense of brilliant luminosity

In the mediumistic trance the subject generally seems to fall into a profound sleep and to retain, on returning to his normal condition, no memory of any experience during the period of the trance But in spite of the seeming unconsciousness of the subject, his movements, generally of speech or writing, express, either spontaneously or in response to verbal interrogation, intelligence and sometimes even great intellectual and emotional activity In many cases the parts of the body not directly concerned in these expressions remain in a completely lethargic condition, the eyes being closed, the muscles of neck, trunk and limbs relaxed, and the breathing stertorous

Trances of these two types seem to have occurred sporadically (occasionally almost epidemically) amongst almost all peoples in all ages And everywhere popular thought has interpreted them in the same ways In the ecstatic trance the soul is held to have transcended the bounds of space or time, and to have enjoyed a vision of some earthly event distant in space or time, or of some supernatural sphere or being The mediumistic trance, on the other hand, popular thought interprets as due to the withdrawal of the soul from the body and the taking of its place, the taking possession of the body, by some other soul or spirit, for not infrequently the speech or writing produced by the organs of the entranced subject seems to be, or actually claims to be, the expression of a personality quite other than that of the sleeper It is noteworthy that in almost all past ages the possessing spirit has been regarded in the great majority of cases as an evil and non-human spirit, whereas in modern times the possessing spirit has usually been regarded as, and often claims to be, the soul or spirit of some deceased human being Modern science, in accordance with its materialistic and positive tendencies, has rejected these popular interpretations It inclines to see in the ecstatic trance a case of hallucination induced by prolonged and intense occupation with some emotionally exciting idea, the whole mind becoming so concentrated upon some image in which the idea is bodied forth as to bring all other mental functions into abeyance

Science regards the mediumistic trance as a state similar to deep hypnosis, and seeks to explain it by the application of the notion of cerebral or mental dissociation in one or other of its many current forms, this assimilation finds strong support in the many points of resemblance between the deeper stages of hypnosis and the mediumistic trance, and in the fact that the artificially and deliberately induced state may be connected with the spontaneously occurring trance state by a series of states which form an insensible gradation between them A striking feature of the mediumistic trance is the frequent occurrence of "automatic" speech and writing, and this feature especially may be regarded as warranting the application of the theory of mental dissociation for its explanation, for such automatic speech and writing are occasionally produced by a considerable number of apparently healthy persons while in a waking condition which presents little or no other symptom of abnormality When, as in the majority of cases, such speech or writing merely gives fragmentary expression to ideas or facts that have been assimilated by the subject at some earlier date, though perhaps seemingly completely forgotten by him, the theory of mental dissociation affords a plausible and moderately satisfactory explanation of them.

But in recent years a new interest has been given to the study of the mediumistic trance by careful investigations (made, mostly by members of the Society for Psychical Research, with a competence that commands respect) which tend to re-establish the old theory of external possession, just when it seemed to have become merely an anthropological curiosity For this aspect of mediumistic trance the article on *Psychical Research* should be consulted

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SPR. IX, X. and XI. *See* also various articles in *Grenzfragen des Nerven und Seelenlebens*, edited by L. Loewenfeld and H. Kurella (Wiesbaden, 1900), especially the article "Somnambulismus und Spiritismus", also articles in *Proceedings of the Society for Psychical Research*, especially pts liii, lv and lvii. and in the *Journ of Abnormal Psychology*, edited by Morton Prince (Boston, 1906–09), also literature cited under AUTOMATISM, HYPNOTISM, MEDIUM, and POSSESSION. (W. McD.)

TRANENT, police burgh of East Lothian, Scotland Pop. (1921), 4,763. It lies 9½ m E. of Edinburgh by road and 1 m. S E of Prestonpans station on the L N E. railway. The town possesses the oldest coal-mining charter (1202–18) in Great Britain, and the mines in the neighbourhood provide the staple industry A fragment of a parish church, said to have been built in the 11th century, still stands The palace of the Setons was demolished towards the close of the 18th century and a modern mansion was erected on its site

In the neighbouring village of Ormiston, in 1885, a granite obelisk was erected in memory of Robert Moffat (1795–1883), a native, the South African missionary and father-in-law of Livingstone At Ormiston Hall, a seat of the marquess of Linlithgow, there is a yew tree, beneath which the reformer George Wishart (1513–1546) used to preach. Hard by is the village of Pencaitland, divided into an eastern and a western portion by the Tyne. The parish church in eastern Pencaitland probably dates from the 13th century. The aisle may belong to the original building, but the rest is of the 16th century, excepting the small belfry of the 17th century The old house of Pencaitland stands in the grounds of Winton Castle, which was erected by the 3rd earl of Winton in 1620 but forfeited by the 5th earl, who was involved in the Jacobite rising of 1715 Five miles south-east of Tranent is the village of Salton (or Saltown), where Gilbert Burnet, afterwards bishop of Salisbury, had his first charge (1665). At his death he bequeathed the parish 20,000 marks for the clothing and educating of poor children He was tutor to Andrew Fletcher, who was born at Salton in 1655 and buried there in 1716. At Fletcher's instigation James Meikle, a neighbouring millwright, went to Holland to learn the construction of the iron-work of barley mills, and the mill which he erected at Salton after his return not only gave Salton barley a strong hold on the market but was also for forty years the only mill of its kind in the British Isles Meikle's son Andrew (1719–1811), inventor of the threshing machine, carried on his trade of millwright at Houston Mill near Dunbar. Andrew Fletcher, also of Salton (1692–1766), nephew of the elder Andrew, became lord justice clerk in 1735 under the style of Lord Milton By his mother's energy the art of weaving and dressing Holland linen was introduced into the village. She travelled in Holland with two skilled mechanics who contrived to learn the secrets of the craft The British Linen Company laid down their first bleachfield at Salton under Lord Milton's patronage. Salton also lays claim to having been the birthplace of the poet William Dunbar.

TRANI, a seaport and episcopal see of Apulia, Italy, on the Adriatic, in the province of Bari, and 26 m by rail W N W of that town, 23 ft above sea-level Pop. (1921), 34,568 The cathedral (dedicated to St Nicholas the Pilgrim, a Greek who died in 1094 and was canonized by Urban II) on an open site near the sea, was consecrated, before its completion, in 1143; it is a basilica with three apses, a large crypt and a lofty tower, the latter erected in 1230–39 by the architect whose name appears on the ambo in the cathedral of Bitonto, Nicolaus Sacerdos It has an arch under it, being supported partly on the side wall of the church, and partly on a massive pillar. The arches of the Romanesque façade are beautifully ornamented; the bronze doors, executed by Barisanus of Trani in 1175, rank among the best of their period in southern Italy. The capitals of the pillars in the crypt are fine examples of the Romanesque. The interior of the cathedral has been barbarously modernized, but the crypt is fine Near the harbour is the Gothic palace of the doges of Venice, which is now used as a seminary S Giacomo and S Francesco also have Romanesque façades and the latter and S. Andrea have domes. The fine castle was begun by Frederick II (1233) and enlarged in the 15th and 16th centuries The Palazzo Caccetta (1458) is a fine Gothic building. Trani produces wine (Moscato di Trani). Trani is the *Turenum* of the itineraries. It first became a flourishing place under the Normans and during the crusades, but attained the acme of its prosperity as a seat of trade with the East under the Angevin princes. Its code of maritime law (the *ordinamenta maris*) is the first of mediaeval codes (1063)

TRANQUEBAR, a town of British India, in the Tanjore district of Madras, on the sea-coast, 18 m. N of Negapatam. Pop. (1921), 11,520 A railway line from Mayavaram was planned in 1924 A Danish factory was opened here as early as 1620. It was taken by the British in 1801, but restored in 1814, and finally purchased, with the other Danish settlements in India, in 1845. In Danish times Tranquebar was a busy port, but it lost its importance when the railway was opened to Negapatam It was the first settlement of Protestant missionaries in India, founded by Ziegenbalg and Plutschau (Lutherans) in 1706; and there is still a Lutheran mission high school and mission press, equipped for printing the native languages

TRANSATLANTIQUE, COMPAGNIE GÉNÉRALE, a maritime steamship line popularly known as "The French Line," was formed as the Compagnie Générale Maritime in 1855 It controlled a fleet of 75 sailing ships, of which many were engaged in the cod-fishing industry off the Newfoundland Banks, and 10 steamers In 1860 the company was awarded the postal contract for a service between Havre and New York The next year the company adopted its present name

The first steamships for its New York service had a gross tonnage of 3,000 tons and a speed of about 8 knots "La Touraine," a turn-screw vessel of 18 knots, built in 1890, held the blue riband of the Atlantic for some time In 1906 the company ran another very fast vessel for her day—"La Province" (21 5 knots on trials), and six years later operated the "France" (24 knots) which still remains one of the fleetest passenger ships More recent additions were the "Paris" (1921) and "Île de France" (1927)

The company maintains, in addition to its New York service, regular passenger and freight services to the West Indies and Spanish Main and to Mexico In the Mediterranean it has an extensive network of lines to North Africa The north and south Pacific are served from Europe by large freighters. In 1928 the fleet of the company consisted of 101 vessels with a total gross register of 570,000 tons The gross tonnage of the Île de France is 44,000 tons (G C. RH)

TRANSBAIKALIA: *see* BURIAT MONGOL A S S R and FAR EASTERN AREA.

TRANS-CANADA HIGHWAY, a highway crossing Canada from ocean to ocean Starting at Halifax, N S, it passes through the Maritime Provinces and along the St. Lawrence river, through Ottawa, to Lake Superior, a distance of about 1,500 miles. It is a graded road from Halifax to Quebec. From Quebec to Ottawa the roadway is paved or hard surfaced; the balance improved, graded or dirt Its central division is not yet completed and the traveller must therefore pass through U S territory from Sault St Marie, to Emerson, south of Winnipeg, Manitoba. The distance from Winnipeg to Vancouver is about 2,000 miles This western section has some semi-hard surfacing but is mostly dirt roadway It passes through Brandon, Man., Regina, Sask., Medicine Hat and Calgary, Alb

TRANSCASPIAN REGION: *see* TURKMEN S S R and KAZAKSTAN A.S S R

TRANSCAUCASIA, a general name given, before the Russian revolution of 1917, to the governments and provinces of Russian Caucasia, excluding the steppe provinces of Kuban and Terek and the steppe government of Stavropol It thus included the governments of Baku, Elisavetpol, Erivan, Kutais and Tiflis; the provinces of Batum, Daghestan and Kars, and the military districts of the Black Sea (Chernomorsk) and Zakataly. It is now applied to the territory of the Transcaucasian Soviet Republic, which embraces the former states of Azerbaijan, Armenia and Georgia. Kars is now included in Turkey.

See republics of ABKHASIA, ADZHARIA, AZERBAIJAN, ARMENIA, GEORGIA, DAGHESTAN and NAKHICHEVAN. Of these republics all except Daghestan joined in 1922 in a Transcaucasian Federation.

History.—On Sept. 20, 1917, a council of Transcaucasian peoples met at Tiflis and declared Transcaucasia to be a Federal republic within the Russian dominions. In May it opened peace negotiations with the Germans and Turks, the latter having invaded the country and captured Batoum and Kars. The Federal Council dissolved, however, on May 26, 1918, Georgia declaring its complete independence and National Councils of Armenians and Tatars taking over the administration of Armenia (Erivan) and Azerbaijan. Separate treaties were signed by Georgia with Germany on May 28 and by the three republics with the Turks and Germans on June 4, which resulted in the "friendly" occupation of Armenia by the Turks and of Georgia by the Germans In the following month the Bolshevik administration at Baku established in March was overthrown and on Aug 4 a British force under Maj-Gen L C Dunsterville occupied the town On Sept 14 they evacuated Baku, which was then occupied by the Turks and became the seat of the Azerbaijan Government. The Turks, however, were compelled to evacuate the whole of Transcaucasia by the terms of the Armistice with the Allies of Oct 30, and in the middle of November, Baku was reoccupied by a British force which administered the district on the collapse of the existing Azerbaijan Government

During 1919 the three Governments gradually established themselves under the protection of the British forces, though Armenia opened hostilities in January against Georgia and in August against Azerbaijan In both cases the disputes (territorial in origin) were settled by British mediation The British forces evacuated the whole of Transcaucasia except Batoum on Aug 28, 1919 In Jan 1920, the Supreme Council sitting in Paris accorded *de facto* recognition to the three Governments On April 27–28 there was a revolution at Baku and the Azerbaijan Government was replaced by a Soviet republic which invited the Russian Soviet forces to occupy the country Georgia and Armenia, however, retained their independence for a time, and the former signed treaties with the Soviet Governments of Azerbaijan (May 7) and Russia (June 6), a step which Armenia refused to take On July 7 the British forces evacuated Batoum and handed over the district to the Georgian Government whose independence was recognized by Soviet Russia in a second treaty signed in August An Armenian Soviet Government was established in December whose independence was recognized by Soviet Russia

On Jan. 27, 1921, the Supreme Council sitting in Paris accorded *de jure* recognition to the Menshevik Government of Georgia, but on Feb 12 there was a rising against this Government in the country and a week later the Russian Soviet troops crossed the frontier Turkish forces then occupied Batoum at the invitation of the Mensheviks, but withdrew on the signature of peace and the proclamation of a Georgian Soviet republic (March 19). In the following May a treaty of Alliance was signed between the Georgian and Russian Soviet Governments Meanwhile the three refugee Governments from Georgia, Azerbaijan and Armenia had fled to Paris and there proclaimed a Caucasian Federation, asserting that the respective Soviet Governments did not represent the wills of the three peoples The three Soviet Governments regulated their relations with Turkey in a treaty signed at Kars on Oct. 13, the provisions of which followed the lines of the treaty concluded in Moscow between Russia and Turkey, March 16. On March 12, 1922, the three Soviet Governments signed an agreement establishing the Transcaucasian S.S.R which, though in close alliance with the Russian Soviet republic, retained independence until the creation of the Union of Socialist Soviet Republics, July 6, 1923, of which it then became a constituent member (*See* Russia.)

TRANSCENDENTALISM is an expression introduced by Kant for "the idea of a science for which the critique of pure reason is to outline the whole plan architectonically. *i.e*, according to principles, with full guarantee of the completeness and security of all the pieces composing this structure" In this sense, it is the system of all principles of pure reason. More precisely, the task of transcendentalism consists in the solution of the question: how are synthetical propositions *a priori* possible, *i.e.*, how can pure intuitions and pure concepts, which are entirely *a priori* and not derived from nor founded on experience, refer to objects of experience and claim for these objects universal and necessary validity? (*Kritik der reinen Vernunft,* 2nd ed p 73) Transcendentalism, according to Kant, is possible only as a system, *ie*, it has to seek its concepts according to a principle because they must issue pure and unadulterated from the understanding as an absolute unity, and must, therefore, themselves cohere with one another according to an idea (*ibid* p 92) As this idea, which establishes and guarantees the coherence between all single cognitions, Kant designates the idea of "possible experience" and an "object of experience" Synthetical judgments *a priori,* whether they belong to the sphere of pure intuition or to the sphere of pure understanding, have the common characteristic that they form those basic functions by which alone it is possible to refer our images to an object and thus to secure for them objective validity In the section "on the supreme principle of all synthetical judgments" Kant shows that this reference to an object is not characteristic of sense impressions as such, but that it is founded on a "synthesis by concepts," *e g.,* the concepts of magnitude, persistence, causality, etc Without such concepts, experience would not be cognition but a mere rhapsody of perceptions which would not enter together into any context of a coherently connected consciousness Cognition *a priori,* accordingly, has truth (*ie*, conformity with the object) only because it contains nothing but what is necessary for the synthetic unity of experience in general. The intuitions and concepts *a priori,* set forth systematically within transcendentalism are, as conditions of the possibility of experience, at the same time conditions of the possibility of the objects of experience and hence applicable to these objects without any restriction (*ibid* p 196 *seq*)

The *term* "transcendental" was not created by Kant The expression goes back to the scholastic philosophy (Knittermeyer *Der Terminus transcendental,* 1920) Here it is synonymous with "transcendent." Transcendental or "transcendent" concepts are such as transcend the realm of finite, conditioned being, and lead on to the Infinite and Unconditioned Only by such a transcendence is metaphysical and religious cognition possible It is necessary to go beyond the variability of finite things and the limits of empirical self-consciousness, if a true knowledge of God is to be reached This use of the word is found already in *Augustine.* In scholasticism, those concepts are called *transcendentia* which are not confined to a specific type of being, but are valid for *all* types Thus the concepts Thing (*res*), One (*unum*), Something (*aliquid*), can be applied to any being Scholasticism gradually developed a fixed order of the *transcendentia* In the *Summa Theologiae* of Albertus Magnus One, True and Good (*unum, verum, bonum*) are introduced as the first essential determinations of being. With Thomas Aquinas, Being is first determined as Thing (*res*) which expresses the "quiddity" or "essence" (*quidditas sive essentia*) of Being; to this are added the concepts One and Something, True and Good (*De Veritate*) *Ens, res, unum, aliquid, verum, bonum,* thus became the "transcendental" concepts of tradition Kant, himself, in the *Critique of Pure Reason,* makes occasional reference to this tradition (2nd ed, p 113)

The new meaning given by Kant to the terms "transcendental" and "transcendentalism," is closely connected with his "revolution in the mode of thinking" In the preface to the second edition of the *Critique of Pure Reason* (p 16) Kant compared this revolution with the change in cosmology effected by Copernicus. "The condition is here the same as with the first idea of Copernicus who, having found that the explanation of the celestial motions did not progress well when he supposed the whole host of stars to turn round the spectator, tried whether it might not succeed better if he made the spectator turn, and left the stars at rest." Thus, in metaphysics, we must not start from a dogmatic assumption about the constitution of *objects* and then determine the mode and character of *cognition,* but, on the contrary, the insight into cognition, into its regularity and structure, must *precede,* and supply the basis for putting and answering the question as to what kind of objects corresponds to that mode of cognition. "If intuition had to follow the constitution of objects, I do not see how one could know *a priori* anything about it, but

if the object (as object of the senses) follows the constitution of our faculty of intuition, I can quite well imagine that possibility." This start from the *mode of cognition*, with the intention of determining the corresponding mode of objects, forms, according to Kant, the basic character of transcendentalism. He calls (*Kritik der reinen Vernunft*, 2nd ed, p 25) all cognition transcendental which is concerned not with objects but with our mode of knowing objects, insofar as the latter is to be possible *a priori*

Transcendentalism, accordingly, does not start with some assumption regarding the essence and constitution of "absolute space," in order to explain the peculiarity of geometrical cognition, but it begins with an analysis of geometry; it shows that all geometry comprises propositions of universal and necessary validity, and it enquires into the "possibility" of these synthetical judgments *a priori*—it investigates "what the conception of space must be, if such a cognition of it is to be possible" (*Transcendental Aesthetic*, §3) The answer to this question is that only if we think of space as an intuition *a priori* can the possibility of the apodictic cognitions of geometry become intelligible Kant emphasises that neither space itself nor any geometrical determination thereof can be called "transcendental"—the term "transcendental" applies rather only to the recognition of the fact that these notions have no empirical origin, and of the possibility by which they can nevertheless refer *a priori* to objects of experience (*ibid* p 80 *seq*) This possibility follows, according to Kant, from the fact that the objects in question are not "things-in-themselves"—not "transcendent" in the sense of dogmatic metaphysics—but phenomena The order and regularity of these phenomena, which we call "nature," does not belong to them independently of the form of our intuition and understanding; but the understanding itself produces this order by connecting the phenomena according to its own laws

Transcendental idealism, therefore, does not reach beyond the sphere of cognition by experience, beyond the realm of the empirical objects, it rather tries to exhibit the foundation of empirical cognition itself In this respect, its use of the word "transcendental" differs, as Kant emphasises, from its older scholastic significance, although even in the *Critique of Pure Reason* it is frequently used in a sense which corresponds to the older view attacked by Kant (A Gideon, *Der Begriff transcendental*, 1903) With particular clearness and pregnancy, the difference appears in Kant's *Prolegomena to any Future Metaphysics*. The word transcendental—it is there declared—does not mean anything which goes beyond experience, but that which, although preceding it (*a priori*), is, nevertheless, only designed to make knowledge by experience possible When these concepts supersede experience, their usage is called *transcendent* The pure forms of intuition, space and time, as well as the categories, as basic concepts of pure understanding, are, therefore, of transcendental *significance*, but not of transcendental *application*; their *validity* is strictly universal and transcends merely empirical incidents, but they extend only to the totality of experience *itself*; they determine its "form," but do not apply to non-empirical, absolute objects In the same manner, Kant determines the concept of "transcendental truth" "In the whole of possible experience lie all our cognitions, and in the general reference to this whole consists the transcendental truth which precedes and makes possible all empirical truth" (*ibid* p 185) (E Cr)

TRANSCRIPTION, in music, is the arrangement of a composition written for one instrument (or group of instruments) for performance by one of another kind, as of an organ work for the piano, of an orchestral work for the organ, and so on

TRANSEPT, in architecture, a transverse section or portion of a hall or building, of considerable relative size, its main dimension being at right angles to the long dimension of the building or hall proper, thus developing a plan of either cruciform or T shape, especially in ecclesiastical architecture, the arms of the church, at right angles to the nave Transepts are found in several of the large early Christian basilicas of Rome, taking the shape of a large, unbroken, transverse hall, whose length is equal to the combined width of nave and aisles, and separated from the nave by a great arch known as the triumphal arch. In the opposite wall an arch of similar size leads into the apse In later basilicas the transept became reduced in importance and the nave ran through unbroken to the apse.

The typical basilica plan, however, has no transept at all, and the transept became a common feature only in Byzantine work from the 8th century, as in S. Mark's at Venice (*c* 1063). It is perhaps due to Byzantine influence that the transept came to be universal in the Romanesque work of France and, less commonly, in Italy In Norman work, both in France and England, transepts were highly developed, frequently designed exactly like the naves, with their own side aisles, triforia and clerestoreys, as in Winchester cathedral (1079–93). These Norman transepts are long; in S Georges at Boscherville (11th century), the north, east and south arms are all equal in length It was probably the opportunity which the transepts furnished for additional altars or for chapels opening out of their eastern sides, as in many Cistercian abbeys, such as Buildwas abbey (1135), that accounts for the universality of the transept. In French examples, outside of Normandy, the projection is frequently less marked, and the transept without side aisles. This became the rule in French Gothic work, in which the transepts often do not project beyond the outer walls of the church, or project slightly

In England, however, long transepts remained the rule until the Perpendicular period, the west transepts at Lincoln (*c* 1200) being 225 ft. long, the transepts of York (1230–60) 220 ft. and those of Lichfield (1220–40) 145 feet In the further effort to increase the number of altars, smaller transepts placed east of the main transept had already appeared in the abbey church at Cluny (1089), and became common in the great abbey churches in England, appearing first at Canterbury (*c* 1170). Other characteristic examples are the eastern transepts of Lincoln (1192), Rochester (*c* 1210). The most beautiful of all are the double transepts of Salisbury (begun 1220) Although the greater number of transepts are square ended, certain occasional examples are apse ended, as in the early basilica at Bethlehem (4th century), S Maria in Capitol and the Holy Apostles (both 12th century, both in Cologne), and the early French Gothic cathedral at Soissons (1175), and that of Noyon (1150) (T F. H)

TRANSFER, the handing over, removal or conveyance of anything from one person or place to another; also the form or method by which it is effected (*see* the articles on LAND REGISTRATION, etc) For the transference of designs, drawings, etc, by means of transfer-paper to the surface of pottery and porcelain, *see* CERAMICS, for their transfer to stones for printing, *see* LITHOGRAPHY

TRANSFER OF STOCKS AND SHARES

Great Britain.—Stocks and shares define the extent of an investor's holding either in a loan to a company, municipality or a government, or in the capital of a company The transfer of stocks and shares is concerned with the formalities that have to be gone through when stocks or shares are bought or sold Usually, this is a question of purchase or sale, but this is not always the case

Three people are directly concerned in every transfer. These are the buyer, the seller and the company or other body which has issued the stock. The buyer has to be assured that the title he acquires is recognized by all concerned, the seller has to be able to prove that he has duly delivered the stock or shares, and the company has to be satisfied that the transfer is a legitimate one, executed in good faith and beyond dispute Other people are concerned indirectly. Thus the buyer and seller always act through agents, such as their solicitor, banker or stock-broker, and the company often employs an agent, such as its bankers, to keep its register of stockholders. Furthermore, when securities are bought and sold on the stock exchange, they may pass through the hands of several intermediaries before they reach the ultimate buyer Finally, the Inland Revenue authorities are concerned, for certain kinds of transfer are liable to duty.

The machinery of transfer is designed to meet the needs of all those mentioned above and to leave no room for dispute. It takes three main forms to suit the three main classes of stocks and shares

(1) **Inscribed Stock.**—Here the names of all stockholders are inscribed in the books kept by the company's or Government's registrar, which is usually a big bank, such as the Bank of England (for British Government stocks) or the Westminster Bank (for certain colonial and corporation stocks). When stocks are bought and sold, the buyer's name is substituted for that of the seller in the registrar's books, which are the sole evidence of possession It is true the buyer gets a "stock receipt," but this is so much "waste-paper" The registrar, of course, has to be satisfied that the transfer is in order Hence he will only act on the instructions of persons known to him. Usually the seller gives his brokers a power of attorney, and as these brokers are known to or can be identified to the registrar, all they have to do is to produce their power of attorney to the registrar as their authority and then the transfer is effected without difficulty. In addition, the seller is notified by post that a power of attorney in his name has been lodged, and is given time to protest if everything is not in order

(2) **Registered Stock.**—Here the stock-holder or share-holder has a certificate showing the nature and extent of his holding, and his name, address and the size of his holding are also entered in the company's share register. The procedure of transfer is different. On a sale being made, the seller's brokers send him a "transfer form," stating the amount and nature of the stock and the price at which it has been sold, and also containing a legal form of agreement as to the sale and purchase This the seller signs in the presence of a witness and returns to his brokers, together with the share certificate. It is then passed on to the buyer's brokers and so to the buyer, who similarly signs it in the presence of a witness It is finally sent with the share certificate to the company's registrar, who, accepting the completed transfer form as his authority, records the transfer and amends the certificate in accordance with the provisions for recording transfers laid down by the company's articles of association

(3) **Bearer Stock.**—Here the possession of the stock or shares by the holder is the only evidence of title required, and so delivery of the stock or shares in question is all that is needed

Certain general points arise. The first is that dealings on the London Stock Exchange are usually "for the account," *i e*, for settlement on every alternate Thursday On this day, stocks and shares must be delivered by the seller to his broker, and the buyer in his turn must pay cash to his broker. Should the seller delay in delivering his certificate and the completed transfer form, his broker may "buy in" the stock against him, and charge the seller with any loss on the repurchase Next, the buyer must not be impatient for his transfer form or share certificate Even after settling day, the form has to come back from the seller be completed by any intermediaries and finally come to him, while many companies provide that transfers have to be passed at the next board meeting before they take effect. Next the transfer form must be filled in and witnessed correctly and without delay, and while, for most stocks and shares, a common form can be used, for some a special form is necessary

Finally, there is the question of transactions "cum" and "ex dividend" A dividend is payable to all stock-holders on a given date, and the purchaser who acquires the stock after that date does not receive the dividend. Hence on that date, the price ceases to be "cum" and becomes "ex div" The same applies to bonus share issues and other privileges or rights belonging to shareholders on a given date, and then the price "goes ex rights" Now the purchaser who buys "ex div" will clearly deduct the dividend from the price he was prepared to pay if he bought "cum div"; thus, if "cum div" price is 88, and the dividend, allowing for income tax, is worth 2¼, the "ex div" price will be 85¾. Now it often happens that a holder will sell "cum div" and that the dividend will be paid before the transfer is registered Then the dividend will be remitted to the seller, but the seller is bound to send it on through his brokers to the buyer.

Stamp duties are borne by the buyer. Bearer stocks and shares are transferred free of duty, but on issue are subject to a duty three times the duty chargeable upon their transfer at par. Inscribed stocks are usually transferable free of duty, as the issuers can and usually do compound the duty by paying a tax of 2s % per annum on the nominal value of the stock The duty on the transfer of registered stocks and shares is normally according to a scale based on a rate of duty of 1% of the price paid, the "price paid" being that paid by the final buyer and inserted on the transfer form in the space "consideration money" When stocks and shares are transferred for a "nominal consideration," *e g.*, from a trustee to his successor or from the holder to his bank who requires them as security for an overdraft or, in certain cases, under the terms of a will, the duty is a fixed one of ten shillings Gifts or exchanges or bequests, where the legatee agrees to accept stock in place of cash, are subject to duty at the normal rate (N E C)

United States.—In the United States the transfer of stock (and it must be remembered that here stock does not signify exactly the same thing that the term does in England, but more nearly has the meaning of the English term "shares") is accomplished quite simply by the transfer of the certificate of stock (*See* STOCKS, SHARES) Such transfer is governed by the Stock Transfer Acts of the several States, most of which have adopted the Uniform Stock Transfer Act. Stock certificates may pass from hand to hand by simple assignment, but in case of sale the purchaser is not a legal stockholder until the stock has been transferred on the books of the issuing company When such a transfer is made the old certificate is cancelled and a new one issued The seller of stock, whose name appears on the face of the certificate, or his authorized representative, must endorse an assignment, which is usually printed on the back of the certificate itself. Such endorsement may be in blank or to a particular person. In all such transfers made on the New York Stock Exchange, it is required that a member of the exchange guarantee the signature of the assignor A bank, trust company or individual may be designated by the issuing corporation as its transfer agent, or its secretary or a special clerk may be given the duty and responsibility of seeing that all transfers are properly made. The several States generally levy a tax upon the transfer of stock The New York State stock transfer tax, which is representative, is 2 cents for each $100 or fraction thereof of stock which has a par value; and a flat tax of 2 cents per share for stock of no par value unless the actual selling value of such stock is in excess of $100 per share, in which case the tax is 2 cents on each $100 or fraction thereof of such selling value (J. H. B)

TRANSFORMATION GROUPS: *see* GROUPS.

TRANSFORMER, an apparatus for changing electrical energy from a given pressure into a higher or lower pressure It is stationary, with no moving or rotating parts, and is operative only with alternating currents It plays such an important part in the transmission and distribution of electricity that the present extensive electrical systems would have been impossible without it Incidentally, since transformers are operative only with alternating currents, all extensive electrical systems have had to adopt the alternating current system so as to use transformers

History and Place in Industry.—Very early in the art it was realized by electrical engineers that, while the generation and utilization of electrical energy are safer and more economical at lower pressures and larger currents, its transmission and distribution are more economical at higher pressure and smaller currents Therefore, in order that a central power house might economically serve even a small territory, it was necessary to have apparatus capable of "stepping-up" the voltage at the point of generation and "stepping-it-down" at or near the points of utilization

Before such an apparatus was invented, physical laboratories used induction coils, similar to automobile spark-coils, for stepping-up battery voltages to high values for experimental purposes, but these were too inefficient for power applications These coils used an open magnetic circuit and required an interrupter, a "make-and-break" attachment, functioning similarly to the distributor in automobile ignition. The necessity for this attachment arose from the fact that currents and voltages could be induced only by fluctuations in flux, and a fluctuating flux could be produced only by a fluctuating current. Therefore, since a battery tended to give a steady uniform current, an interrupter was necessary to produce abrupt changes in current.

It was early realized that if alternating currents are utilized, no interrupter is necessary; and, if the magnetic circuit is made completely closed, the performance characteristics of such a coil are remarkably improved

The first successful transformer was demonstrated by William Stanley in the United States It was put in service in Great Barrington, Mass, in the spring of 1886. Besides for transmission and distribution, transformers are used in a very great variety of services for converting alternating current energy from the pressure at which it is available to the pressure most suitable for the object in view: ringing door-bells, requiring very low safe voltages, welding ship plates, requiring very large currents, operating X-ray tubes, or producing "lightning" bolts requiring enormous voltages Their use in radio for coupling as well as for filament lighting and other power supply is well-known

General Principles of Operation.—*Voltage Transformation* Fig 1 is a simplified diagram of a transformer, showing a closed magnetic circuit M, a lower voltage winding L, and a higher voltage winding H If an alternating voltage is applied to the terminals of one of the windings, say L, leaving the terminals of the other winding, H, open, a small current flows into the excited winding L sufficient to produce a counter voltage equal to the impressed voltage The apparatus in always so designed that the counter voltage is almost entirely one of self-induction, the voltage consumed in the resistance of the conductor usually being less than one-tenth of 1% of this self-inductive drop The voltage of self-induction is produced by an alternating magnetic flux in the core, which in turn is produced by the alternating current flowing in L The relationship between the total or maximum flux and the induced voltage, E_L is

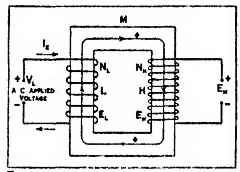


FIG 1—DIAGRAM OF TRANSFORMER WITH SECONDARY OPEN-CIRCUITED (SHOWING INSTANTANEOUS CONDITIONS)

$$E_L = 4.44 f N_L \phi\ 10^{-8}$$

where E_L is the effective (root-mean-square) voltage across L produced by self-induction, f is the frequency of the impressed voltage (periods or cycles per second), N_L is the number of turns in series in winding L, and ϕ is the peak value of the alternating flux ϕ

Obviously, the alternating flux ϕ, linking winding H as well as L, will induce a voltage in H proportional to its turns

$$E_H = 4.44 f N_H \phi\ 10^{-8}.$$

Comparing E_L and E_H, it is seen that

$$\frac{E_L}{E_H} = \frac{N_L}{N_H};$$

that is, the induced voltages of the two windings are directly proportional to their respective turns Thus is obtained the voltage transformation from a given value to another value

Current Transformation—The transformer is now excited but as yet unloaded, that is, no current or power is drawn from it If now a load, with impedance Z, is connected across the terminals of the second winding, H, fig 2, the voltage appearing at its terminals will send a current I_H into the load, equal to

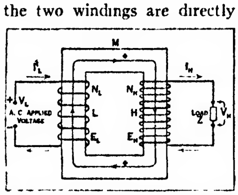


FIG 2—DIAGRAM OF TRANSFORMER WITH SECONDARY LOADED (SHOWING INSTANTANEOUS CONDITIONS)

$$I_H = \frac{E_H}{Z}.$$

This current tends to demagnetize the flux ϕ and thus to reduce the counter E M F of induction But since the voltage impressed on L is maintained at full value, an additional current, I_L, flows into L sufficient to maintain the flux ϕ. This additional current I_L, as also the current I_H, being produced by the load, are called the load currents of the windings, to distinguish them from the no-load current which flows only in the excited winding and which is called *exciting current*

To neutralize the demagnetizing effect of I_H, it is necessary and sufficient that the magnetomotive force or ampere-turns associated with I_L be equal and opposite to that associated with I_H.

$$I_L \times N_L = -I_H \times N_H$$

or

$$\frac{I_L}{I_H} = -\frac{N_H}{N_L}.$$

That is, the load currents in the two windings are inversely proportional to their respective turns, and thus is obtained current transformation It may be noted that current and voltage transformation are in inverse ratio, so that when one is "stepped up" the other is "stepped down" in the same ratio

Energy Relationship—That winding of the transformer on which voltage is impressed and into which energy flows is called the primary, and the other winding, from which energy is drawn out, is called the secondary Either the higher or the lower voltage winding may be used as the primary, and the other as the secondary, so that the operation of a transformer is reversible

The energy flowing into a circuit being proportional to the product of current and voltage, for the load circuit it will be $I_H E_H$, and for the primary circuit $I_L E_L$ By the law of conservation of energy, these two must be equal to each other in an ideal transformer Comparing the values of $I_H E_H$ and $I_L E_L$ from the foregoing, they are seen to be equal and opposite to each other, that is, as much additional energy flows into the primary as is drawn out from the secondary In an actual transformer, some energy is lost within the transformer, so that the energy output is always slightly less than the energy input

Rating of a Transformer.—The type of service for which a transformer is suitable is expressed by its rating, covering usually the following items (1) Kv-a (*i e*, kilovolt-amperes), representing the power capacity, (2) voltages of the various windings, (3) frequency, (4) temperature rise The rating plate usually gives information also with reference to the method of cooling, type of construction, and the proper connections to make

Performance Characteristics.—The degree of excellence of a transformer is indicated by its performance characteristics which usually appear in guarantee specifications as follows (1) exciting current, (2) core loss, (3) copper loss, (4) leakage reactance or impedance, (5) voltage regulation, (6) efficiency, (7) temperature rise, (8) insulation strength Item (5) is a function of item (4), and item (6) is a function of items (2) and (3), so that the controlling independent characteristics are items (1), (2), (3), (4), (7) and (8) The resultant characteristics that interest operators are (1), (5), (6), (7) and (8).

(1) *Exciting Current*—It has been indicated already that the voltages of the various windings of a transformer are induced by an alternating magnetic flux in its core, and that sufficient exciting current flows into the primary winding to produce the necessary flux from instant to instant For a given frequency, terminal voltage and the number of turns, the necessary flux is completely determined by the formula given above The necessary exciting current is then determined with the aid of the characteristic curve of the material used in the magnetic circuit Thus, given the total flux ϕ, and cross-section A of the magnetic core, the flux density B in the core follows as

$$B = \frac{\phi}{A}$$

By referring to the characteristic curve of the core material, the value of the necessary exciting ampere-turns corresponding to the flux density B is obtained This divided by the turns of the excited winding gives the necessary exciting current in amperes. Finally, if this exciting current is multiplied by 100 and divided by the rated load current of the winding, the per cent exciting current is obtained Obviously, the exciting current does not flow into a useful load, and is in a sense wasted. It is therefore desirable that

it be limited to as small a value as possible. In commercial power transformers it is limited to between 1% and 10% of the rated useful load current of the transformer. In miniature transformers, it may greatly exceed the latter limit.

Low exciting current is obtained by using high permeability material for the magnetic circuit, low flux density, short length of magnetic circuit, and greater number of turns per volt in the windings Various alloys of iron (usually silicon-steel) are used on account of their high permeability

(2) *No-Load Loss or Core Loss.*—The alternations of the magnetic flux in the transformer core waste energy (in the form of heat) due to (*a*) hysteresis and (*b*) eddy currents. Both the hysteresis loss and the eddy current loss are found to be very much less in silicon-steel than in many other kinds of iron alloys, and therefore this material is used exclusively for all power and distribution transformers It also shows superior permeability (lower exciting current) compared with common forms of iron at moderate flux densities A further advantage of silicon steel is found in its non-aging quality, while common forms of iron increase in core loss with use The eddy current loss is reduced by laminating the core and insulating the laminations from each other either by oxide scale or preferably by thin enamel. The thicknesses of laminations used commercially are· for 50 to 60 cycle frequencies about 0·014 in , for lower frequencies as much as 0 025 in , and for audio and radio frequencies 0·007 in , or smaller Silicon steel being very hard and somewhat brittle, its rolling into thinner sheets than the above is difficult and expensive In commercial power transformers, the core loss varies from a quarter of 1% to several per cent

(3) *Load Loss or Copper Loss.*—The load currents in the windings, flowing against the resistances of the conductors, produce an energy loss in them equal to I^2R The resistance R is to be understood as the alternating-current resistance, which usually is higher than the direct-current resistance of the winding, due to skin-effect or non-uniform distribution of current among the various filaments of the conductor The copper loss is tested or measured best by short-circuiting one winding of the transformer and putting excitation on the other winding sufficient to circulate the rated current in the windings This test is sometimes spoken of as the impedance test, as it makes possible the measurement of the "impedance volts" of the transformer, as well as its "impedance watts," which is another term used for the alternating-current copper loss of the transformer

(4) *Leakage Reactance or Impedance* —Although the magnetomotive forces in the primary and the secondary windings due to the load currents are equal and opposite to each other, and therefore neutralize each other in any magnetic circuit common to both —for example the steel core—yet they produce leakage fluxes in the spaces between the two coils, giving rise to a *leakage reactance.* This reactance, combined vectorially with the effective resistance of the windings, constitutes the leakage *impedance* of the transformer. Ordinarily, the reactance is many times the resistance of the windings, and hence substantially equal to the impedance. The leakage impedance of a constant potential transformer serves a protective purpose in limiting the short-circuit current of the transformer. However, it produces an undesirable effect in reducing the secondary voltage. (See *Voltage Regulations.*)

The reactance voltage, expressed as a percentage of the rated circuit voltage, varies from 3 to 15%, the lower values occurring in distribution transformers, the higher in the larger power transformers. In order to hold the reactance of a transformer within the range indicated above, the primary and secondary windings have to be closely interlaced If the windings were separated from each other, the reactance would be prohibitively high and the voltage regulation correspondingly poor.

(5) *Voltage Regulation*—Reference to this has already been made. With a constant voltage maintained on the primary of the transformer, the no-load voltage of the secondary is higher than its full-load voltage If the excitation is so adjusted as to make the secondary terminal voltage the full rated value of full-load, and then, without changing the primary impressed voltage, the load is removed, the secondary voltage will rise above the full-load value. This rise is called the regulation drop and is usually expressed as a percentage of the rated full-load voltage.

The regulation is ordinarily calculated as follows: Given %IR, the per cent alternating current resistance, or, better yet, the per cent impedance watts, of the transformer; %IX, the per cent reactance of the transformer; *p*, the power factor of the load, and, *q*, the reactive factor of the load, then,

$$\%\,\text{regulation} = p \times \%IR + q \times \%IX + \left(\frac{p \times \%IX - q \times \%IR}{200}\right)^2.$$

This formula is an approximation but yields more accurate results than some absolute formulae in actual manipulation Fig. 3

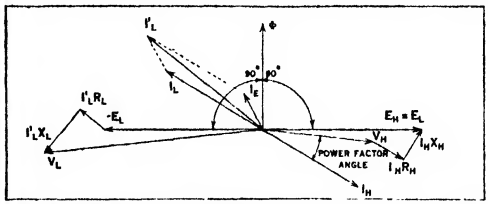


FIG. 3.—COMPLETE VECTOR DIAGRAM OF ONE-TO-ONE RATIO TRANSFORMER

is a vector diagram, showing the various component voltages

(6) *Efficiency*—The total losses of a transformer in power and distribution service vary from about ½ of 1% to about 4%, depending on size, frequency, voltage, etc , making the efficiency vary from 96% to 99 5% It is this fact of high efficiency, coupled with the further fact of the absence of any mechanical motion that has made the transformer a most valuable apparatus and has led to the adoption of alternating currents by most systems

(7) *Temperature Rise*—The maximum load that may safely be put on a transformer is limited by its temperature rise The insulations commonly used in transformers, being largely organic substances, are subject to rapid deterioration under overheat. Temperature limits vary in different countries, ranging from 50° to 65° C rise above the ambient (surrounding) temperature.

(8) *Insulation Strength*—Transformers not only produce higher and lower voltages, but they also insulate one circuit from the other and from ground The safety of both the transformer and the circuits which it links is therefore dependent on the strength of its insulation For rules of various societies on this subject and for methods of making such tests reference may be made to the appropriate literature listed in the bibliography.

Transformer Connections.—For polyphase circuits, a great number of transformer connections have been developed, the standard connections for three-phase circuits being the Y and the delta connections Various connections have also been developed for accomplishing transformation from a polyphase system of a given number of phases to one of a different number of phases, with or without voltage transformation

Structural Classification of Transformers.—When the windings of a transformer surround the magnetic circuit the transformer is *core type;* and when the magnetic circuit surrounds the windings the construction is *shell type.* The windings may be either cylindrical and arranged one inside the other, in which case they are *concentric;* or they may be flat coils and sandwiched in with each other (to obtain reasonably low leakage reactance), in which case they are *interleaved.* The windings may be interleaved with either core or shell type of magnetic circuit The coils may be wound on circular forms, in which case the transformer is said to be of *circular-coil construction;* or they may be wound on rectangular forms, as in the so-called *pancake* or *shell-type* coils

Transformers may be oil-immersed or dry. The former is very desirable for the higher voltage and larger power units for improved insulation and cooling, while the latter is more desirable for miniature transformers for greater convenience. Sometimes considerations of fire risk lead to the use of dry transformers in even large sizes, which then are cooled by an air blast Based on the method used for cooling, transformers may be, (1) *water-*

cooled, in which case cool water is circulated in sealed tubes immersed in the insulating oil filling the transformer case; (2) *air-blast,* in which air is blown by fans through the air ducts of the windings; (3) *air-cooled* or *natural draft,* depending on natural radiation and convection from the exposed surface of transformer or its case; (4) *forced oil,* in which the hot oil is pumped out into radiators, cooled and returned into the transformer; (5) *air-jet cooled,* in which jets of air are blown on the tank and its radiating pipes to break up the stagnant film of air adhering to them and thus to accelerate the cooling by convection of air currents.

Auto-Transformers.—In cases where primary and secondary voltages of a transformer are not very widely different from each other and insulation of the two circuits is not essential, economy can be effected by making some portions of the windings common to both circuits. Auto-transformers used for starting motors at reduced voltage are called *compensators.* (*See* ELECTRICAL POWER TRANSMISSION; ELECTRICITY SUPPLY)

BIBLIOGRAPHY —S A Stigant and H M Lacey, *The J & P. Transformer Book* (1928), E. G Reed, *Essentials of Transformer Practice* (1927); M Vidmar, *Die Transformatoren* (1927), M Vidmar, *Der Transformator im Betrieb* (1925); W. T Taylor, *High Voltage Transformers* (1922), G Kapp, *Transformers for Single and Multiphase Currents*, and J A Fleming, *Alternate Current Transformer in Theory and Practice.* Also the standardization rules of the various engineering societies such as the American Institute of Electrical Engineers and the British Engineering Standards Association. (A. BOY; F. W. P.)

TRANSIT CIRCLE or **MERIDIAN CIRCLE,** a telescope for measuring the time when a star passes across the meridian and at the same time measuring its altitude These two measurements determine respectively the right ascension and declination, and hence the place of the star on the celestial sphere. Because of its fundamental importance in positional astronomy, and as the source of standard time furnished to the community, the transit circle is traditionally regarded as the leading instrument, at least in the great national observatories; but in modern times important observatories have grown up whose work lies wholly in other directions The transit circle looks rather like a big gun on a gun-carriage, and to the stranger the surprising thing about this kind of telescope is that it cannot be turned to all parts of the sky, it only moves up and down in the north and south line, looking out through a slit in the walls and roof. Nor can it be used for prolonged study; the observation is a snap-shot as the object passes rapidly across the field of view

Suppose that we are going to remeasure the exact position of some star We choose from the catalogues a star which is due to pass across the north-south line in a minute or so, and by means of a setting circle we elevate the telescope to the proper angle to catch it. The aperture of the object-glass is probably 8 or 9 in, and it will easily show stars to the ninth magnitude Whilst waiting, let us examine the field of view. Turning on a faint artificial illumination, we see stretched across the field a number of "wires" which are actually made of spider-web; there is one horizontal wire which we can move up or down by turning a micrometer screw, and a considerable number of vertical wires (perhaps ten). Our star now enters the field—at the extreme right since the telescope inverts—and is seen travelling rapidly towards the left. We shift the telescope slightly so as to bring the star almost on to the horizontal wire, and then clamp the instrument at that altitude. Now the star is approaching the series of vertical wires; as it passes each, we press a key which records the instant on a chronograph on which the standard sidereal clock is recording the seconds.

Near the centre of the field there is an intermission which gives us a few moments for making the altitude observation. Turning the micrometer screw, we make the horizontal wire bisect the star, repeating this two or three times to reduce accidental errors. There is no time to read the micrometer head, but it is furnished with some printing or recording device which will keep a record of our settings We now finish tapping off the passage over the vertical wires, and the star disappears from view We have next to go round to the side of the instrument and read four long microscopes which are viewing a graduated circle attached to the telescope Their combined reading will ultimately tell us at what elevation the telescope was clamped; we must add on to that the reading of the micrometer head so as to include the extra displacement given to the wire to bring it on to the star.

The whole observation takes two minutes or less, but there is a great deal of work in store for the computer. He must sort out the taps on the chronograph belonging to this star, and also the records of the micrometer head. The error and rate of the standard clock must be worked up from the "clock stars" observed during the night. The large correction for refraction must be computed and applied to the altitude Various observations for adjustment will have been taken, and from these the collimation, azimuth, level, and zenith-point corrections must be deduced and applied. There will be further corrections, not specially connected with the instrument, to be included before the final place of the star is obtained in the form of mean right ascension and declination This typical procedure may be varied somewhat. The most important modification is the use of the travelling-wire micrometer (*see* MICROMETER), which is now generally employed in first-rate work Attempts have been made to substitute some photographic or photoelectric method for visual observation.

In olden times the altitude observation and the time observation were made with different instruments, called respectively the *mural circle* and the *transit instrument.* The mural circle is obsolete; but the transit instrument survives as a small portable instrument used for determining longitudes and for the most accurate determinations of time. The transit instrument is virtually a transit circle shorn of its graduated circles and microscopes

The transit circle is used for determining the positions day by day of the sun, moon and planets. For stellar work its scope is limited to the brighter stars, roughly those brighter than mag. 9 0 (there are more than 100,000 of these). There is no advantage in observing fainter stars with it, since the work can be done more speedily and accurately by photography; but photographic measures are relative, and the positions can only be made absolute if the photograph contains some "reference stars" whose absolute positions are already known from meridian work Thus transit circle observation is extended only so far as to provide accurate positions of a reasonable number of reference stars on all photographs.

TRANS-JORDAN, a territory under British mandate, bounded west by Palestine, north by Syria, east by Najd and 'Iraq, and south by Hejaz, whose north district ('Aqaba-Ma'an) has, since its occupation by British forces in 1925, been *de facto* included in the mandated area. The Jordan, Dead sea and Wadi 'Araba form the west frontier, from which the land rises abruptly to the mountains (4,000–5,000 ft) of Gilead, Moab and Edom, which are the most fertile parts of the country and produce excellent grapes (for raisins), wheat and other crops. Along the east edge of this highland belt runs the Hejaz railway, beyond which is the desert stretching to the frontier, which is undefined where it marches with 'Iraq and Hejaz and was fixed so far as Najd is concerned by the Treaty of Hadda (1925). Under the Ottoman régime this tract formed part of the Wilayat of Syria, becoming after the World War part of the short-lived Arab kingdom of Syria On Faisal's expulsion by the French in 1920 the three Trans-Jordan districts of 'Ajlun, Balqa and Karak formed a loose semi-independent federation under the general control of British representatives appointed from Palestine In April, 1921, Sharif 'Abdullah, second son of King Husain, suddenly arrived at 'Amman with an Arab force for the invasion of Syria and was recognized by Great Britain as Amir of an independent state comprising the Trans-Jordan districts. At first the Palestine authorities exercised a rigid control over 'Abdullah's administration with the result that intrigues and other more serious trouble occurred In October the experiment was tried of allowing the Trans-Jordan Government a greater latitude, but, after a period of comparative success and tranquillity, 'Abdullah's reckless extravagance and irresponsibility resulted in its failure. A British proclamation of 1923 recognizing the independent status of Trans-Jordan subject to certain conditions never became operative and at the beginning of 1924, after an abortive rebellion of the 'Adwan tribe in Sept., 1923, and further financial complications, the

British Government decided to suspend the experiment and to establish direct control over the more important branches of the administration through British officials directly responsible to the Palestine Government. A considerable increase in the number of British officials and the transfer of the Palestine gendarmerie *en bloc* to Trans-Jordan resulted in fact in the carrying on of the administration on Crown-colony lines and the local government, existing as a façade, exercised little or no independent authority.

The position being thus stabilized, negotiations between the British Government and 'Abdullah resulted in Nov., 1927, in the signing of a treaty, by which the independence of the Trans-Jordan Government was formally recognized with such stringent provisions for British supervision and control in all departments of the administration that all semblance of real independence was effectively disguised In fact, the treaty formally legalized the *status quo*, and the only innovation introduced by it was the provision made for an elective legislative assembly designed to control 'Abdullah but powerless to act in opposition to the mandatory Power. Local feeling has run high against the treaty and 'Abdullah has been accused of betraying the interests of the country for a personal advantage Nevertheless the status of the country and its relations with the Mandatory are for the time being regulated by this instrument which ensures a measure of harmony between the policies, particularly in the economic field, of Palestine and Trans-Jordan. The clauses of the Palestine mandate relating to the establishment of a national home for the Jews do not operate beyond the Jordan, but the plans, now far advanced, for the exploitation of the potash and other contents of the Dead sea, of which half belongs to Trans-Jordan, indicate a settled policy of co-operation between the two countries under effective British control Under this arrangement economic prosperity is assured as a substitute for political independence, and the still exiguous revenues of the country, which are eked out by a British grant-in-aid, should in due course be capable of bearing the whole cost of its administration besides providing much needed funds for development in various directions Occasional trouble between the Badawin tribes of Najd and Trans-Jordan is perhaps inevitable in the process of change that is going on in a desert that knew no frontiers and recognized raiding as a reasonable pastime. Latterly courts of arbitration have been convened for the settlement of such incidents without however achieving much success and much yet remains to be done before the relations of Trans-Jordan with Hejaz-Najd can be regarded as satisfactory

The population of Trans-Jordan is about 300,000 of whom half are Badawin, there are 30,000 Circassians inhabiting a number of colonies planted by the Turkish Government after the Russo-Turkish war of the '70s and about 40,000 Christians of various sects The chief towns are 'Amman (20,000), Salt (20,000), Karak (8,000), Irbid and Ma'an (3,000 each). At the beginning of the Christian era 'Amman (Philadelphia), Jarash (Gerasa), Umm Kais (Gadara) and other places were important centres of Greco-Roman civilization Later Trans-Jordan was part of the territory of the local kingdom of Ghassan and was conquered by the Muslim armies in 637 During the Crusades Karak was an important administrative centre of Oultre-Jourdain. (*See* also ARABIA and PALESTINE) (H ST. J B. P)

TRANSKEI, one of the divisions of the Cape Province of South Africa, east of the Kei river, being part of the country variously known as Kaffraria, or "the Native Territories" The majority of the inhabitants are Fingoes.

TRANSMISSION LOSS, as applied to radio, indicates the loss of power suffered by a transmitted wave in passing along a transmission path or through a circuit device

TRANSMITTER: *see* MICROPHONE, TELEPHONE.

TRANSMITTING SET, a device for producing radio-frequency power and modifying it in accordance with a signal.

TRANSMUTATION OF THE ELEMENTS. The transmutation of one metallic element into another was one of the chief objects of the earliest chemists, or alchemists, while to-day, under the influence of modern views on the constitution of matter, transmutation has again been attempted in various ways. Between the ancient and the modern tradition, however, there is a complete break, both as regard purpose and method The alchemist was mainly interested to produce, from base metals, gold and silver in large quantities, on account of their intrinsic worth, the man of science of to-day has striven to effect the transformation because of the important light which such a process, however small the quantities involved and whatever the elements concerned, would throw on atomic theory For ALCHEMY *see* that heading The present article is concerned with *Transmutation in Modern Times*

The discovery of radioactivity brought the question of the transmutation of the elements under the serious attention of men of science, and the development of the modern theory of the atom, leading up to Rutherford's experiments on the disruption of the nucleus, seemed to indicate a possibility of producing artificial transmutation The various attempts which have been made along different lines have not led to any convincing success

Radioactive Transmutations and Transmutation Produced by Alpha Particles.—The theory of radioactive transformation, put forward in 1902 by Rutherford and Soddy, associated the emission of α- and β-rays with actual changes in the chemical and physical nature of the atoms emitting the rays, and asserted that in radioactive processes we actually have one element gradually transmuted into another, the number of atoms changing in unit time being a definite fraction λ of the number of atoms present. The value of λ is characteristic of the kind of atom in question It is now definitely established that for each α-particle emitted by a given radioactive element one atom of that element is transformed into an atom of an element whose atomic weight is less by 4, while its atomic number is less by 2, the unit of mass being one-sixteenth the mass of an oxygen atom while, in the case of β-transformations, the atom does not change its mass appreciably, but its atomic number increases by 1 (*See* RADIOACTIVITY, ISOTOPES, NUCLEUS) The change in properties attending this spontaneous transmutation is in many cases very striking Thus radium is an element very much resembling barium, it is a metallic solid at ordinary temperatures, which readily forms halogen compounds Radium emits α-particles and changes to a gas, the so-called radium emanation, or radon, which is, chemically speaking, extremely inert. This gas in its turn emits α-particles and changes to a solid

Although, generally speaking, the radioactive elements are obtainable only in very small quantities, often unweighable, their electrical properties are so remarkable and so characteristic that their identification is certain, while in some cases, notably with radium and its product radium emanation, the quantities are sufficient to enable the physical and chemical properties to be obtained by ordinary means For instance, the spectra of the two elements are radically different. the metallic nature of radium can be seen by inspection of the purified metal. the density of the gaseous emanation has been found by delicate weighings, and the vapour pressure of the liquefied gas measured There is, then, no doubt that in radioactivity we are witnessing a transformation of the elements, but this transformation is outside our control We cannot by heat or cold hurry it or delay it, the rate at which it takes place is uninfluenced by pressure, by chemical combination, or any other agent at our disposal in the laboratory

In the case of radioactive substances we cannot, then, be said to be *effecting* a transmutation of the elements, but merely to be observing one staged by nature However, the great energy of the radiations from radioactive substances, and the marked chemical effects which they can produce at once suggest them as weapons with which to attempt the transmutation of elements normally stable. The α-rays in particular represent so marked a localization of energy that they would appear most likely to be effective in this respect

The first experimental attempts to provoke a transformation by means of the radiation from a radioactive substance were made by A. T. Cameron and Sir William Ramsay in 1907 and 1908 They first found that radium emanation in pure water produced not only helium, but also neon and a trace of argon They also announced that in a solution of copper salts a conversion of a minute part of the copper into lithium took place

as a result of the action of the α-particles. Rutherford and Royds, however, found that emanation in water produced only helium, which is to be expected, for it is now abundantly established that the α-particles are doubly charged atoms of helium. The neon and argon observed by Cameron and Ramsay are attributable to a small leak of air, very minute traces of these gases being detectable by the spectroscope. Other workers were unable to confirm the production of lithium, and it was soon generally accepted that the presence of this metal was due to the admission of traces of impurity, and not to transformation

The difficulty of these experiments is that the amounts of elements supposedly produced by transmutation are excessively minute and the spectroscopic methods used for detection exceedingly sensitive, so that the slightest defect in the manipulation is sufficient to produce a spurious appearance of transformed matter. In 1913 N Collie and H Patterson described experiments which they considered to show that the passage of an electric discharge through hydrogen in X-ray bulbs produced helium and neon, the source of which was supposed to be a transmutation of some one or more of the elements present in the walls of the tube, or of the hydrogen or mercury vapour However, J. J. Thomson and other workers showed that the gases were already in the walls of the tube, and that the action of the discharge was merely to liberate, not to manufacture, them

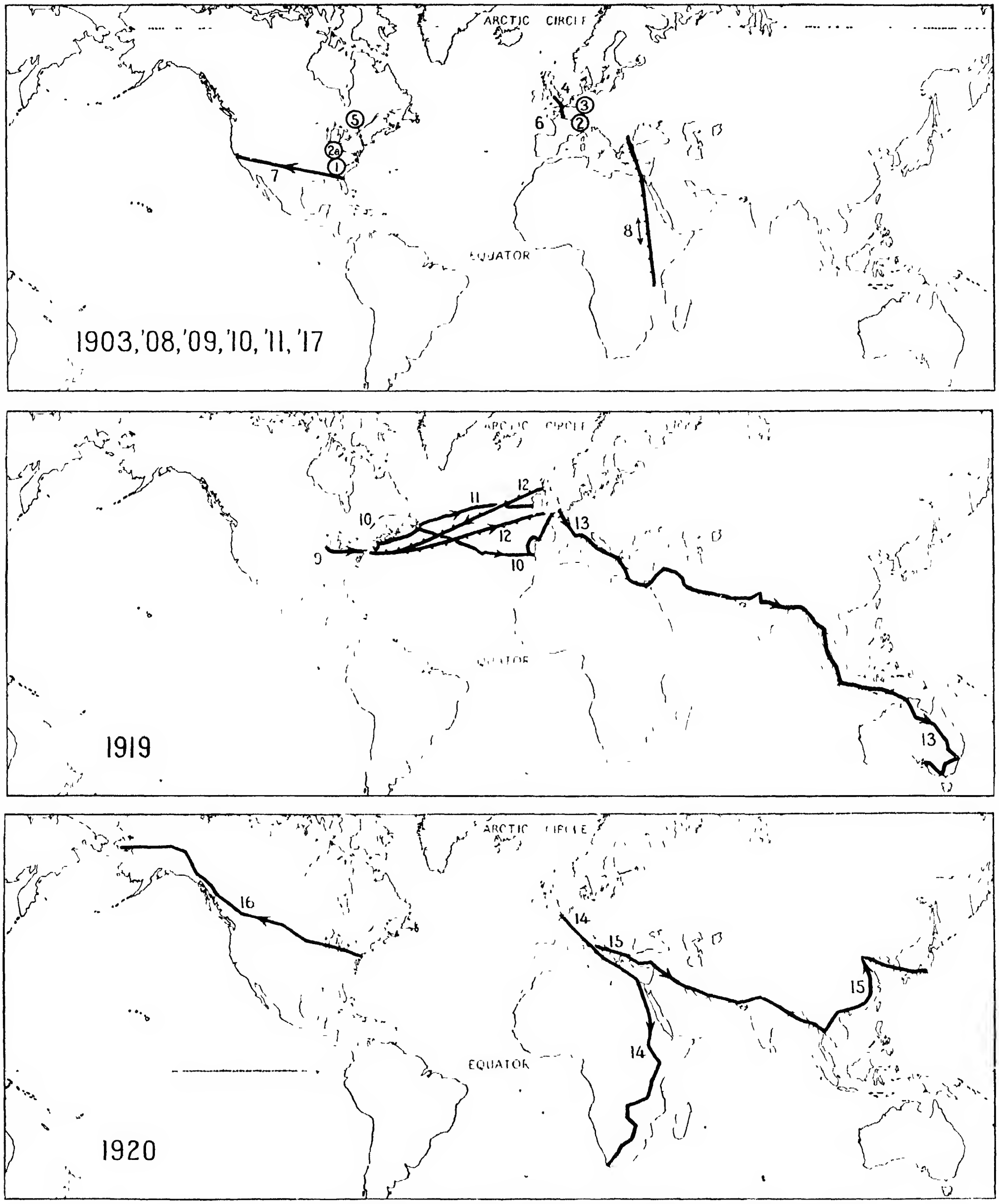
After this the question of transmutation was left alone for some years, until interest was revived by the experiments of Rutherford on the disruption of atomic nuclei by bombardment with α-particles These experiments are described under NUCLEUS. Rutherford and his collaborators showed by the method of scintillations, which enables single atoms to be observed, that, in the case of certain elements, swift α-particles can knock a proton from the nucleus, the process resulting in the formation of a nucleus of a fresh kind, that is, in a transmutation of the element in question The expulsion of a proton, however, only takes place very rarely, since, for it to occur, the α-particle must strike the nucleus with a full collision, and not at a glancing angle, and the nucleus is very minute compared with the atom itself. Rutherford's calculations, confirmed by the ray-track photographs of Blackett, show that of the incident α-particles only something of the order of 2 per 100,000 produce a disintegration of the nucleus in the case of nitrogen, which means that the whole of the α-rays from 1 gramme of radium in equilibrium with its products (and 1 gramme of radium, costing £20,000 or so, is far more than a physical laboratory can hope to possess) would only transmute about two ten-millionths of a gramme of nitrogen in a year—an unweighable quantity. There is, therefore, no question of producing by this method sufficient transmuted matter for ordinary chemical or physical tests to be applied, and, in fact, although the expulsion of the proton is established beyond doubt in the case of the elements boron, nitrogen, fluorine, neon, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, argon and potassium, it is not known what elements are formed when atoms of these elements are so transmuted The uncertainty is as to what becomes of the α-particle If it expels the proton and itself passes on a given atom will be transformed to one whose atomic number is lower by 1, and whose atomic weight is lower by 1. if, on the other hand, the α-particle sticks in the nucleus the resulting atom will have its atomic number greater by 1 than its parent, and atomic weight greater by 3 Blackett's photographs of ray tracks indicate that in the case of nitrogen the latter is the case, so that each nitrogen atom transmuted becomes an oxygen atom, which, having atomic weight 17 instead of 16, is an isotope of ordinary oxygen. On the other hand, the ray-track photographs of Harkins and Ryan, and of Akiyama, taken in air (which comes to the same thing as nitrogen, since no evidence for the disruption of the oxygen nucleus has ever been obtained) show cases of disintegration with tracks of expelled proton, struck nucleus, and α-particle after collision This would indicate that the α-particle does not always stick in the nucleus. This point awaits further elucidation.

Recent Attempts at Artificial Transmutation.—The many lines of work which are described in the articles NUCLEUS and ISOTOPES have confirmed the hypothesis that the nucleus is built up of electrons and protons, the net positive charge of the nucleus giving the atomic number and determining the number of electrons in the extranuclear structure of the neutral atom, and so the chemical properties of the atom, while the number of protons gives the atomic mass. These ideas, and the experiments on nuclear disintegration by α-particles to which reference has just been made, have encouraged many workers to endeavour once more to effect a transmutation of the elements in weighable quantities, or, failing that, in quantities demonstrable by chemical and physical tests. If it were possible either to add an electron to, or to subtract a proton from, the nucleus of an element of atomic number Z, then an element of atomic number Z-1 would be formed. Attempts have been made to effect both these changes As the naturally unstable, or radioactive elements, are the heaviest ones in the periodic table most workers endeavouring to provoke a transmutation have made their choice among the heaviest of the non-radioactive elements, namely the following, the atomic numbers being given in brackets: gold (79), mercury (80), thallium (81), lead (82), bismuth (83). On account of the apparent ease of purification, mercury has been a popular choice.

Nagaoka, studying in detail certain satellite lines in the spectra of mercury and of bismuth, came to the conclusion that these lines were best explained by the hypothesis that the nuclei of these metals contain a single proton slightly detached from the main nucleus, and capable of executing coupled vibrations with it, that is, a proton which, while forming part of the nucleus, is more loosely bound than any other proton or electron of the nucleus He concluded that it might be possible to strike the proton out of the nucleus, and thus effect a transmutation He used purified mercury for his experiments, the method being to pass intense discharges, from an induction coil capable of giving a spark 4 ft in length, between a tungsten wire and a mercury surface To keep the terminal voltage high with the short spark gap used, the mercury was covered with paraffin oil or other suitable oil; the discharge was passed for some hours Nagaoka found gold in the pasty mass of oil and mercury formed, using the ruby glass test for the detection No estimate of the amount of gold so formed was made

Miethe was led to his experiments on transmutation as the result of the observation that when a mercury-vapour lamp, of Jaenicke type, was run with too strong a current a black deposit was formed, in which he found gold There was no particular theoretical reason for anticipating that the experimental conditions adopted would force an electron into the nucleus, but Miethe came to the conclusion that there must be some special state of ionization of the mercury atom produced which was favourable to the transmutation, and, with his assistant, Stammreich, carried out many experiments, in which currents of 12 amperes or so, at a terminal voltage of 170 volts, were passed for many hours through mercury vapour lamps burning at atmospheric pressure These experimenters reported yields of gold up to one-tenth of a milligramme, and also, a fact which is hard to explain on the most fantastic theory, a formation of silver. In later experiments Miethe adopted the method of constantly interrupting the arc, a procedure which he considered to exercise a favourable influence on the formation of gold. Although the amounts of gold found were very small, crystals recognizable under the microscope were obtained, and various tests, such as the streak of fine gold, gave a satisfactory result.

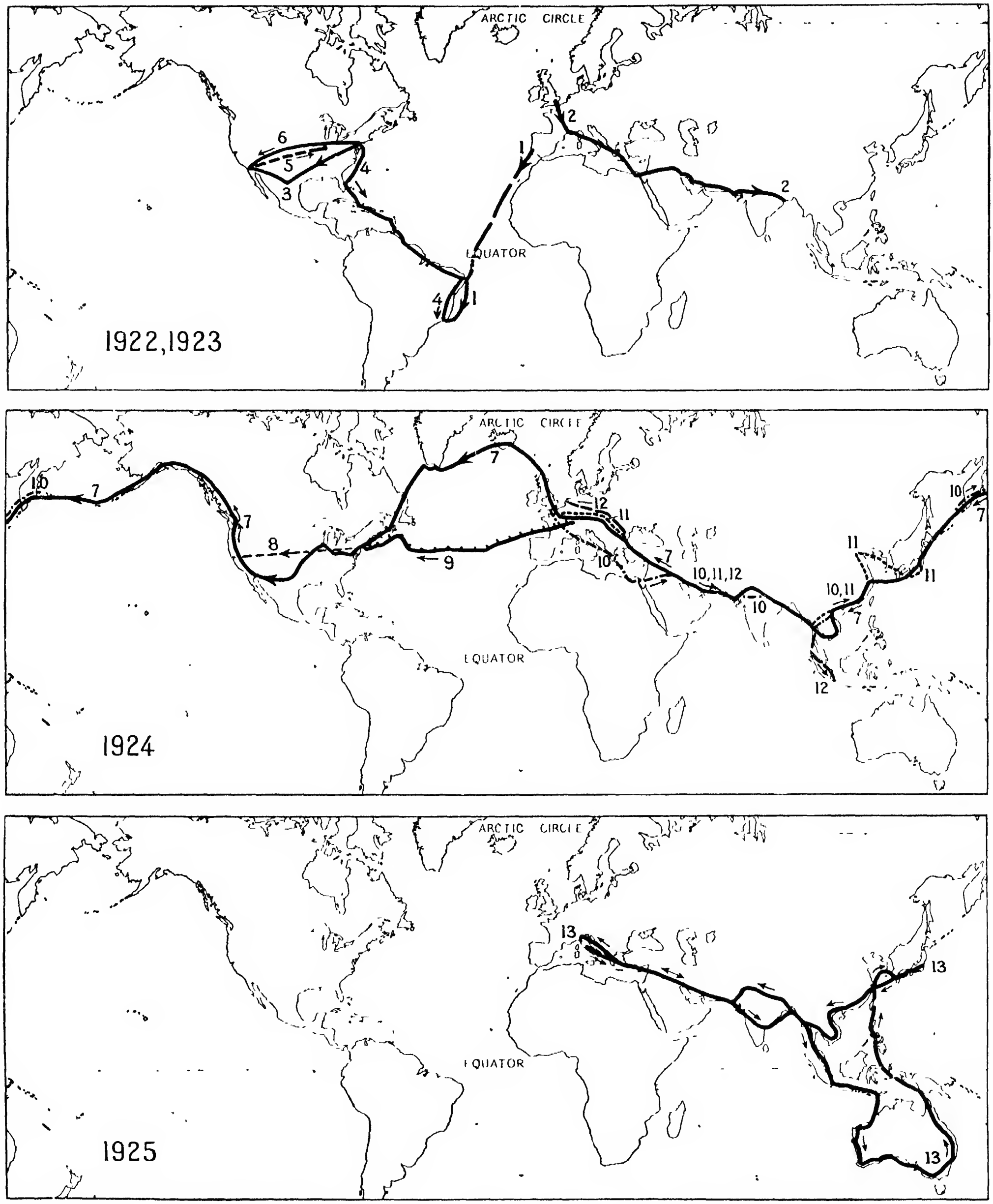
Smits and Karssen endeavoured to effect a transmutation of lead by Miethe's method, and built for the purpose a special lead arc, on the pattern of a mercury vapour lamp, the discharge passing between surfaces of molten lead enclosed in a vessel of quartz glass. Special devices were needed to prevent the lamp breaking when it cooled after running. After the lamp had been in operation for some hours, with a heavy current passing, the spectrum of mercury was observed. With certain conditions thallium was also detected. Smits and Karssen stated that the lead was shown spectroscopically to be free from mercury and thallium before the experiment, but admitted that sometimes the experiment does not succeed, and that the precise conditions for



HISTORIC FLIGHTS FROM 1903 TO 1920

1 Orville Wright in first aeroplane, Kitty Hawk, N C 1903. 2. Henry Farman, first passenger flight, Ghent, France, 1908 (2a) Orville Wright, 9 minute flight with passenger, at Ft Myer, Va, 1908 3 Louis Blerlot, across English Channel, 25 miles, 1909 4 Louis Paulhan, London to Manchester, 183 miles, 1910 5 Glenn Curtiss, Albany to New York, 135 miles, 1910. 6 M. Prier, London to Paris, 290 miles, April 12, 1911 7. R C Fowler, Jacksonville, Fla, to San Francisco, Calif, 2,232 miles, 1912. 8 German dirigible L 59, Bulgaria to Daka Oasis, German East Africa, 1,365 miles, 1917 9 Capt E F White, Chicago to New York, 727 miles, 1919 10 U S Navy flight, Lieut Cmdr A C Read, Newfoundland to England, 3,925 miles, 1919 11 Capt John Alcock and Lieut Arthur W Brown from Newfoundland to Ireland, 1919 12 Dirigible R 34 under Major G G Scott, Scotland to New York and to England, 6,400 miles, 1919 13 Capt Ross Smith, London to Port Darwin, Australia, via Asia, 1919 14 Major C J Q Brand and Lieut Col. P. Ryneveld, London to Capetown, via Cairo, 12,000 miles, 1920. 15 Lieuts Masiero and Ferrari, Rome to Tokyo, 1920 16 Flight of 4 O H planes under Capt. St Clair Street, Mineola, Long Island, N Y, to Nome, Alaska, 9,000 miles, 1920

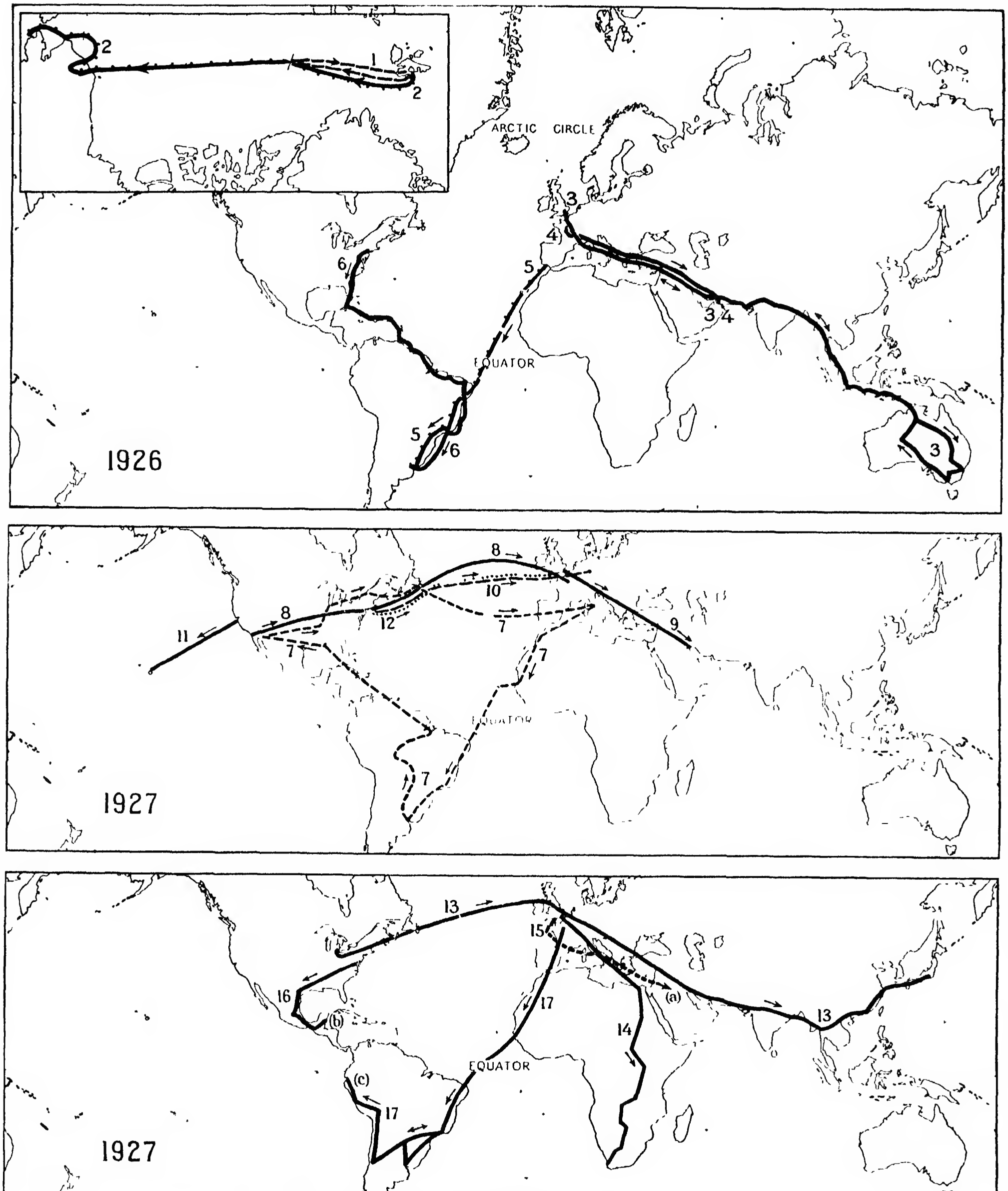
Plate II TRANS-OCEANIC AND TRANS-CONTINENTAL FLIGHTS



NOTABLE FLIGHTS FROM 1922 TO 1925

1 Capts. Scadusa and Continho, Portugal to Brazil, 1922 2. Maj. Wilfred Blake and Capt. Norman Macmillan, Croydon to Calcutta, 1922 3 Lieut James H. Doolittle, Jacksonville, Fla, to San Diego, Calif, 1922 4 Walter Hinton and companions, New York to Brazil, 1922 5 Lieuts Oakley Kelly and J A Macready, San Diego to Indianapolis, 2,060 miles, 1922 6 Lieuts Oakley Kelly and J A Macready, New York to San Diego, Calif, 2,516 35 miles, 1923 7. U.S Army, Round the World Flight, 27,553 miles, 1924 8 Lieut Russell Maughan, New York to San Francisco, 2,540 miles, 1924 9 Dirigible Z R 3, under the command of Dr Hugo Eckener, Friedrichshafen, Germany, to Lakehurst, N J, 5,066 miles, 1924 10 Maj Stuart MacLaren, England to Petropavlovak, Komandorski Islands, North Pacific, 1924 11 Lieut Pelletier d'Oisy, Paris to Shanghai, 1924 12 Van der Hoep, Amsterdam to Batavia, 15,000 miles, 1924. 13 Cmdr. De Pinedo, Rome-Tokyo-Melbourne-Rome, 34,000 miles, 1925

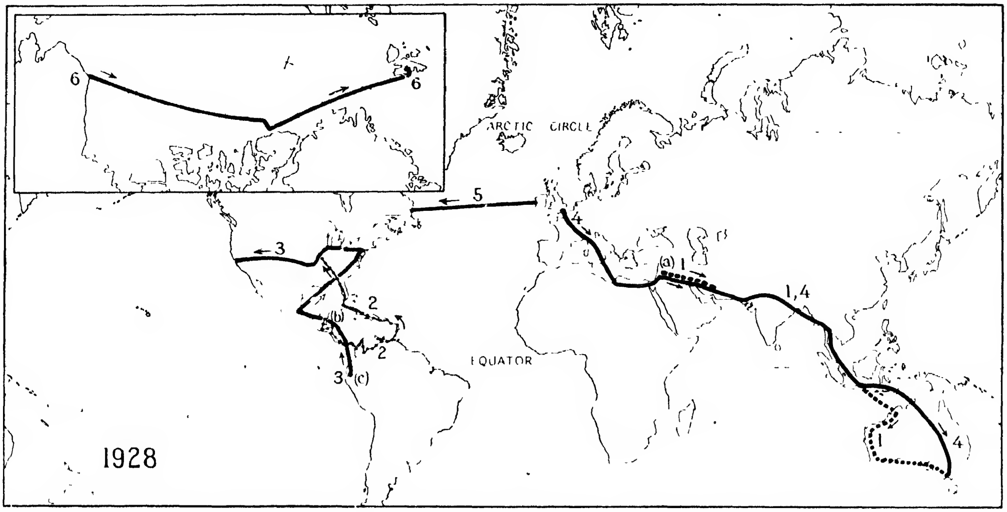
TRANS-OCEANIC AND TRANS-CONTINENTAL FLIGHTS PLATE III

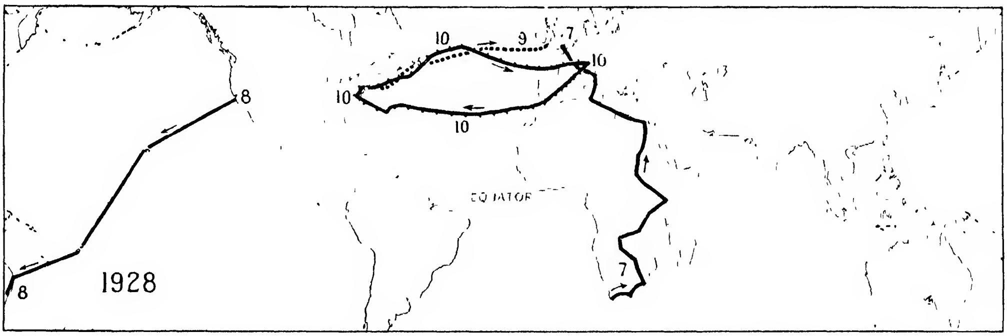


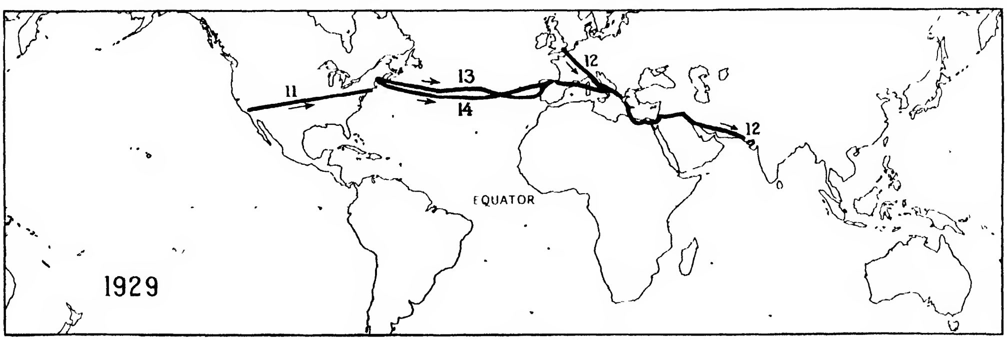
NOTABLE FLIGHTS OF 1926 AND 1927

1 Cmdr Richard Byrd and Floyd Bennett, North Pole flight, 1926 2 Amundsen, Ellsworth and Nobile, Spitsbergen-Alaska flight, 2,700 miles, 1926 3 Alan Cobham, England to Australia and return, 28,000 miles, 1926 4 Capt Costes and Rignot, Paris to Persia, 3,313 miles, 1926 5 Cmdr Franco, Spain to Argentina, 6,232 miles, 1926 6 Bernardo Duggan and companions, New York to Buenos Aires, 9,376 miles, 1926 7 Cmdr de Pinedo, Italy to America and return, 25,000 miles, 1927 8 Charles Lindbergh, San Diego to New York to Paris, 1927 9 Lieuts Gillman and Carr, England to Persian gulf, 3,400 miles, 1927 10 Chamberlin and Levine, New York to Eisleben, Germany, 3,911 miles, 1927. 11, Lieuts Maitland and Hegenberger, San Francisco to Honolulu, 2,400 miles, 1927 12, Byrd, Acosta, Noville and Balchen, New York to Ver-sur-Mer, France, 3,477 miles 1927 13 Edward Schlee and William Brock, Detroit-Tokyo, 12,295 miles, 1927 14 Lieut Bentley, London to Capetown via Cairo, 1927 15 R A F Squadron, Plymouth to Melbourne, 1927 1928 (For continuation *see* 1, Plate IV) 16 Col Lindbergh, Pan-American Flight, 9,060 miles, 1927-1928 (For continuation *see* 2, Plate IV) 17 Lieut Costes and Lieut Cmdr Lebrix, Paris to Africa, South America, Mexico, United States, across Pacific via boat to Tokyo China, India and return to Paris, 35,000 miles, 1927-1928 (For continuation *see* 3, Plate IV)

PLATE IV TRANS-OCEANIC AND TRANS-CONTINENTAL FLIGHTS







NOTABLE FLIGHTS OF 1928 AND 1929

1. Continuation of R.A.F. 15, Plate III 2 Continuation of Lindbergh flight of 16, Plate III. 3. Continuation of Costes-Lebrix flight of 17, Plate III 4 Bert Hinkler, London to Port Darwin, Austr., 12,000 miles, 1928 5. Capt. Hermann Koehl, Baron Ehrenfried Guenther von Huenefeld and Commandant James Fitzmaurice, Bremen from Dublin, Ireland, to Greenley Island, Newfoundland, 1928 6. Sir George H Wilkins and Carl Eielson, Point Barrow, Alaska, across Polar Sea to Spitsbergen, 1928. 7 Lady Mary Heath, Capetown, South Africa, to Croydon, England, 1928 8 Capt Kingsford-Smith and companions, Oakland, Calif., to Brisbane, Austr., via Honolulu and Fiji Islands, 1928 9 Amelia Earhart, Wilmer Stultz and Louis Gordon, Trepassy Bay, Newfoundland, to Burry Port, Wales, 1928 10 Graf Zeppelin, under Dr Hugo Eckener, Friedrichshafen, Germany, to Lakehurst, N J., and return, 1928. 11 Frank Hawks, Los Angeles to Long Island, 1929 12 British-India Airline, London to Karachi, India, and return. 13 Lotti, Assolant, Le Fèvre and Stowaway, Old Orchard Beach, Me., to Spain, 1929. 14. Roger Williams and Lewis Yancey, Old Orchard Beach, Me., to Santander, Spain, to Rome, 1929

a positive result are not known. In one successful experiment they reported mercury in quantities of from ·1 to ·2 milligrammes. In the latest communication of Smits (*Nature*, vol. cxx., p. 475, 1927) he describes sparking experiments in which carbon disulphide was used as a dielectric. The traces of mercury obtained in the mixture of dispersed lead and carbon obtained by this method were afterwards traced by him to mercury contaminations in the carbon disulphide.

Another attempted transmutation is that of hydrogen into helium, on which a long series of particularly careful experiments has been made by Paneth and Peters. Calculation shows that this transformation, which demands the combination of four hydrogen nuclei with two electrons to form the helium nucleus, should be attended by a very great liberation of energy, namely 7×10^{11} gramme calories per 4 grammes of helium formed Paneth and Peters have perfected a spectroscopic technique, which permits, in favourable cases, 10^{-10} c c of helium (2×10^{-14} grammes) to be detected They attempted to see if helium could be produced by passing electric discharges of various types through hydrogen, without success They then looked for a formation of helium in the presence of a catalyst, for which purpose they either passed large amounts of hydrogen through heated palladium, or used finely divided palladium to absorb the hydrogen, and after an interval burnt the hydrogen with pure oxygen, at the surface of the catalyser, and examined the residual gases. Helium was found in small quantities, and at first the experimenters believed that it had been formed from the hydrogen Atmospheric air contains minute traces of helium, but a small air leak was ruled out as a source of the gas, as no neon was detected

Pushing their enquiries further, Paneth and Peters discovered that glass in contact with the atmosphere takes up minute quantities of helium, which afterwards leave the glass surface if it be heated in the presence of hydrogen. Once the helium has been driven off in this way the glass is no longer dangerous as a source of helium contamination, but if the glass be exposed once more to the air it again becomes contaminated. Thus the apparent production of small quantities of helium, not only in Paneth and Peters' own work, but also in the experiments of Collie and Patterson and other workers, including the more recent publications of Riding and Baly (1925) is explained. There is no transmutation, but merely a transfer of atmospheric helium into the apparatus by the intermediary of the glass. Paneth and Peters now (1928) state definitely that they have repeated the experiments of all previous experimenters on the formation of helium, with the necessary precautions, and that there is no production of helium amounting to 10^{-10} c.c. in any of them. It may be noted that there is about 5×10^{-6} c.c. of helium in 1 c c. of air, so that the 10^{-10} c.c. which can be detected by Paneth is the amount contained in only one fifty-thousandth of a c c. of air.

Criticism and Conclusions.—It has been shown that claims for artificial production of helium rest upon faulty experimental technique; it may be asked how things stand with the work of Nagaoka, Miethe, Smits and others on the transmutation of mercury and lead.

Here again subsequent workers have been unable to repeat the results, working under apparently the same conditions, and various plausible suggestions have been put forward as to why the original positive results were obtained. Garrett, in particular, has repeated with great care the experiments of Miethe and Nagaoka under a variety of conditions, without being able to detect any formation of gold, although the presence of 10^{-8} grammes of gold would have made itself evident to his tests. He reaches the conclusion that the gold in Miethe's experiments was derived from material in the electrodes and in the vessels. Garrett has further tried to convert tin into indium, and titanium into scandium, by Smits' method, without success. As regards Nagaoka's experiments, the theory has been attacked by Runge, and the experimental work by R. W. Wood, while the isotope of mercury invoked by Nagaoka in support of his theory has since been shown by Aston not to exist. The work of Miethe and Stammreich was extensively criticized at the conference of physicists (Physikertag) held at Danzig in 1925 (see *Physikalische Zeitschrift*, 26, 842, 1925). In short it may be said that no single case of artificial transmutation, in quantities however small, by methods other than the α-ray method of Rutherford, has won acceptance. In the case of the reputed transformations of hydrogen into helium the source of contamination has been traced beyond a doubt; in the other cases where transmutation has been claimed there are no convincing theoretical grounds for supposing the process possible, there are many possible sources of error, and expert experimenters who have repeated the experiments have failed to obtain positive results.

BIBLIOGRAPHY.—For a general view of the work of the alchemists, *see* the standard histories of chemistry, *e g.*, Ernst von Meyer, *History of Chemistry* (Eng. trans, 3rd ed, 1906). For further details *see* F. Hoefer, *Histoire de la Chimie* (1866); L. Figuier, *L'Alchimie et les Alchimistes* (1854); A E Waite, *Lives of the Alchemystical Philosophers* (1888), and *The Secret Tradition in Alchemy* (1926).

For radioactive transformations, *see* bibliography to RADIOACTIVITY; for transmutations produced by α-particles, *see* bibliography to NUCLEUS.

For recent attempts at transmutations consult, under the names cited in the text of the article, the index of *Nature*, vols. 116, 117, 118, 119 (1925–27).

Full references to previous work are given by W. M. Garrett in "Experiments upon the Reported Transmutation of Mercury into Gold," *Proceedings Royal Society*, A, 112, 391 (1926), and in "Experiments to test the Possibility of Transmutation by Electronic Bombardment," *Proceedings Royal Society*, A, 114, 289 (1927). *See* also F. Paneth and K Peters, "Heliumuntersuchungen," *Zeitschrift fur physikalische Chemie*, 134, 353 (1928), and same journal, Abteilung B, 1, 170 (1928). (E. N. DA C. A)

TRANS-OCEANIC AND TRANS-CONTINENTAL FLIGHTS. At Kitty Hawk, North Carolina, on Dec. 17, 1903, Orville Wright (*q v.*) made the first aeroplane flight in history. It lasted only 12 seconds, but before the day was over Wilbur Wright (*q.v.*) completed a flight of 59 seconds duration. Improvements and constant practice enabled the brothers to lengthen these records. In 1905 they made 45 flights, the longest lasting 38 minutes At Le Mans, France, on Sept. 21, 1908, Wilbur exceeded all previous records with a flight lasting 1 hour and 31 minutes which covered a distance of 56 miles. In the same year a number of flights by Henry Farman and Louis Bleriot were made which exceeded 30 miles in length The first notable flight over water was the crossing of the English Channel by Bleriot on July 25, 1909. At the opening of the World War flights of two or three hundred miles were being made.

The War intensified aeronautical activity and provided much spectacular achievement, but distance flying was not the primary aim The development of air-craft during the war-period was immediately apparent in 1919 when aviators, seeking peace channels for the employment of their skill and surplus machines, achieved a number of notable flights. This year, but 16 years after the first flight at Kitty Hawk, witnessed the crossing of the Atlantic Ocean by both aeroplane and dirigible. The first successful flight across the Atlantic was achieved by aviators of the U.S Navy using Navy-Curtiss flying boats. Of the three that started, only one, the NC4, piloted by Commander A. C. Read, completed the trip. Scarcely two weeks after this success Capt. John Alcock and Lieut. Arthur Brown made the first non-stop flight of the Atlantic flying 1,960 miles of ocean between St. Johns, Newfoundland and Clifton, Galway, Ireland, in 16 hours and 12 minutes. Within a month the British dirigible R34 left East Fortune near Edinburgh, Scotland, and crossed to Roosevelt Field on Long Island in four days. Its return trip, even more successful, was made in 75 hours despite fog, squalls and head winds. The flight of Ross Smith from London to Australia inaugurated a number of distance flights by British aviators which were to prove the eventual feasibility of air-lines to distant parts of the empire. The next five years were occupied chiefly by continental flights and by the lengthening of the non-stop distance record. In 1923 the United States was first spanned from the Atlantic to the Pacific in a single flight. The year 1926 was notable for two flights across the North Pole, one by plane and the other by dirigible Lindbergh's perfectly executed flight in 1927 from New York to Paris attracted world-wide attention. The year witnessed three additional crossings of the Atlantic by plane and a

number of tragic failures. It also witnessed the first crossing from the United States to the Hawaiian Islands. Subsequent flights of importance as well as other notable early flights are shown on the accompanying maps. (*See* also AERONAUTICS, AEROPLANE, AIRSHIP, etc.)

TRANSOM, in building, a generic word for many types of horizontal, structural members. Thus in shipbuilding a transom is a form of stern in which the rear end of the boat finishes, not in a series of continuous curves, but in a single transverse plane, which in small boats is formed of a single board; also a built-in berth or bed is frequently termed a transom. In architecture, a transom is a horizontal member across a window or door opening, dividing it vertically into separate portions or lights; in modern doorways the area above such a transom bar, which is sometimes treated as a separate hinged or pivoted, glazed sash, is itself known as a transom. During the mediaeval period, when grouped and traceried windows were frequently of great height, lateral stability to the slender mullions, or vertical dividing strips, which had been furnished in the early Gothic period by iron bars, came in Perpendicular work in England, to be furnished by continuous, horizontal transoms of masonry. These were supported by arches over each light or window division, were usually moulded with a cornice and were occasionally crowned by decorative battlements. In large windows several rows of transoms were used, thus dividing the whole window into continuous horizontal bands of arch-headed lights. (*See* TRACERY.) With the common introduction into secular Gothic work of swinging casements, the use of transoms became general throughout northern and western Europe, in order to keep the size of the swinging sash small, and in Germany, England and France, the use of mullioned and transomed windows continued well into the Renaissance period. (T. F. H.)

TRANSPORT. This subject has been dealt with in separate articles as follows. RAILWAYS, LOCOMOTIVES, TRAMWAYS; ELECTRIC TRACTION, TUBE RAILWAYS, TUNNELS, MOTOR CAR, MOTOR VEHICLES (COMMERCIAL); MOTOR TRANSPORT (COMMERCIAL), TRAFFIC AND TRAFFIC REGULATION; ROAD CONSTRUCTION.

Turning to transport at sea, a series of articles will be found under the headings SHIP; SHIPBUILDING, BARGES AND CANAL CRAFT, SHIPBUILDING. WORLD'S STATISTICS; SHIPPING, HISTORY OF, SHIPPING: *Tonnage;* SHIPPING: *Merchant Ships of the World;* SHIPPING: *Registration, Classification and State Regulation;* SHIPPING LINES; SHIPPING ROUTES; LLOYDS'; LLOYDS' REGISTER OF SHIPPING; and INSURANCE: *Marine.*

As to waterways, a series of articles will be found under the headings CANAL AND CANALIZED RIVERS; RIVER ENGINEERING, LOCK and WEIR. There are separate articles devoted to the PANAMA CANAL and the SUEZ CANAL.

The group of subjects connected with ports and coast protection is treated under PORT, PORT ECONOMICS, PORT OPERATION, DOCKS, DOCKS, FLOATING; HARBOUR, BREAKWATER, COAST PROTECTION, JETTY, PIER, LIGHTHOUSE; LIGHTSHIP, BUOYS.

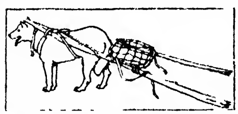
Articles on air transport will be found under AERONAUTICS, AVIATION, CIVIL, AIR ROUTES; and TRANSPORTATION BY AIR.

Below is given a brief general history of the subject.

PRIMITIVE TRANSPORT

Woman was no doubt the first beast of burden, but her training was perhaps due less to her lord and master than to her children. Apes carry their young about, the latter assisting by clinging to the mother's fur with fingers and toes. Human mothers are furless, human babies less prehensile, and many are the contrivances for carrying babies or small children while leaving the hands free. The Eskimo hood, the American papoose frame, the Kafir skin bag, the Chinese yoke, the New Guinea net or the Andaman sling are all baby-carriers, and similar devices may be used for carrying other loads. The daily labours of fetching water and firewood and of collecting roots, berries and other vegetable produce are usually women's work throughout the world; and while the man walks unencumbered save by his weapons, the woman carries all household gear when on the trail. For on the march the man is the hunter and fighter and must have his hands free. S. Hearne's Indian guide Matonabee explained this clearly: "When all the men are heavy laden they can neither hunt nor travel to any considerable distance, and in case they meet with success in hunting, who is to carry the produce of their labour? Women were made for labour, one of them can carry or haul as much as two men." Matonabee himself chose his wives for their strength—"many would have made good grenadiers," says Hearne—and frequently boasted that few women could carry or haul heavier loads. The average woman's load in summer was about 140 lb. and in winter she hauled a greater weight. The Eskimo, a peaceful people who have no special weapons of war, divide their loads fairly evenly between men and women, though the women are usually the stronger, and a tired boy will transfer his load to his sister.

Pack Animals.—The use of animals for transport—the dog, the ox, the horse, the ass, the reindeer, camel and elephant in the Old World, the dog and the llama in the New—marked a great advance, especially as most of the Old World animals were also milk-yielding. The baskets, crates, carrying bags and other appliances could now be removed from the backs of women to those of pack animals, and not infrequently the harness is still the woman's concern, though the man has charge of the pack animal. The distribution of these transport animals depends upon their occurrence in a wild state, their subsequent diffusion, and the distribution of their fodder, or their ability to adapt themselves to varying conditions. The reindeer cannot thrive beyond the limited range of the "reindeer moss" which is their chief food. Unless trained to do so, they will not willingly eat any artificial fodder, or even the moss that has been collected by hand. The llama is confined to the sierras of South America, and the long strings of them that were used for conveying merchandise down to the lower plains soon sickened in the enervating climate. The elephant, owing to his appetite and delicacy, has a restricted range in southern Asia and has not been domesticated in Africa, while in the latter continent the tsetse fly hinders the efficiency of animal transport over the central area.



A DOG USED FOR TRANSPORT BY THE INDIANS OF THE PLAINS IN NORTH AMERICA

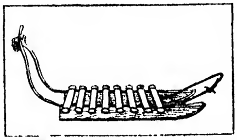
The dog was possibly one of the earliest animals to be used in transport, but owing to its small size and limited strength, it was only trained when no better animal was available. But throughout the Arctic regions of the New and in much of the Old World the dog is invaluable, its light weight enabling it to run over snow-covered ground, and its tractability making good team work possible.

The ox was the most widely distributed of all the transport animals. Various species existed in a wild state in North America, Africa, Europe and Asia, and though the American bison was never tamed, the domestic ox was common in Europe and Asia in the stone age. Whether its first use was for food or for transport is impossible of proof, its flesh was always appreciated, and while its milk would be its chief value to pastoral societies, then as now, its use in dragging the plough would help the agriculturalist in some of his heaviest work. The ox wagon was a familiar means of transport in Mesopotamia and Egypt, as is seen on ancient monuments; it is a common sight round the Mediterranean to-day, and has spread to South Africa and South America, the ox being used in the former continent for riding as well as draught. In Asia the yak is as essential for transport and valued for its milk in the Himalayas as the buffalo in southern India.

The horse still runs wild in large herds over the central Asiatic plains whence the domestic horse is assumed to have been derived. It appears to have been the earliest domesticated animal in Japan where it was ridden, not used for draught, and its westward spread altered the history of Europe, both political and social. Stray horses running wild over the plains and horses deliberately let loose in America soon produced wild herds both in the northern and southern continents, and profoundly influenced the mode of life of the American Indians. The horse is rarely used by the African native, except by those in close contact with the Arabs; drought and heat in the north and the tsetse fly to the south

retarded its distribution and use. Human carriers (men, not women) are the usual means of transport over the greater part of the continent south of the equator as far as the cattle areas, where their place is taken by the ox.

The reindeer provides not only transport, but milk, flesh and skins as well, and a herd of them constitutes wealth in Siberia. Moreover, they support themselves on the "reindeer moss" (*Cladonia rangiferina*) wherever it is not too deeply buried in snow. The Lapp deer are much stronger and more heavily built than those of the semi-wild Chukchi herds in eastern Siberia, which are not strong enough to carry a man, and are not so highly valued for draught. Lapp law forbids a heavier load than 130 lb. on the back and 190 lb. on the sledge. Enormous distances are travelled by Tungus traders with their well trained teams. In early winter, when in good condition after their summer pasturing, a good team will keep up a speed of 10 to 12 miles an hour all day long, and a good bull will travel 150 miles a day if the snow is hard and the temperature some 30 to 40 degrees below zero. No attempt was ever made by the Amerinds to train the American reindeer.



ESKIMO SLEDGE, MADE OF DRIFT-WOOD AND WHALE BONES WITH CARIBOU ANTLERS FOR STEERING

The camel, whether the wild Bactrian camel or the domesticated Arabian (whose ancestry is unknown), with its thirst-defying stomach, its capacity for thriving on desert herbage, and its flat feet spreading out over, instead of sinking into, the soft sand, has made life and wealth possible in the oases of the Sahara. It rivals the horse in the drier districts of Asia from the Holy Land to China, and it has rendered invaluable service in the exploration of the deserts of Australia. The camel fails—apart from the absence of suitable climate or fodder—in the tenderness of its pads over rough, stony, rocky or icy ground. It cannot be shod like a horse, though its feet are often protected by artificial shoes, or pieces of leather are stitched on to its tough soles. The camel provides not only transport, being surpassed in strength only by the elephant and surpassing all other animals in endurance, it supplies milk, flesh, skins, wool and hair. A good riding camel will cover 150 miles in a day, and the baggage camel may carry over 1,000 pounds.

The wild guanaco or mountain camel of South America has a wide range over the higher lands of the continent, but the llama and its relative the paco or alpaca were domesticated and trained for transport only in the Peruvian area. The llama can carry only about 100 lb., and cannot be used for draught, but as they are very docile, a large herd of several hundreds was sent out with merchandise in charge of a few herdsmen, and in the absence of larger animals their value was very high. They still hold their own in high altitudes in competition with mules or donkeys.

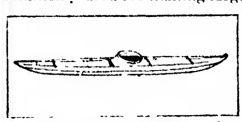
The domestication of the African elephant is doubtful, but the Indian elephant was early trained for transport and for use in war. Its great strength and intelligence can be used to advantage, especially in pathless jungle, and for transporting heavy weights for road and bridge building, but owing to its enormous appetite, which can only be satisfied where vegetation is lavishly abundant, and the delicacy of its constitution compared with ox, horse or mule, its economic value and range therefore are definitely and narrowly limited.

Draught.—Man can drag more than he can carry on his back, and where the surface of the country is suitable some contrivance is made for hauling. The American Indians, if they had no sledges, dragged skins sewn into bags along the frozen ground, and though over the whole of Arctic America packs are carried on the back (human and canine) in the summer, as soon as the ground hardens, sledges are made and far heavier loads can be transported. The Eskimo sledge consists essentially of three pieces, the sides and cross pieces of wood lashed together with raw hide, and the runners or shoes. These are typically of whalebone or walrus ivory (now replaced by iron) pegged on. For winter travel a layer of mud or lichen mixed into a paste is smeared on, coated with ice. The western sledge is 3½ to 4ft. long; the eastern type 12 to 24ft. long according to the locality, with five to nine crossbars. This can carry a load of 1,000 lb. and keep up a steady pace of two miles an hour, drawn by a man, his wife and a couple of dogs. South of the frozen land the toboggan takes the place of the sledge, and in the bison area the special method of packing led to the development of the *travois*. Here the tent poles were fastened into bundles, one on either side of a dog—later a horse—with the ends of the poles trailing on the ground; the skin cover rolled into a bundle was tied on transversely across, and any household goods piled on the top. This suggested the fixed V-shaped framework known as the *travois*. Some such primitive construction preceded the wheeled cart of the Old World, and its last surviving descendants are farm sleds for hauling timber, the sledge on runners used for carting furze in the north of England, or the slide-car used for carting turf in Antrim. The wheel is not a primitive invention as applied to transport, and although wheeled chariots, especially for war, were familiar in early historic times in Assyria and Egypt, there was no wheeled vehicle in America before the discovery of the continent by Europeans.

TRANSPORT BY WATER

This usually requires less effort than transport by land, and is often more highly developed among primitive peoples. The earliest type of boat is the raft, made of grass, logs of wood, bundles of reeds or other light materials tied together, on which man can float. Such was the "raft" of the Tasmanians, made of eucalyptus bark tied in cigar-shaped bundles 9 or 10ft. long, thinning at either end. Similar floating rafts of varying materials were used by early Egyptians on the Nile, and by the Inca on Lake Titicaca. The Jarawa on the small island of South Andaman have no canoes, but lash bamboos together to form rafts for crossing creeks or inlets; the Semang of the Malay Peninsula float down rivers by the same means, returning overland. In Africa, as in Mexico and Peru, large gourds are used for ferrying. On the Hadeija (running into Lake Chad) the Hausa ferrymen, balanced on a calabash, paddle themselves across with arms and legs, earning for themselves the name of *jemage* or "bats"; for transport guinea corn stalks (*Sorghum*) are laid across the calabashes to make a platform. Inflated skins take the place of gourds among the pastoral people of western Asia or north Africa, and inverted pots are used to support the rafts for ferrying across the Nile river. Another primitive type of boat found on the Tigris or Euphrates is the round *gufa*, made of basket-work, covered with skins coated with bitumen which was described by Herodotus (i. 194). The coracles of the ancient Briton, described by Pliny and still used in Wales and round the coasts of Ireland, the skin-covered canoes used by hunters in British Columbia, the "bull-skin boats" in the western States of America are varying developments of the same type.

The finest examples of skin boats are the Eskimo *umiak* and *kayak*. The *umiak* is often called the "woman's boat," but, except in Greenland, it is more used by men than women, and is the boat commonly used for hunting large game. It may be from 10 to 50ft. long, with wide flat bottom, broad spread, and little distinction between stem and stern. The framework, lashed together with sealskin thongs, is covered with large seal skins strongly stitched together and put on green so that they shrink tight. The cover is lashed to the gunwale, and can be tightened as it stretches in getting wet. The *kayak* is seldom used for transport, but is essentially hunting and fishing equipment. It is made in the same way as the *umiak*, but is entirely enclosed in skins save for a small hole. It may be 25ft. long, but is only just wide enough to contain the hunter, who in his waterproof coat slips into the central hole, ties the string of his coat round the rim, and is absolutely impervious in his buoyant craft; he can travel at twice the pace of a two-man canoe, and ventures out



FROM WISSLER "THE AMERICAN INDIAN" (OXFORD UNIVERSITY PRESS)

ESKIMO KAYAK, MADE OF SKIN STRETCHED OVER A TIGHT FRAMEWORK WITH A HOLE FITTING THE HUNTER'S WAIST

in a rough sea. Skin boats are more fitted for temporary than for permanent use; great care has to be taken in beaching them, while, if left in the water, the skins soon rot. Both *kayak* and *umiak* are rapidly dying out.

Where suitable trees of good size are found a simple type of boat is made of a sheet of bark. The Lillooet canoes of British Columbia were formerly always of bark, poplar, cottonwood, spruce, cedar or birch. In the spring two rings were cut round the trunk and a line connecting them, and the bark was pried off in one piece. This was fixed to a wooden framework by sewing with root-fibres, and all the crevices were caulked with moss and gum. The Australian bark canoes are of eucalyptus. A large sheet is peeled off, the ends are turned up, and either tied or sewed, and the joints caulked with resin.

The boat made out of a solid tree-trunk has many advantages. In Melanesia (Kiwai island) there is a tradition of the time when the only craft consisted of a solid log or tree trunk balanced by double outriggers supporting a platform fixed to sticks driven into the trunk. This type may everywhere have been the precursor of the hollowed log, but dug-outs are so widely distributed in time and space that their origins are forgotten. Ancient dug-out canoes, sometimes 50 to 60ft. long, are found in British peat bogs, but it is not possible to date them with any precision, and metal tools were probably used in their construction, though stone adzes are still preferred by the canoe makers of New Guinea.

The Andamanese hollowed out their canoes with shell adzes, without the aid of fire, but they chose soft-hearted wood such as Sterculia, and caulked the ends with beeswax (nowadays they nail up the end with a piece of tin). Some of the finest dug-out canoes are made by the coast tribes of British Columbia. The only tools used in pre-trading days were stone axes, hammers and chisels, and the wood was the native "cedar." To fell the tree, two circular and parallel incisions are made in the trunk, nine or ten inches apart, and the wood is pried or pecked out piece by piece; when it is felled, the length for the canoe is cut off in the same way. It is hollowed out with fire and adze, and roughly shaped. Next fires of smokeless embers are lit near by but not near enough to scorch, and the inside is filled with water brought to a boil with heated stones. This plims and softens the fibre of the wood and allows of the expanding and stretching of the sides, which are fixed in position to the desired width by thwarts pegged in place. Some of the canoes are from 30 to 50ft. long, and will carry 60 to 100 people.

The finest and most varied boats are found among the islands of Polynesia. There are relics of primitive types, rafts of poles lashed together, or bundles of bulrushes, and the Moriori of Chatham island used to venture out to sea, 60 of them at a time, on a raft of flax flower stems (*Phormium tenax*) floating on sea kelp bladders. But beautifully balanced dug-out canoes with or without outriggers and carvel-built plank boats ingeniously lashed together with cord are universal, and in these the long voyages of hundreds of miles from island to island are undertaken. The most imposing of the double canoes were those of the Society islands, the lightest those from Hawaii, and the strongest those of New Zealand. The plank-built canoes were usually made of bread-fruit tree wood (*Artocarpus incisa*) very carefully fitted together.

The whole process of boat-building, from the felling of the trees to the launching of the boat is generally safeguarded by feasts, charms, prayers and varied ceremonies to ensure good luck. Human victims as sacrifices are characteristic both of Oceania and of parts of Africa. Charms are often attached to boats, especially to assist in fishing or in war. An eye painted or incised in the bows, which in Egypt represented the eye of Osiris, is seen round the Mediterranean, off the coasts of India and China, and also North America, still occasionally retaining a magical significance.

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HISTORY OF TRANSPORT

Early Inland and Ocean Transport.—Where rivers were available, as in China and Egypt, rafts and boats were used in the early stages of civilization, and it was natural that canals extending or connecting river channels should be dug. The Phoenicians, Greeks and Romans were able to navigate the ocean in vessels equipped with sails and with one to three banks of oars, and it was by means of these craft, that they established and maintained their colonies. The Roman armies and their equipment and supplies were transported to Carthage or Gaul in these boats. The early civilizations developed in river regions with special opportunities of production and transport, and about the Mediterranean, an inland sea providing a navigable highway. Rome built up and maintained a far-reaching empire by military power, by an efficient system of law and administration and by building roads. Without her system of roads, she could not have governed her empire. When the Roman power was overthrown, and road building ceased in Britain, Gaul and Mediterranean lands, economic, social and political life became local. In course of time a feudal society developed that prevailed for centuries. The forces that brought about the change from the feudal to a national organization of society were many, but the improvements in facilities of transport by sea and land were potent factors.

The mariner's compass, though the properties of the lodestone were known in China and India long before they were in Europe, did not have much influence in the East because the Orientals were not maritime people; but in Europe from the 14th century on, mariners could sail by the compass whither they would, and by the end of the 15th century the sailing vessel had carried men to America and around Africa to India. The world was known to be a sphere and the new continent of America had been discovered. The services rendered by the sailing vessel from the 15th to the 19th century in the discovery, settlement and development of new lands, are well known. It is, indeed, remarkable that these slow-going craft of only 80 to 300 tons' capacity could have so influenced the world's history. The largest of the three vessels in which Columbus made the voyage that resulted in the discovery of America, the "Santa Maria," was a decked ship of 100 tons; the "Pinta" and the "Niña" were caravels of 50 and 40 tons respectively. It took from Aug. 3 to Oct. 12, ten weeks, to make the passage via the Canary islands to Watling's island in the Bahamas. The sailing vessel provided a transport unit and facility appropriate to the commercial requirements of the 17th and 18th centuries. Trade, still in large part barter, was in small quantities, and the ships were in most instances operated by the merchants in the conduct of their business. Traders could advantageously send the small vessels of that day to shallow harbours as well as to deep ones. The common carrier, as distinct from the merchant, operating vessels over fixed routes did not become general until the 19th century.

Road and Canal Building in the 17th and 18th Centuries.—France was the leader among European countries in developing a modernized inland transport system. The work was begun in 1597 by Sully, who made a start with the task of creating a national system of roads surfaced with broken stone. The great road-builder of France, however, was Colbert, who became comptroller of France in 1661. By enforcing the feudal system of compulsory labour of all able-bodied peasants he brought about the surfacing of 15,000m. of road. The roads thus built were not scientifically constructed and maintained. In 1775, Tresaquet, by making provision for drainage of the roadway, began the construction of better roads and he substituted a continuing force of paid workers in place of the intermittent labour under the *corvée* system. Two Scotsmen however, Thomas Telford (1757–1834) and John Loudon MacAdam (1756–1836) were the first to build roads according to the scientific methods that have been followed to the present day, emphasizing the necessity of providing a well-drained roadway.

Telford's practice was to lay a base of large stone on which smaller stones were placed, the surface being made of finely broken rock. MacAdam began with crushed rock a few inches in diameter, and omitted the foundation of large stone. He showed that the angular surfaces of crushed rock, when pressed together by a heavy roller, would give to a layer a few inches in thickness strength sufficient to sustain the load that is ordinarily imposed on a highway. The MacAdam road was thus lighter and less expensive to construct than the Telford road. The MacAdam foundation is still used in road building, although there may be a binding of cement and the surface may be a layer of asphalt or of concrete. Great Britain has until recently looked to the parishes and counties to construct and maintain public roads. From 1760 onward parliament chartered a large number of turnpike companies which built toll roads after the crude manner that prevailed until near the end of the 18th century, when Telford and MacAdam began their work In 1763 a stage coach journey from London to Edinburgh required 14 days

This situation in Britain was first ameliorated by the construction of canals, the first of which, promoted by the duke of Bridgewater to connect Worsley, and thus Liverpool, with Manchester, was opened in 1761. This canal reduced the cost of coal in Manchester 50% The 3,000 m. of canals constructed in the British Isles between 1760 and 1830, the rapid improvement of the highways from 1800 on and the development of railways after 1825 made it possible for England, in advance of other European countries, to market factory-made goods in large quantities at home and abroad, and thus to establish an economic and commercial leadership, which, until recent years, she maintained without serious challenge England's maritime supremacy was established before the Napoleonic wars, and from 1815 to the present her merchant marine has provided her world-wide commerce with ample transport facilities.

England was not the first country to construct modern canals, Holland began first. France emphasized canal building for two centuries and by connecting her main rivers and improving their channels created a national system of inland waterways. Germany, like France, has made large use of her natural waterways, but their improvement came mainly during the latter part of the 19th century The waterways contributed to the economic development of many other countries, including the United States during the 19th century, but the rôle they have played has been a minor one in comparison with those of the railroad, the ocean steamship, and latterly, of the automobile, the bus and the truck.

The Railway, Its Economic Significance.—The introduction of the locomotive and the railway inaugurated an economic and social revolution. It gave man the service of a power capable of indefinite technical development to assist him in expanding his economic activities and his social contacts The railways, followed and supplemented in turn by the steamship, telegraph, telephone, electric railway, automobile, aeroplane and wireless communication, have during the past 100 years transformed the world. Changes have come with accelerating rapidity until there seems to be no limit to the degree of world unity made possible by developments in transport and communication.

Though it would seem that a century of technical progress would have brought the locomotive to the limit of its mechanical possibilities, improvements in power efficiency and fuel economy have been more rapid since the World War than during any previous decade. Among the innovations of the last sixty years are: (1) The rolled steel rail which began to be laid about 1870 made possible the construction of a track capable of withstanding the strain of the heaviest and fastest trains; (2) trains could not be safely run at high speed until they were equipped with power brakes. George Westinghouse successfully applied the air brake to passenger trains in 1868 and to freight trains in 1887. The air brake reduced by 90% the time and distance required to stop a train by hand brakes; (3) the transport of fresh meat and fruit was successfully accomplished during the 1870's with the refrigerator car Fresh meat from cattle reared on the ranches of the United States, Canada, Australia, Argentina and Brazil has, by refrigeration on land and at sea, been made marketable at all places reached by organized transport. Likewise fresh fruit, and more recently fresh vegetables, are marketed hundreds and thousands of miles from the orchards, vineyards or plantations where they are produced; (4) the operation of freight trains on regular schedule and at increased speed may seem to be a matter of small consequence, but it is placing production and merchandising upon a new basis. The merchant does not now have to carry a large quantity of goods nor does the manufacturer have to stock up with large amounts of materials and supplies Business is done with a smaller amount of inactive capital, productive activity and the employment of labour are more continuous, (5) as it is by the application of power that the work of transport is done, power efficiency determines the progress made by transport The technical achievements of recent years give promise of great advances in the future in connection with all transport facilities—railways, electric railways, ocean vessels, motor vehicles, aeroplanes and airships

The Ocean Carrier and Its Development.—On the ocean, as well as on the land, rapid changes are taking place in the mechanism and services of transport and these changes are affecting industrial and commercial conditions on a wide scale. The wooden sailing vessel gradually gave way to the steel steamship during the first three quarters of the 19th century. Fulton's "Clermont" inaugurated steamboat navigation on inland waterways in 1807; the "Royal William" made the first transatlantic voyage solely by steam power in 1833; the screw propeller was invented in 1836; and the iron hull dates from about 1840 The Inman line adopted the propeller in 1850, and the Cunard line in 1862 The "Great Eastern," the giant of its time (1869), had not only a screw propeller, but paddle wheels, and six masts for sails. Twin screws were first used on warships in 1880 and on a passenger vessel in 1888 Steel began to take the place of iron in hull construction about 1880

The relatively slow technical development of the ocean vessel was largely due to the limitations of the marine engine. The engines with low steam pressure and consequently long slow piston stroke could be used to drive paddle wheels by direct crank shaft action, whereas gearing and loss of power were involved in giving the propeller the requisite speed While direct acting engines were used to drive propellers as early as 1854, it was after 1870 that the present type, the inverted, direct acting, compound steam engine came to be exclusively used; then the ocean vessel developed rapidly in speed, size and economy of service. The conspicuous, much advertised passenger liners attracted most public attention, but their influence was small in comparison with that of the slow freight steamers, often called "tramps," which after 1870 could move cargo so cheaply as to make possible the shipment, for practically any distance, of bulk cargoes of grain, coal, ore, lumber, phosphate rock and the other essentials of industrial expansion

The ocean vessel and ocean transport are undergoing revolutionary changes, due to the invention of the internal combustion engine, the use of oil for fuel, and the operation of freight vessels less as individual units and more in line services with scheduled sailings The turbine, which had been invented in 1883–84, was introduced in warships and large high speed ocean vessels about 1900; but while the turbine was superior to the reciprocating engine for some purposes, its use did not involve a fundamental change such as accompanied the introduction of the internal combustion engine named after its inventor, Rudolf Diesel. The Diesel engine does away with the boilers and furnaces, it occupies less space than steam equipment and thus adds to available cargo capacity It consumes much less fuel, gives a vessel a much greater sailing range and is more economical to operate. For these reasons it is being so largely adopted for vessels of moderate size and speeds that ocean shipping promises to be motorized in large part in the relatively near future. The check upon the general Dieselization of shipping thus far has been the higher cost of installation and the weight of the Diesel engine and its auxiliaries, but these handicaps are being steadily

overcome by designers and builders

The Electric Railway.—Electric power has been employed in three fields of transport, for city street railways, surface, elevated and underground, for interurban railways, and, to some extent, as a substitute for steam locomotives on railroads in large city terminals, tunnels and on heavy mountain grades where current can be generated by water power

When the motor-bus appeared on the city streets a few years ago, the electric railways were supplying all organized urban transport, and supplemented by suburban extensions they had in three decades, by providing rapid transit, caused cities to spread out over ever enlarging areas and had done much to improve living conditions for the constantly increasing number of people who live in cities The importance of the interurban electric railway has been greatly reduced by the rapid development of motor-bus service. Many interurban, and also suburban electric lines have ceased to operate in the United States, and in most countries the suburban and local passenger traffic of steam railways, especially in the United States, has been greatly reduced mainly by the extensive use of private automobiles and also by the competition of motor-buses Indeed local and short distance passenger transport seems to be steadily transferred from the steam and electric railways to the highways

At the beginning of this century it was thought that steam railways would be electrified, there being no question as to the general superiority of electricity as a motive power, but electrification has thus far been confined mainly to tunnels, to eliminate the smoke and gases, to a few large city terminals, also for the same reason, and to some mountain grade sections where electric locomotives are more efficient than steam and where current can usually be obtained from water-power The general electrification of steam railways in the near future is not probable for the reason that the cost of the change would so increase the investment in the railways as to make impossible a profitable rate of return on the increased capital Moreover, the steam locomotive has of late improved rapidly in power, efficiency and economy and has made electrification seem less important than formerly The application of the Diesel engine has great possibilities

Highway Transport—the Automobile Age.—The movement for good public roads began in western Europe 100 years before it started in the United States, a newer country with a sparser population and less accumulated capital Moreover, the early and wide-spread development of railways in the United States provided facilities for other than short-distance and local transport that were fairly adequate until near the end of the 19th century. Then it became manifest that in the more thickly populated north-eastern States improved county and State roads were necessary New Jersey acted first, adopting a State highway law in 1890, Massachusetts, New York and some other States soon followed with similar acts The movement, however, would probably have been much slower than it was, had it not been for the automobile, the use of which rapidly increased after 1900 and particularly from 1910 onward, until at the present time there are as many automobiles in the United States as there are families The demand of the private automobile owners throughout the United States for roads that are good throughout the year was strengthened during and after the World War by the operators of motor-buses and of motor trucks, whose use for local passenger and freight transport had increased with great rapidity The States (aided from 1915 by the Federal Government) have provided the country with a comprehensive system of State and inter-State highways The improved highway and the automobile in the United States have brought mechanical transport to each man's door, and the same is true in varying degree in many other countries.

The effect of making mechanical transport universally available has been to create new conditions of living, to increase economic activity, to stimulate wider intellectual interest, to raise standards of living Possibly the immediate consequences of the sudden change from a relatively static to a highly mobile society may not all be advantageous, but mankind may be expected to adjust itself to the new order of things and to meet successfully the social problems of the automobile era, as it has met the difficulties that have arisen in the past.

Air Transport and Its Effects.—No other facility of transport is receiving so much attention from the public and from technical experts as the aeroplane. The great interest aroused in aeronautics—in the aeroplane and the airship—by the World War has continued unabated, the aim of present efforts (1929) being to establish air transport of passengers and high class package freight, as well as the mails, upon a self-supporting commercial basis. For a discussion of this subject *see* TRANSPORT BY AIR. (E. R. J.)

TRANSPORT, MINISTRY OF: *see* GOVERNMENT DEPARTMENTS.

TRANSPORT BY AIR. Aircraft were first used on regularly scheduled routes in Germany where for four years prior to the World War Zeppelin airships carried passengers between the larger cities Immediately after the war British aeroplanes were employed in a passenger service between London and Paris. Soon all other large nations had their own air-transport, though with the exception of the United States, they were compelled to grant liberal subsidies to maintain the lines in continuous operation

The first scheduled air-mail service was started by the Post Office Department in the United States May 15, 1918, using military planes on the initial route between New York and Washington, D C. The trans-continental route between New York and San Francisco was then opened, and in 1926 was lighted for night flying between New York and Omaha, Neb.

In accord with the Federal policy that the Government should not engage in private business the Post Office Department relinquished the mail routes to private contractors under the provisions of the Kelly Act of 1926 That legislation is credited with having established air-transport on a self-sustaining basis By its terms the Post Office Department lets mail contracts at a pound rate This form of indirect subsidy has supported the operators through the early years of experiment, permitting them to develop better equipment, train their personnel and cultivate popular patronage.

The Air Commerce Act of 1926 was another agency calculated to develop air-transport. It created a law for licensing planes and pilots, regulating all civil flying and maintaining the American airways under the Department of Commerce The Aeronautics branch of that department charts routes, equips airways for night flying, establishes lighted beacons and radio communications in much the same manner as other bureaux provide ports, lighthouses and other navigational aids for surface vessels

On Jan. 1, 1929, there were 15,128 miles of airways in the United States, two-thirds of their aggregate distance lighted and prepared for night flying. Twenty-two companies were operating 33 air-mail routes under contract with the Post Office Department Mail planes were flying an average of 27,848 miles every 24 hours

Ten other air-transport companies were carrying either passengers or express, or both With 13 of the mail operators, which also carried passengers and express, these American lines transported 52,934 passengers on scheduled flying service in 1928; that was about four and a half times the number flown in the preceding year The average fare was 10 cents a mile

The year 1928 was the first in which the companies carried express under contract with the American Railway Express Company, and the amount flown during the twelve months was 1,222,843 pounds. The contract air-mail lines carried 3,632,059 pounds of mail, thrice the poundage of the preceding year The 33 operating companies flew more than 10,000,000 miles in 1928.

Air-transport in the United States had progressed to such a stage in 1929 that close observers felt warranted in recognizing it as of equal importance with terrestrial transportation First and last this importance is based on speed, the dispatch with which persons and things can be carried from one place to another without delay

The cargo planes in 1929 were averaging about 125 miles an hour; and that, admittedly, was not fast enough to take traffic

away from the surer surface transport An average speed of 150 miles an hour for passengers and 175 miles an hour for mail and express would, it was believed, result in popularizing air-transport and placing it on a par with the railroads and motorbuses.

Such speeds, along with the solution of several technical problems, were promised for the near future; and the engineering genius of the nation was at work toward that end.

In Europe the record of air-transport is vastly different. There are no great distances within the limits of a majority of European countries, hence no especial need for such speed as the aeroplane alone can provide. In the British Isles train and bus service has been entirely adequate The cross-Channel air service between London and Paris would not be profitable if operated without liberal subsidies. It is maintained primarily because it is an important section of the air-transport system which Britain is establishing between London, Egypt, the Near East, South Africa and India. Eventually, it is believed, passengers will be carried on those routes in giant airships, while fast planes will be used to carry mails and urgent express.

The French Government maintains its military aviation facilities by supporting the aeroplane industry, buying military machines for the air forces and commercial planes for the operating companies. The operation of the French air lines was so generally unsatisfactory late in 1928 that the Government adopted a policy of reorganization, uniting and regrouping the principal subsidized lines and stipulating the degree of service they must render. French lines operating throughout Europe, across the Mediterranean to Africa and in South America, by connecting with steamship service between French Africa and Brazil, were designed primarily to maintain a great reserve force for the French defensive establishment The same condition existed in Italy, where the Fascist policy was to create air highways for exactly the same purpose as the Roman roads were built, to facilitate communications of a political nature

The German Government and a majority of the German States grant liberal subsidies to the commercial air-transport lines, the principal one being the Deutsche Luft Hansa, the largest, most popular and profitable air-transport system in Europe. Luft Hansa aeroplanes operate between all German centres and make connections with those of other nations at practically every large city in Europe Night flying had not progressed to any extent anywhere on the Continent at the beginning of 1929.

Among the problems remaining to be solved before air-transport may be considered equally practicable with surface methods is the development of aeroplane radio to a degree where it can be made available for direct conversation between the pilot in the machine and persons on the surface, this in order that he may be kept constantly informed of his location in darkness, storm or fog, that he may be warned to swerve from his course and head for some other field where it may be advisable for him to land, especially when there is fog at his original destination Thus far there is no device enabling a pilot to make a safe landing in fog, no matter if he knows he is directly over his airport

With the widespread development of municipal airports the change of course is not so much of a problem, so far as safety is concerned; but it does affect the comfort and convenience of passengers For example, one bound for New York does not like to find oneself set down in Philadelphia because of fog at the other terminal That was the chief problem awaiting solution in 1929.

A most important phase of air transport in 1929 was the development of air-rail service whereby the air lines and the railroads might work together in a co-ordinated system, flying passengers and express part of the way and for the remainder taking them aboard trains In both the United States and Europe the railroads had accepted in principle the idea that the faster vehicle might be of the greatest value in reducing operating costs, not as a competitor but as a supplementary carrier.

If the railways could succeed in removing from their rights-of-way all fast trains, no small part of the maintenance costs would be eliminated because the fast traffic requires much more repair, supervision and greater safeguards

Instead of setting up their own private air lines to compete with air transport companies, the railways were joining with the existing lines, rearranging schedules, locating terminal and transfer facilities, training personnel and generally paving the way for a completely equipped air-rail service. A majority of the railroad executives were hopeful that the day might soon arrive when they would be able to entrust to aircraft all of their fast, long-distance passenger traffic

With the long trunk line systems fairly established in practically every country there remained the establishment of short haul or feeder lines, and considerable progress was being made in that direction in all countries The linking together of all communities within a nation's boundaries was promised for an early date That would make air transport a distinctly national institution

Following that there must develop international routes connecting all countries. Expert opinion holds that the airship must become the common carrier for all long distance routes over the water, principally because it can carry heavy loads at a greater net profit; also because it can remain in the air, supported by buoyant gas, even when the engines fail For shorter distances over water and routes overland within a radius of 1,000 miles the aeroplane is superior and more profitable. There is every indication that the two types, heavier and lighter-than-air, will be employed together within the next five years, airships and planes being used to link all countries in one vast system affording a continuous world-wide service travelling at an average of 100 miles an hour or even better in any kind of weather (H M)

TRANSUBSTANTIATION, the term adopted by the Roman Catholic Church to express her teaching on the subject of the conversion of the Bread and Wine into the Body and Blood of Christ in the Eucharist Its signification was authoritatively defined by the Council of Trent in the following words "If any one shall say that, in the Holy Sacrament of the Eucharist there remains, together with the Body and Blood of Our Lord Jesus Christ, the substance of the Bread and Wine, and shall deny that wonderful and singular conversion of the whole substance of the Bread into (His) Body and of the Wine into (His) Blood, the species only of the Bread and Wine remaining—which conversion the Catholic Church most fittingly calls Transubstantiation—let him be anathema" (Sess xiii *can* 2) The word Transubstantiation is not found earlier than the 12th century. But in the Eucharistic controversies of the 9th, 10th and 11th centuries the views which the term embodies were clearly expressed, as, for example, by Radbertus Paschasius (d 865), who wrote that "the substance of the Bread and Wine is efficaciously changed interiorly into the Flesh and Blood of Christ," and that after the consecration what is there is "nothing else but Christ the Bread of Heaven" The words "substantially converted" appear in the formula which Berengarius was compelled to sign in 1079 We may take it that the first use of the word is in a passage of Hildebert de Savardin (d 1133), who brings it into an exhortation quite informally, as if it were in common use. It is met with in a Decretal of Innocent III The fourth Lateran Council fully adopted it (1215) It is clear from the treatise of Radbertus Paschasius already quoted that the word "substance" was used for *reality* as distinguished from *outward appearance*, and that the word "species" meant *outward appearance* as opposed to *reality* The terms, therefore, were not invented by St Thomas Aquinas, and are not mere scholastic subtlety The definition of the Council of Trent was intended both to enforce the accepted Catholic position and to exclude the teaching of Luther, who, whilst not professing to be certain whether the "substance" of the Bread and Wine could or could not be said to remain, exclaimed against the intolerance of the Roman Catholic Church in defining the question

Bibliography.—For a full and recent exposition of the Catholic teaching on Transubstantiation the reader may consult *De ecclesiae sacramentis*, auctore Ludovico Billot, S J. (Rome, Propaganda Press, 1896) *See* also the *Catholic Encyclopaedia*, article "Transubstantiation" The Abbé Pierre Batifol, in his *Études d'histoire et de théologie positive*, 2me série (*Elaboration de la notion de conversion*, and *Conversion et transubstantiation*) treats it from the point of view of

development (V. Lecoffre, Paris, 1905). (J. C. H.; X.)

TRANSVAAL, an inland province of the Union of South Africa between the Vaal and Limpopo rivers. It lies, roughly, between 22½° and 27½° S. and 25° and 32° E, and is bounded on the south by the Orange Free State and Natal, on the west by the Cape Province and the Bechuanaland Protectorate, on the north by Rhodesia, and on the east by Portuguese East Africa and Swaziland Save on the south-west the frontiers, for the main part, are well defined natural features From the south-west to the north-east corners the colony is 570 m; east to west its greatest extent is 397 m The total area is 110,450 sq.m, a little less than the area of Great Britain and Ireland.

PHYSICAL FEATURES

About five-sixths of the country lies west of the Drakenberg (*q v*). The boundary of the Transvaal over against Portuguese East Africa runs along the Lebombo Range, between which and the Drakenberg is a belt of low country The Lebombo Hills approach within 35 m. of the sea at Delagoa Bay. The part of the plateau, east of Johannesburg, is from 5,000 to 6,400 ft high; the western and somewhat larger half is generally below 5,000 ft and sinks to about 4,000 ft on the Bechuanaland border. This plateau land is called the high veld, and covers about 34,000 sq m The northern edge of the plateau follows an irregular line from somewhat north of Mafeking on the west to the Mauchberg on the east This edge is marked by ranges of hills such as the Witwatersrand, Witwatersberg and Magaliesberg; the Witwatersrand, which extends eastward to Johannesburg, forms the watershed between the rivers flowing to the Atlantic and Indian Ocean. Farther north, beyond the intervening slopes and low bush, are two elevated regions covering together over 4,000 sq m They are the Waterberg, and, more to the east, separated from the Waterberg by the valley of the Magalakwane tributary of the Limpopo, the Zoutpansberg An eastern offshoot of the Zoutpansberg is known as the Murchison Range The low land between the high veld and the Waterberg and Zoutpansberg is traversed by the Olifants River, an east flowing tributary of the Limpopo.

The true high veld, extending east to west 120 m, and north to south 100 m, consists of rolling grass covered downs, absolutely treeless, save where, as at Johannesburg, plantations have been made by man, the crest of the rolls being known as *builts* and the hollows as *laagtes* The surface is occasionally broken by kopjes—either table-shaped or pointed—rising sometimes 100 ft. above the general level Small springs of fresh water are frequent and there are several shallow lakes or pans—flat bottomed depressions with no outlet The largest of these pans, Lake Chrissie, some 5 m long by 1 m broad, is in the south-eastern part of the high veld The water in the pans is usually brackish The middle veld is marked by long low stony ridges, known as rands, and these rands and the kopjes are often covered with scrub

The banken veld, formed by the denudation of the plateau, is much broken up and is rich in romantic scenery. It covers about 27,000 sq m, and has an average breadth of 40 m In places, as between Mafeking and Johannesburg, the descent is in terrace-like steps, each step marked by a line of hills; in other places there is a gradual slope and elsewhere the descent is abrupt, with outlying hills and deep well-wooded valleys The rocks at the base of the slopes are granite, the upper escarpments are of sedimentary rocks. Thence issue many streams which in their course to the ocean have cut their way across the ranges of hills which mark the steps in the plateau, forming the narrow passes or *poorts* characteristic of South African scenery.

As in the middle veld, rands and kopjes occur in the low or bush veld, but the general characteristic of this part of the country, which covers over 50,000 sq m, is its uniformity. The low veld east of the Drakenberg begins at about 3,000 ft. above the sea and slopes to 1,000 ft or less until it meets the ridge of the Lebombo hills The lowest point is at Komati Poort, a gorge through the Lebombo hills only 476 ft above the sea. West and north of the Drakenberg the general level of the low veld is not much below that of the lowest altitudes of the middle veld, though the climatic conditions greatly differ. North of the Zoutpansberg the ground falls rapidly, however, to the Limpopo flats which are little over 1,200 ft. above the sea. Near the northwest foot of the Zoutpansberg is the large saltpan from which the mountains get their name The low veld is everywhere covered with scrub, and water is scarce, the rivers being often dry in winter.

River Systems.—There are four separate river basins in the Transvaal Of these the Komati (*q.v.*) and its affluents, and the Pongola and its affluents rise in the high veld and flowing eastward to the Indian Ocean drain but a comparatively small area of the province, of which the Pongola forms for some distance the south-eastern frontier. The rest of the country is divided between the drainage areas of the Vaal and Limpopo The absence of alluvial deposits of any size is a characteristic of the Transvaal rivers. For the climate of the Transvaal *see* SOUTH AFRICA, UNION OF.

Vegetation.—Forest patches are confined to deep kloofs, to the valleys of the larger rivers and to the seaward slopes of the Drakensberg and other ranges, where they receive mists and rains from the moisture laden winds. Many trees have been introduced and considerable plantations made, as for instance on the slopes between Johannesburg and Pretoria Among the most successful of the imported trees are citrus trees, the Australian wattle and the eucalyptus. Grassland is the prevalent association in the province. (*See* SOUTH AFRICA, UNION OF)

Fauna.—When first entered by white men the Transvaal abounded in big game, the lion, leopard, elephant, giraffe, zebra and rhinoceros being very numerous, while the hippopotamus and crocodile were found in all the rivers The indiscriminate destruction of these animals has greatly reduced their numbers. Shooting is now restricted by legislation In the Pretoria Game Reserve and in the Kruger National Park shooting and hunting are absolutely prohibited The latter was formed by the amalgamation of the Shingwedzi and Sabie Reserves. It covers over 20,000 sq m in the low country, and promises to be one of the finest nature reserves in the world

Insects abound, the greatest pest being the tsetse fly, common in the low veld Six species of tick, including the blue tick common throughout South Africa, are found, especially in the low veld, where they are the means of the transmission of disease to cattle Mosquitoes, locusts and ants are also common

Population.—The population in 1921 included 543,485 whites, who had increased by 1926 to 608,622. A large proportion of these live on the Witwatersrand, on the coalfield or in Pretoria The natives in 1921 numbered 1,495,869 Apart from the large numbers employed in the gold and coal mines, the natives are found chiefly in the northern part of the province. Basuto are numerous in the Zoutpansberg and Lydenburg districts. Bechuana are largely confined to the west and south-west. Amazulu are found principally in the Wakkerstroom and Standerton districts, and Amaswazi in the Barberton, Ermelo and Wakkerstroom districts Shangaan and other East Coast tribes form an appreciable element in Barberton, Lydenburg and Zoutpansberg Asiatics totalled nearly 16,000 They are largely engaged in trade, and are settled on the Witwatersrand, in Pretoria and Barberton The number of mixed and others was 32,291. These include a few Hottentots and Koranna, who live chiefly in the south-west of the province. (*See* SOUTH AFRICA, UNION OF, and separate articles on the several tribes.)

Towns.—Pretoria is the administrative capital of the Transvaal, and of the Union of South Africa. The city of Johannesburg is the largest urban agglomeration in the Union. Germiston and Boksburg are virtually suburbs of Johannesburg. Among the other towns are Potchefstroom, Klerksdorp, Middelburg, Barberton, etc. (*See* separate articles.)

Mineral Resources.—The Transvaal, the principal gold producing country in the world, is noted for the abundance and variety of its mineral resources The minerals chiefly mined besides gold are diamonds and coal, but the country possesses also platinum, silver, iron, copper, lead, cobalt, sulphur, saltpetre and many other mineral deposits.

Gold.—The principal gold-bearing reefs are found along the

Witwatersrand ("The Rand"). Probably connected with the Rand reefs are the gold-bearing rocks in the Klerksdorp, Potchefstroom and Venterskroon districts Other auriferous reefs are found all along the eastern escarpment of the Drakensberg and are worked in the De Kaap (Barberton) district, on the Swaziland frontier, in the Lydenburg district, in the Murchison Range and in other places in the Zoutpansberg Goldfields also exist in the Waterberg and on the western frontier in the Marico district (the Malmani fields) The total value of the gold extracted from mines in the Transvaal from 1884 to 1926 was £885,841,707. (*See* also South Africa, Union of. *Geology*)

Diamonds—The chief diamond fields are in the Pretoria district The ground was discovered to be diamondiferous in 1897, but it was not until 1903, when mining began on the Premier mine, situated 20 m north-east of Pretoria, that the wealth of the fields was proved In June 1903 mining began and the diamonds found in the first five months realized over £90,000 On the 27th of January 1905, the largest diamond in the world, weighing 3,025¾ carats, over 1⅓ lb avoirdupois, was found in the mine and named the Cullinan The Premier mine is of the same character as the diamond mines at Kimberley (*see* Diamond), and is considerably larger The area of the "pipe" containing blue ground is estimated at 350,000 sq yd

Besides the Pretoria fields there are diamondiferous areas (alluvial diggings) in the Bloemhof district on the Vaal river northeast of Kimberley, and in other regions In 1926 the whole output of diamonds in the Transvaal was valued at £4,487,921.

Platinum—In 1924, in the Lydenburg district, a bed of norite, an igneous rock in the Bushveld Igneous Complex, was found to contain platinum, the quantity varying from 2 to 5 pennyweight per ton The outcrop of this bed has been traced for about 60 miles In 1925 platinum bearing rocks were recognised near Potgietersrust The Bushveld norite has also been traced in the Rustenberg area for about 100 m At present production is only in the experimental stage

Coal and Other Minerals—There are extensive beds of good coal, including thick seams of steam coal near the Rand and other goldfields. Coal appears to have been first discovered in the neighbourhood of Bronkhorst Spruit between the Wilge and Olifants rivers, where it was so near the surface that farmers dug it up for their own use In 1887 coal was found at Boksburg in the East Rand, and a mine was at once started The principal collieries are those at Boksburg and at Brakpan, also on the East Rand, with a coal area of 2,400 acres, at Vereeniging and Klerksdorp, near the Vaal, at Watervaal, 12 m north of Pretoria, and in the Middelburg district, which now supplies most of the coal used by the gold mines. Like that of Natal the Transvaal coal burns with a clear flame and leaves little ash. The mines are free from gas and fire damp and none is more than 500 ft. deep The output in 1926 was over seven and a half million tons

Iron and copper are widely distributed The Yzerberg near Marabastad in the Zoutpansberg consists of exceedingly rich iron ore, which has been smelted by the natives for many centuries. Silver is found in many districts, and mines near Pretoria have yielded in one year ore worth £30,000

Salt is obtainable from the many *pans* on the plateaux, notably in the Zout(salt)pansberg, and was formerly manufactured in considerable quantities

Agriculture.—Next to mining, agriculture is the most important industry The chief occupation of the majority of the white farmers is stock-raising The high veld is admirably adapted for the raising of stock, its grasses being of excellent quality and the climate good. Even better pasture is found in the low veld, but there stock suffers in summer from many endemic diseases, and in the more northerly regions is subject to the attack of the tsetse fly The banken veld is also unsuited in summer for horses and sheep, though cattle thrive Much of the stock is moved from the lower to the higher regions according to the season. Among the high veld farmers breeding of merino sheep is popular

The amount of land under cultivation is very small in comparison with the area of the province. The small proportion of land tilled is due to many causes, among which paucity of population is not the least. Moreover while large areas on the high veld are suitable for the raising of crops of a very varied character, in other districts, including a great part of the low veld, arable farming is impossible or unprofitable. Many regions suffer permanently from deficient rainfall, in others, owing to the absence of irrigation works, the water supply is lost, while the burning of the grass at the end of summer, a practice adopted by many farmers, tends to impoverish the soil and render it arid The country suffers also from periods of excessive heat and general drought, while locusts used to sweep over the land, devouring every green thing In some seasons the locusts, both red and brown, come in enormous swarms covering an area of 5 m broad and from 40 to 60 m long. The chief method employed for their destruction is spraying the swarms with arsenic. The districts with the greatest area under cultivation are Heidelberg, Witwatersrand, Pretoria, Standerton and Krugersdorp. The chief crops grown for grain are maize (mealie), kaffir corn and wheat (*See* South Africa, Union of) Maize is the staple food of the natives Oats, barley and millet are largely grown for forage Oats are cut shortly before reaching maturity, when they are known as oat-hay The chief vegetables grown are potatoes, pumpkins, carrots, onions and tomatoes Fruit farming is a growing industry on the slopes of the plateaux and in the warmer valleys, where citrus and other sub-tropical fruits thrive, as, for example, about Rustenberg, Waterberg, etc In 1925 there were nearly two million orange trees in the province, mostly navel oranges Grapefruit trees numbered about 27,000, peach trees 33,000, and apple trees nearly 200,000 Apples, and, to some extent peaches thrive better in the higher districts These figures refer to trees, the fruit of which is mostly grown for export

Cotton growing is making satisfactory progress The number of morgen under this crop in 1919–20 was 3,275 in 1925–26 it had increased to nearly 28,000 Cotton grows well in the western part of the Transvaal, north of the Magaliesberg Range, and in the low veld of the north and east, where frost is absent for six or seven months Tobacco is grown in the Magaliesberg area, and about Potchefstroom, the cultivation of over 7,000 morgen in 1926 yielding nearly eight million pounds of tobacco

There are few manufacturing undertakings other than those connected with mining, agriculture and the development of Johannesburg There is a large factory for the supply of dynamite to the gold mines The building and construction trade is an important industry on the Rand, where there are also brickworks, iron and brass foundries, breweries and distilleries There are a number of flour mills and jam factories in various centres A promising home industry, started under English auspices after the war of 1899–1902, is the weaving by women of rugs, carpets, blankets, etc, from native wool Iron and steel works have been established at Vereeniging and Pretoria

Provincial Government.—At the head of the executive is a provincial administrator, appointed by the Governor-General-in-Council. He holds office for five years, and is assisted by an executive committee of four members elected by the provincial council The provincial council consists of 50 members, elected for the same constituencies and by the same electorate as are the members of the House of Assembly The provincial council, which has strictly local powers, sits for a statutory period of three years.

Education.—Since 1910 education, other than elementary, is under the control of the Provincial Council At the head of the permanent staff is the Director of Education The province is divided into 31 school districts, in each of which is a school board, consisting partly of elected and partly of nominated members: its functions are advisory Both primary and secondary education are free Attendance is compulsory for European children between the ages of 7 and 15. The age limit has been raised to 16 in 27 of the school districts Religious teaching is confined to the undenominational instruction in Bible history In 1926 there were over 1,200 State and State-aided schools for Europeans, and 435 for non-Europeans Many of the latter are directed by missionary bodies (For higher education, religion, and defence *see* South Africa, Union of) (F R C; R U S)

HISTORY

At the beginning of the 19th century the country now known as the Transvaal was inhabited, apparently somewhat sparsely, by Bavenda and other Bantu negroes, and in the south-west by wandering Bushmen and Hottentots About 1817 the country was invaded by the chieftain Mosilikatze and his impis who were fleeing from the vengeance of Chaka, king of the Zulus The inhabitants were unable to withstand the attacks of the disciplined Zulu warriors—or Matabele, as they were henceforth called—by whom large areas of central and western Transvaal were swept bare The remnants of the Bavenda retreated north to the Waterberg and Zoutpansberg, while Mosilikatze made his chief kraal at Mosega, not far from the site of the town of Zeerust, and near the Bechuana border At that time the region between the Vaal and Limpopo was scarcely known to Europeans In 1829, however, Mosilikatze was visited at Mosega by the celebrated missionary to the Bechuana, Robert Moffat and between that date and 1836 a few British traders and explorers visited the country and made known its principal features Such was the situation when Boer emigrants first crossed the Vaal

FOUNDATION OF THE REPUBLIC

As shown elsewhere (*see* South Africa, Union of and Cape Colony) the Voortrekkers had an intense desire to be rid of British control, and to be allowed to set up independent communities and govern the natives in such fashion as they saw fit The first party to cross the Vaal consisted of 98 persons under the leadership of Louis Trichard and Jan van Rensburg They left Cape Colony in 1835 and trekked to the Zoutpansberg Here Rensburg's party separated from the others, but were soon afterwards murdered by natives. Trichard's party determined to examine the country between the Zoutpansberg and Delagoa bay Fever carried off several of their number, and it was not until 1838 that the survivors reached the coast Eventually they proceeded by boat to Natal. Meantime, in 1836, another party of farmers under Andries Hendrik Potgieter had established their headquarters on the banks of the Vet river Potgieter and some companions followed the trail of Trichard's party as far as the Zoutpansberg, where they were shown gold workings by the natives and saw rings of gold made by native workmen. They also ascertained that a trade between the natives and the Portuguese at Delagoa bay already existed On returning to the Vet, Potgieter learned that a hunting party of Boers which had crossed the Vaal had been attacked by the Matabele, who had also killed Boer women and children This act led to reprisals, and on Jan. 17, 1837, a Boer commando surprised Mosilikatze's encampment at Mosega, inflicting heavy loss on the Matabele without themselves losing a man—for the Boers had, and the Matabele had not, firearms In November of the same year Mosilikatze suffered further heavy losses at the hands of the Boers, and early in 1838 he fled north beyond the Limpopo, never to return Potgieter, after the flight of the Matabele, issued a proclamation in which he declared the country which Mosilikatze had abandoned forfeited to the emigrant farmers After the Matabele peril had been removed, many farmers trekked across the Vaal and occupied parts of the district left derelict Into these depopulated areas there was also a considerable immigration of Basuto, Bechuana and other Bantu tribes

The first permanent white settlement north of the Vaal was made in Nov 1838 by Potgieter and some followers who settled on the banks of the Mooi river and founded the town of Potchefstroom The next settlement appears to have been in the Magaliesberg, where Rustenburg was founded At that time the emigrant farmers had set up the republic of Natal; in 1840 Potgieter's party entered into a loose alliance with the Natal Boers and with those at Winburg, north of the Orange. In this alliance Natal had the leadership, but in 1843 the British annexed Natal and in the following years many burghers left that country, recrossed the Drakensberg, and set up an independent Government in the Transvaal. Dissensions among the immigrants broke out almost at once and in 1845 Potgieter, with a considerable number of Potchefstroom burghers and some from Winburg migrated north-east towards Delagoa bay, where Potgieter made a treaty with the Portuguese A spot on the inner slopes of the Drakensberg was chosen as headquarters and there was built the village of Andries Ohrigstad. It proved fever-ridden and was abandoned, a new village being laid out on higher ground and named Lydenburg by the farmers in memory of their sufferings at Ohrigstad Other emigrants settled in the Potchefstroom district and in 1848 Andries Pretorius (*q.v.*) became their leader. Pretorius, in the middle of that year, had fought unavailingly against the establishment of British sovereignty by Sir Harry Smith (*q.v.*) between the Orange and the Vaal The Transvaal thus became the refuge of the most irreconcilable to British rule of the Dutch farmers—who were, however, much more pastoralists than agriculturalists

Sand River Convention.—Pretorius persuaded the more responsible farmers to agree to one *volksraad* for the whole country, but Potgieter, by nature a dictator, would not agree and he and his friends removed from Lydenburg farther north to the Zoutpansberg However the British Government abandoned its claim to regard all the emigrant farmers beyond the Vaal as British subjects Commissioners sent to the Orange Sovereignty opened negotiations with Pretorius and on Jan 17, 1852, a convention was signed at a farm by the Sand river, in the Orange Sovereignty, acknowledging the independence of the Transvaal without regard to the divisions among the Boers The first article of the Sand River Convention was as follows.—

> The assistant commissioners guarantee in the fullest manner, on the part of the British Government, to the emigrant farmers beyond the Vaal river, the right to manage their own affairs, and to govern themselves according to their own laws, without any interference on the part of the British Government, and that no encroachment shall be made by the said Government on the territory beyond to the north of the Vaal river, with the further assurance that the warmest wish of the British Government is to promote peace, free trade, and friendly intercourse with the emigrant farmers now inhabiting, or who hereafter may inhabit, that country, it being understood that this system of non-interference is binding upon both parties

At this time there were settled north of the Vaal about 5,000 families of European extraction They had obtained independence, but as has been shown they were far from being a united people. When Pretorius conducted the negotiations which led to the signing of the Sand River Convention, though he had the support of the Rustenburg and Lydenburg districts, he did so without consulting the *volksraad,* and Potgieter's party accused him of usurping power and aiming at domination over the whole country However, the *volksraad,* at a meeting held at Rustenburg on March 16, 1852, ratified the convention, Potgieter and Pretorius having been publicly reconciled on the morning of the same day Both leaders were near the end of their careers; Potgieter died in March and Pretorius in July 1853

The Constitution.—Upon the death of Andries Pretorius his son Marthinius was (Aug 1853) elected commandant-general of the Potchetstroom and Rustenburg districts, he had been in office little more than six months when the Orange Sovereignty was abandoned by the British and the Orange Free State as an independent republic took its place. Martinius Pretorius was a man of large ideas and he worked for the union of the Boer States First he had to start with his own country. In 1855 the town of Pretoria was founded and the Pretoria district created; in 1856 the burghers of Potchefstroom, Rustenburg and Pretoria united to form "the South African Republic." The title was chosen, a national flag (the *Vierkleur*) adopted and the constitution (*grondwet*) elaborated at a special session of delegates held in December at Potchefstroom It was decided that Pretoria should be the capital of the State The legislative power was given to a *volksraad,* elected by the burghers (that is the franchise was confined to white men); the administration was entrusted to a president aided by an executive council which included a popularly elected commandant-general. Members both of the *volksraad* and council were to be of European blood and members of the Dutch Reformed Church. A high court of justice separate from the *volksraad* was instituted. The constitution further expressly declared that no equality of coloured people with the white inhabitants would be tolerated either in Church or State Paul Kruger, then a

man of 30 and leader of the Rustenburg burghers, took a leading part in framing the constitution

The Civil "War."—At the time both Lydenburg and Zoutpansberg repudiated the authority of the South African Republic of which, as a matter of course, Pretorius was elected president (Jan 1857). The same year Pretorius, with Kruger's aid, tried unsuccessfully, by means of an armed raid, to compel the Free State to join the S A R Pretorius nevertheless retained many supporters in that State. Not long afterwards the efforts of the British high commissioner, Sir George Grey, for a federation of all the South African states came to nothing Pretorius now secured the incorporation of Lydenburg and Zoutpansberg in the S A R A vacancy occurring in the presidency of the Free State, Pretorius was elected He went to Bloemfontein with the fixed object of uniting the two Boer republics He found, however, discontent in the Free State, a depleted treasury and much trouble with the Basutos Moreover the British authorities frowned on proposals for the union of the O F S and the S A R Old rivalries broke out in the Transvaal, and the country presented the spectacle of two rival presidents, or acting presidents, and two rival Governments This in turn led to a sort of civil war, though without actual fighting There was a "bombardment" of Potchefstroom —with one gun—by Paul Kruger and on that occasion three lives were lost and a few burghers wounded In this conflict Kruger supported the side which he held to be the legal government and called his force the army of the State (*staatsleger*) Pretorius intervened more than once; at last in April 1863 he resigned his presidency of the Free State, but in the Transvaal a new election resulted (Oct 1863) in the return of W. J C van Rensburg as president (Rensburg had been one of the acting-presidents since April 1862, his rival being Stephanus Schoeman, the Zoutpansberg commandant-general, a son-in-law of Potgieter) The Pretorius party declared van Rensburg improperly elected and brought their *volksleger* (people s army) into the field under Com J Viljoen Kruger called out his *staatsleger* and seeing that he was being outmanoeuvred determined to fight in earnest "He shot to kill and ended the civil war" (Walker's *History of South Africa*) The parties now in fact came to terms, a new election was held and this time Pretorius was returned at the head of the poll, while Kruger became commandant-general On May 10, 1864, Pretorius took up the presidency again In February John Brand had become president of the Free State and he succeeded in making it a model commonwealth Pretorius lacked the ability and solidity which distinguished Brand and he had even more intractable human material with which to deal

Church Controversies: the Doppers.—Political dissension had been accompanied by ecclesiastical strife Practically all the burghers were members of the Dutch Reformed Church, but the Cape synod of that Church had disapproved the *trek* and the emigrants had been left almost without ministers They were, however, deeply religious in a narrow Calvinistic fashion, and in all their settlements built a church even though without a minister Their literature was almost confined to the Bible, many of them looked upon themselves as the chosen people on a new pilgrimage, so that church affairs filled an important part in their lives After much controversy it was decided in 1853 that there should be no incorporation of the Transvaal churches with the Cape Synod; for one thing the Transvaalers objected to the legal equality of blacks with whites permitted in the colonial churches.

In 1858–59 another cause of dissension arose There was already in some strength among the burghers the sect of Doppers, who contended that while hymns were good spiritual aids in private devotion, they should not be sung in church, not being (like the psalms) part of holy scripture. In 1858 the Rev. D Postma, of the Separatist Reformed Church of Zwolle, Holland, became minister at Rustenburg and at once gained the support of all the Doppers. At a general assembly at Pretoria in Jan. 1859 Postma refused to use hymns, and Kruger and other laymen gave notice that they had left the *Hervormde Kerk* (the Dutch Reformed Church) and proposed to form a new church Efforts at compromise failed and later in the year the Separatist (Dopper) Church was formed Its official title is *Christlijk Afgeschiedene Gereformeerde Kerk*. During the civil war Kruger got the constitution altered so that a member of any Reformed Church might hold full political rights

From the first, whatever their internal dissension, the Transvaal Boers had vast territorial ambitions; at an early stage they even put forward a claim to all the land north of the Vaal from ocean to ocean, and they repeatedly and persistently tried to get an outlet to the sea One of their earliest claims, made a few weeks after the signing of the Sand River Convention, was to the land of the Bechuana, and Andries Pretorius asked the British to close the "lower road," that is the route to the far interior opened up originally by the missionaries, Moffat and Livingstone This request was followed (Aug 1852) by a raid on the Bakwena Bechuana—who were said to be harbouring a chief who had looted Boer cattle. In this "punitive expedition" Livingstone's house at Kolobeng was looted, and some 200 to 300 women and children carried off by the Boers The struggle for Bechuanaland thus begun lasted for nearly 40 years, ending in the discomfiture of the Boers (*see* BECHUANALAND)

The Slavery Charge.—The action of the commandos against the Bakwena brought against the Boers the charge of slavery, and the apprentice law passed by the *volksraad* in 1856, it was alleged, practically legalized slavery It must be remembered that when the Boers first emigrated to the Transvaal, slavery had been but recently abolished in Cape Colony, Potgieter and others of the *Voortrekkers* may have been slave-owners, but slavery as such was not recognized in the Transvaal The organized native tribes with whom they had dealings were usually required to produce a "labour tax" in kind; that is, the chief had to furnish labourers to perform specific work There was no great hardship in this. But many farmers on the borders of the old Cape Colony had had a habit of kidnapping Bushmen children and others and "apprenticing" them together with other apprentices obtained in a more legitimate fashion This reprehensible habit persisted among the Boers in the Transvaal—among whom were many bad characters who had no claim to be farmers and who were not all of Dutch blood The apprentice system was in existence in other parts of South Africa, and almost inevitably led to abuses The Apprentice Law of 1856 in the Transvaal was an effort to mend matters It provided safeguards against misuse of power, that it had to be repeated three or four times showed how its provisions were disregarded The apprentices were usually small children, exchanged for goods by their parents "picked up starving" on the veld "orphans" (a plentiful supply), young persons obtained from tribes fighting one another, children, in short, obtained in any fashion, in 1864 Martinus Pretorius is reported as asking the Landdrost of Zoutpansberg to buy him half-a-dozen little Kafirs at a time when the Swazis were raiding The worst feature of the system was that there was a regular traffic in apprentices This practice, forbidden by the law, made of apprentices goods and chattels Thus the charge of practising virtual slavery was justified Towards the natives in general the Transvaalers adopted an attitude of modified indifference, they had their locations and could manage their own tribal affairs as long as they provided the farmers with the needed labour; missionaries among them were tolerated, but the Boers made no attempt to produce a civilized class of African But they adopted very stern measures against misdoers Thus in 1854 to avenge the murder of a party of Boers (including women and children) M Pretorius led a commando against the chief Makapan, many of whose people, who had taken refuge in caverns, were smoked or starved to death and many others shot while attempting to escape. This chastisement kept the tribes quiet for years.

When in 1864 M. Pretorius again became president the Transvaal was suffering from the depression which at that time affected the whole of South Africa, and it had trouble with the Zulus, with the Bechuana, and with the powerful tribes in the Zoutpansberg Schoemansdal (named after Com.-gen Schoeman) in the Zoutpansberg, was then the most important settlement of the district. In 1867 Schoemansdal and a considerable portion of the district were abandoned on the advice of commandant-gen-

eral Kruger, and Schoemansdal was burnt to ashes by natives It was not until 1869 that peace was patched up, and the settlement arrived at left the mountain tribes in practical independence.

Meanwhile the public credit and finances of the Transvaal had gone from bad to worse The paper notes, issued since 1865, had been constituted by law legal tender for all debts, but in 1868 their power of purchase was only 30% compared with that of gold, and by 1870 it had fallen as low as 25% Civil servants, who were paid in this depreciated scrip, suffered considerable distress The revenue for 1869 was stated as £31,511; the expenditure at £30,836

Territorial Disputes.—While the situation was very sombre there came the discovery of diamonds in Griqualand and of gold at Tati, and again the claims of the Transvaal to territorial expansion were put forward. Following the discoveries at Tati, Pretorius, in April 1868, issued a proclamation extending the Transvaal frontiers on the west and north so as to embrace the gold field and all Bechuanaland The same proclamation extended Transvaal territory on the east so as to include part of Delagoa bay The eastern extension claimed by Pretorius was the direct sequel to endeavours made shortly before by a Scotsman from Natal (Alex McCorkindale) to develop trade along the Maputa river But it was also part of the old desire of the Transvaal Boers to obtain a seaport, a desire which had led them as early as 1860 to treat with the Zulus for the possession of St Lucia bay That effort had, however, failed And now the proclamation of Pretorius was followed by protests on the part of the British high commissioner, Sir Philip Wodehouse, as well as on the part of the consul-general for Portugal in South Africa The boundary on the east was settled by a treaty with Portugal in 1869, the Boers abandoning their claim to Delagoa bay; that on the west was dealt with, partially, in 1871

Disputes on the Bechuana border had been constant; they became again prominent by the discovery of alluvial diamonds in the strip of land between the Vaal and Harts rivers, to the sovereignty of which there were rival claims A little later the famous dry diggings on the De Beer and other farms were discovered They were south of the Vaal and to them the Orange Free State laid claim. But there was a rival claimant in the Griqua chief, Nicholas Waterboer, and since 1862 the Griqua claims had been urged by his agent David Arnot, a clever Cape Colony attorney, who in the end bluffed all his opponents The various claims including those of the Barolong Bechuana to land north of the Vaal where, as at Bloemhof, Transvaal authority was in fact exercised, were submitted to the arbitration of R W Keate, lieutenant-governor of Natal His award was made in Oct. 1871, and was admittedly just on the evidence produced It gave Waterboer all he claimed—though he had no title whatever to the diamond fields—and the Barolong, an area which the Transvaal actually held Now Waterboer, before the arbitration court met, had offered his territory to Great Britain and it was known to all the parties that the offer would be accepted Accordingly a few days after the publication of the Keate award, Sir Henry Barkly, the high commissioner, took over as British territory Waterboer's land (*see* GRIQUALAND) This included the triangular piece of land above the confluence of the Vaal and Harts rivers, in which diamonds had first been found. As to the land awarded to the Barolong, no steps were taken to enforce the Keate award; the Transvaal Boers remained in possession of Bloemhof and all the farms they held—and disputes with the Bechuana continued

President Burgers.—The award caused a strong feeling of resentment among the Transvaal burghers and led to the resignation of President Pretorius and most of his executive. The burghers now cast about to find a man who should have the necessary ability, as they said, to negotiate on equal terms with the British authorities should any future dispute arise They asked President Brand of the Free State if he would come over and rule them. Brand declined, telling the Transvaalers—greatly perturbed though he was by the loss of the Kimberley diamond fields—that their true interests lay in friendship with, not in hostility to, Great Britain and the British Having failed with Brand, the Boers invited the Rev. Thomas François Burgers, a member of a well-known Cape Colony family and a minister of the Dutch Reformed Church known to be of "liberal" views in theological matters, to allow himself to be nominated. Burgers accepted the offer, and in 1872 was elected president. About this time gold reefs were discovered in the Zoutpansberg district near Marabastad, and a few gold seekers from Europe and Cape Colony began to prospect the northern portions of the Transvaal. The miners and prospectors did not, however, exceed a few hundred for several years.

Burgers was able, active, enlightened and impulsive; a visionary rather than a man of affairs or sound judgment He foresaw a great future for the country, but he neglected practical steps to ensure ordered progress, he took up, with all its entanglements, the policy of intrigues with native chiefs beyond the border, and was unable to control the tribes within the border. He held firmly to the belief in having an outlet to the sea free from British control, and in 1875 proceeded to Europe with the project of raising a loan for the construction of a railway to Delagoa bay, though no survey for a railway had been made He was empowered by the *volksraad* to raise £300,000, but with great difficulty he obtained in Holland the sum of £90,000 only, and that at a high rate of interest. With this inadequate sum some railway plant was obtained, which subsequently lay derelict for ten years at Delagoa bay While in Europe, Burgers visited France and Germany, and found in the latter country an awakening interest in South Africa; it was the period of the first stirrings of a colonial policy in Germany. On his return to the Transvaal in 1876 Burgers found that the condition of affairs in the State was worse than ever. The acting-president had in his absence been granted leave by the *volksraad* to carry out various measures opposed to the public welfare, native lands had been indiscriminately allotted to adventurers, and a war with Sikukuni (Secocoeni), a native chief on the eastern borders of the country, was imminent. A commando was called out, which the president himself led The expedition was an ignominious failure, and many burghers did not hesitate to assign their non-success to the fact that Burgers' views on religious questions were not sound Indeed a party of Boers—some 300—had trekked across the Kalahari into Angola largely because they disliked the rule of a heretical *predikant* Burgers then proceeded to levy taxes, which were never paid, and to enrol troops, which never marched The Transvaal was in a bad way, financially it was well-nigh bankrupt.

FIRST ANNEXATION BY GREAT BRITAIN

It was in conditions such as these that the British secretary of State for the colonies, the 4th earl of Carnarvon, launched his scheme for the confederation of the various South African States and colonies The story is told elsewhere (*see* SOUTH AFRICA, UNION OF) In the Transvaal the agent selected to carry out Lord Carnarvon's policy was Sir Theophilus Shepstone (*q v*), the chief of the native affairs department in Natal, a man with a profound knowledge of the mind of the negroes of South East Africa, and also with a considerable knowledge of Boer mentality. He was in London in 1876 and was then given a dormant commission dated Oct 5, 1876, instructing him to visit the Transvaal and empowering him, if it was desired by the inhabitants and in his judgment necessary, to annex the country to the British Crown. Sir Theophilus went to Pretoria in Jan. 1877, with an escort of 25 mounted police, and entered into conferences with the president and executive as to the state of the country. Federation plans were being considered in Cape Colony and Natal and in the Free State; there was also a party in the Transvaal in favour of union. One of the chief difficulties was the different conception of native policy held in the various colonies and States; and the treatment of the natives in the Transvaal caused grave concern to its neighbours The impetus for federation, however, came from without, and the *volksraad*, after having Carnarvon's proposals put before it, rejected them.

When the *volksraad* realized that Shepstone was about to take a decisive step it hurriedly passed a number of reforms, but this

kind of insincere death-bed repentance was useless. On April 12, 1877, Shepstone issued a proclamation annexing the South African Republic to the British Crown. There were protests, some purely formal, others expressing indignation truly felt, but there was no active opposition and a considerable number of the town-dwellers welcomed annexation

Shepstone had given assurances that it was the wish of the British Government that the Transvaal "shall enjoy the fullest legislative privileges compatible with the circumstances of the country and the intelligence of its people." But he did little to substitute anything better for the Government he had found in office, a Government he had characterized as "a thorough sham" Nevertheless he had done something by the abolition of obnoxious taxes while public credit was restored (in the last days of Burgers the Transvaal £1 notes were worth only 1s). Moreover the continuance of the apprentice system—not of the traffic in apprentices—with Shepstone's approval and aid, did not, at least, alienate Boer opinion The true hindrance to acceptance by the Boers of British rule was the failure to redeem the pledge to grant the Transvaal "the fullest legislative privileges" Shepstone at the outset had wanted to summon the *volksraad* (May 1877), but here he met with opposition from the high commissioner, Sir Bartle Frere, who had himself ideas as to what the new constitution should be and wished to consult leading burghers on the matter.

The Agitation for Retrocession.—That the British annexation at first caused no grave discontent may be inferred by the retention of office by all the members of Burgers' executive council except Piet Joubert, "the irreconcilable" The rest, including Paul Kruger and Dr E J P Jorissen (a Hollander brought out by Burgers) kept their posts and drew their salaries as British officials In accordance with a last resolution of the *volksraad,* Kruger, who was accompanied half-heartedly by Jorissen, was given leave to go to London, where he was told by Carnarvon that the act of annexation was irrevocable, but was promised concession in the matter of local government, including the use of Dutch Kruger and Jorissen in turn promised to endeavour to "promote a feeling of satisfaction", showed some anxiety to continue in government employment and after a visit to the Continent returned home This was in Jan 1878, and they found that in the Transvaal the phase of acquiescence in annexation was rapidly passing, for reasons already indicated. Another deputation to London was decided upon, Kruger on this occasion being accompanied by Piet Joubert Before Kruger left Pretoria Shepstone dismissed him from office, holding that it was not the place of an official to be endeavouring to overthrow the Government in whose service he was This deputation spent some months in England (July–Oct 1878) but failed to get satisfaction Carnarvon's federation scheme was moribund and he himself had been succeeded at the Colonial Office by Sir Michael Hicks Beach. Sir Michael told the deputation indeed (despatch of Sept. 16, 1878) that the cabinet intended to grant the Transvaal "to the utmost practical extent its individuality and powers of self-government," but not independence On their way back to the Transvaal Kruger and Joubert met the high commissioner in Natal Frere endorsed Hicks Beach's promise of self-government for the Transvaal, and the Boer leaders (both competent men on the question) gave Frere sound advice in regard to the war with the Zulus then impending. That war began in Jan 1879 and soon there came the disaster of Isandhlwana. Discontent with British rule in the Transvaal was by this time marked; advocates of extreme Dutch Afrikanderdom went so far as to consider it meritorious of the Transvaal burghers to refrain from helping the Zulus against the British.

Shepstone was now replaced by Col. Owen Lanyon, administrator of Griqualand West, an able, active man, but not *persona grata* to the Boers. Then in April 1879 Frere himself visited the Transvaal; and found assembled to meet him on the road to Pretoria an armed commando of recalcitrant Boers who had established a *laager* and looked threatening. Frere induced them to disperse; he set Lanyon to work to effect real reforms. And again he repeated the assurances that the Transvaal would be granted home rule. Just at this time however Frere received news that he had been censured for his Zulu policy by the home Government (the Disraeli cabinet), and he returned to Cape Town. As high commissioner for South-East Africa he was succeeded by Sir Garnet Wolseley. The Zulu War ended, Wolseley in Sept. 1879 came to Pretoria and told the malcontent Boers (by this time the majority of the burghers) in grandiose words that the sun would forget to shine and the Vaal flow backwards sooner than the British flag would cease to fly over the Transvaal. Wolseley gave the country relief in one direction, he reduced to submission (Dec 1879) Sikukuni (Secocoeni), a chief who had long given the Transvaal trouble Instead of granting a liberal constitution he mocked the Boers' hopes by setting up (March 1880) a nominated legislative council In May 1880 Wolseley returned home

Meanwhile events in Great Britain had taken a turn which gave encouragement to the Boers. Gladstone became prime minister and on being directly appealed to by Kruger and Joubert, he replied that the liberty which they sought to manage their own affairs, and which it was the desire of the British Government they should possess, might be "most easily and promptly conceded to the Transvaal as a member of a South African Confederation." That was in June 1880

The Majuba Campaign.—In November matters were brought to a head by the wagons of a farmer named Bezuidenhout being seized in respect of the non-payment of taxes, and promptly retaken from the sheriff by a party of Boers Lanyon began to recognize that the position was becoming grave, and telegraphed to Sir George Colley, the high commissioner of South-East Africa, for military aid This, however, was not immediately available, and on Dec 13 the Boers in public meeting at Paardekraal resolved once more to proclaim the South African Republic, and in the meantime to appoint a triumvirate, consisting of Kruger, Pretorius and Joubert, as a provisional government. Formal proclamation of the republic was made on Dec 16 (Dingaan's Day) at Heidelberg Hostilities forthwith began The first shots fired were outside Potchefstroom, which was then occupied by a small British garrison On Dec. 20, some 240 men under Col. Anstruther, chiefly belonging to the 94th Regiment, while marching from Lydenburg to Pretoria, were surprised at Bronkhorst Spruit, and cut up by the Boer forces Pretoria, Rustenberg, Lydenburg and other smaller towns had been placed in a position of defence under the directions of Col Bellairs Sir George Colley, with 1,400 men, marched towards the Transvaal frontier, but before reaching it he found, on Jan 24, 1881, that the Boers had already invaded Natal and occupied Laing's Nek. He pitched his camp at Ingogo Having been defeated at Laing's Nek, and suffered considerable loss in an engagement near Ingogo, Colley took a force to the top of Majuba, a mountain overlooking the Boer camp and the nek He went up during the night, and in the morning was attacked and overwhelmed by the Boers (Feb 27) Of the 554 men who constituted the British force on Majuba, 92 (including Sir George Colley) were killed and 134 wounded.

For a considerable time before hostilities began efforts had been made in South Africa to adjust the differences between the Transvaalers and the British, notably by President Brand of the O F S. Early in December Brand sent an urgent warning to Cape Town, which reached London only three weeks later and was disregarded. At the opening of parliament on Jan 6, 1881, the queen's speech spoke of the duty of vindicating her majesty's authority; on Jan 26 the first intimation was made—to Cape Town, not to Colley—that the British Government was prepared to negotiate. It was not until the day of the reverse at Ingogo (Feb. 8) that Colley was told of the negotiations Kruger only received the day after Majuba a despatch from Colley of Feb 21, stating that on the Boers ceasing armed opposition, the British Government would be prepared to appoint a commission with large powers Kruger's reply, construed as a virtual acceptance of the British offer, did not reach Sir Evelyn Wood (Colley's successor) until March 7; the previous day a truce had been arranged These negotiations were kept entirely from the knowledge of the British people, who only knew that Sir Frederick Roberts and 10,000 men had been ordered out to South

Africa When they learned that negotiations for peace were proceeding without an attempt to "avenge" Majuba there was great indignation Gladstone insisted that that incident should not be allowed to interrupt negotiations The fact remains that it was only after the British arms had suffered reverses that the British cabinet opened negotiations Alike by the Boers and by the "loyalists" in South Africa the peace shortly afterwards concluded was regarded as a British surrender. The bitterness felt by the British over their "betrayal" was intense, so intense that it turned to hatred in many cases Nor would it be easy to exaggerate the feeling of disgust felt by the Natalians over Gladstone's action. Nevertheless in view of the "loitering unwisdom" shown by the British almost from the day of annexation the retrocession of the Transvaal was the proper end of the episode

A convention signed at Pretoria on Aug 3, 1881, regulated the new relations between the Transvaal and the British Government The Boers were granted internal self-government, but British suzerainty was explicitly maintained, a British Resident was appointed to Pretoria; the country was to be called the Transvaal State, the frontiers (for the first time) were defined In drawing up the convention Wood had as colleagues Sir Hercules Robinson (the new high commissioner) and Chief Justice de Villiers, of the Cape bench, an Afrikander who, like President Brand, had done much to keep in check Dutch feeling in South Africa generally The government of the Transvaal was handed over to the Boer triumvirate on Aug 8; it was continued in their name until May 1883 when Kruger was elected president—an office he held until the Transvaal again lost its independence

FROM RETROCESSION TO THE SOUTH AFRICAN WAR

The Transvaal in 1881 was in a much better condition than in 1877, in material matters the retrocession conditions much favoured the Boers And a new commercial era was dawning But the burghers were dissatisfied with the limitations of the Pretoria Convention; nor did they keep its terms Especially they encroached once again on Bechuanaland, where they set up the so-styled republics of Stellaland and Goshen Kruger, in reply to remonstrances, described this as an "irresponsible" movement for expansion, came again to London (Nov 1883) and with the 15th earl of Derby, then secretary of State for the colonies, concluded another agreement known as the London Convention It was signed on Feb 27, 1884, being the third anniversary of the fight at Majuba The London Convention neither denied nor affirmed British suzerainty—Lord Derby maintained that he had preserved the substance if not the word—but limits were still imposed on complete independence The State was permitted again to call itself the South African Republic; but it bound itself not to extend its borders, which were once again strictly defined, to allow freedom of trade, travel and residence to "all persons" other than natives, not to impose any taxes, local or general, upon foreigners other than those imposed on citizens of the republic (this to apply to the persons, property, commerce and industry of such foreigners) and to conclude no treaty or engagement with any other State or nation (the Orange Free State excepted) nor with any native tribe east or west of the republic until such treaty had been approved by the British Government

Territorial Expansion.—Notwithstanding the precise fixing of the boundaries of the republic by the London Convention, Kruger endeavoured to maintain the Boer hold on Goshen and Stellaland, but the British Government on this point proved firm, and an expedition set out in 1884 under Sir Charles Warren, broke up the freebooters' two states, and occupied the country without a shot being fired (*see* BECHUANALAND) This at last put an end to Boer attempts at encroachment westwards, and a little later treaties with Lobengula and the grant to Cecil Rhodes and his co-directors of a charter for the British South Africa Company put a check on designs the Boers held to expand northwards (*see* RHODESIA).

On the eastern border the policy of expansion was also followed by the Boers, and in this instance with more success Following the downfall of the Zulu power after the British conquest in 1879, several parties of Boers began intriguing with the petty chiefs, and in May 1884, in the presence of 10,000 Zulus, they proclaimed Dinizulu, the son of Cetywayo, to be king of Zululand (*see* ZULULAND) As a "reward" for their services to the Zulus, the Boers, under Gen Lukas Meyer, then took over from them a tract of country in which they established a "New Republic" In 1886 the "New Republic," with limits considerably narrowed, was recognized by Great Britain, and the territory became incorporated with the Transvaal in 1888 A similar policy eventually brought Swaziland almost entirely under their dominion (*see* SWAZILAND) At the same time Kruger revived the project of obtaining a seaport for the State, one of the objects of Boer ambitions since 1860 (vide *supra*) Kruger endeavoured to acquire Kosi bay, to the north of Zululand and only 50m east of the Swazi frontier In this endeavour he was foiled, for the British annexed Tongoland and with it Kosi bay, but that was not until 1895

Gold Discoveries: Influx of Uitlanders.—In 1884, the year of the London Convention, the Sheba gold mine in the de Kaap valley—where gold had been found as far back as 1875—had attracted a population of about 1,000 For the first time gold digging in the Transvaal ceased to be a precarious method of earning an existence Barberton was founded, there was a rush to the fields from Europe as well as South Africa Soon, however, came collapse, by the end of 1887 the Barberton fields were mostly deserted In the meantime, gold had been discovered on the Witwatersrand The gold fields there were proclaimed and Johannesburg founded at the end of 1886 In a very few years it was seen that here was the richest gold field in the world, and a republic composed mainly of cattle and sheep farmers of very limited outlook and education was speedily faced with a difficult problem Thousands of whites poured into the Transvaal so that in a few years the *uitlanders* came to outnumber the native white population The newcomers included a large proportion of South Africans, both Dutch and English speaking, from the Cape, Natal and the Free State; equally with Europeans and Americans they were regarded as *uitlanders* This new population was concentrated in one region—the Rand

President Kruger and the *raad* had two points to consider (1) economic, (2) political The Boers gained by the development of mining, both individually and as a State Land went up enormously in value; so attractive were the prices realized that a third or more of the area of the country was sold to *uitlanders* But with speculation and wealth came also corruption and peculation, vices to which many members of the Boer executive succumbed But the Boer was shrewd and at once grasped the need of railway transport from the mines to the sea From their first crossing of the Vaal the Boers had sought an outlet at Delagoa bay—its great attraction being that it was not under British control Alternatively, or additionally, they had sought a seaport of their own—hence the effort to secure Kosi bay In 1884 Kruger granted a concession to Hollander and German capitalists of all rights to build railways in the Transvaal, this led to the formation of the Netherlands South African Railway Company The grant of monopolies, as an easy way of raising revenue, had become a feature of Transvaal methods from the time of the retrocession in 1881 In 1882 a monopoly was granted for the manufacture of spirituous liquor. By 1889 the list of things under monopoly grants, besides railways and spirits, included dynamite, iron, sugar, wool, bricks, jam and paper The dynamite monopoly, a necessity for the mines, pressed particularly heavily on the gold industry.

The political policy of the Boers was animated by a lively distrust of everything British With many of his people Kruger came also to distrust the Cape Dutch, whose interests suffered with those of other *uitlanders,* from the policy of rigid exclusion of the newcomers from political power in the Transvaal. In 1882 a law had been passed raising the period of residence necessary to obtain full franchise rights from two to five years—a reasonable requirement; but the Boers soon foresaw that before long under that law many *uitlanders* would qualify for the franchise Other measures, then, must be tried to maintain Boer supremacy. In 1887 Kruger endeavoured to induce the Orange

Free State to enter into an offensive and defensive alliance with the Transvaal against the "common enemy" President Brand, who did not see an enemy in Great Britain, refused. but in 1889 Kruger got his treaty with the new president of the O F S—F. W. Reitz. Next came, in 1890, a raising of the franchise qualification, followed in 1894 by other laws, the effect being that no foreigner under 40 could obtain the franchise, and then only if he had lived 14 years in the Transvaal. Kruger's object was the preservation of the independence of the country; that is the maintenance in full power of the Boer burghers, his distrust of the British had led him to open relations with Germany, which country, with her colonial fever then at the full, responded at once, but with a natural regard to German rather than Boer interests

The mining industry on the Rand had grown very rapidly. At first there was the usual rush and struggle on the gold fields, but in four or five years, while there was the inevitable gathering of undesirables and of those who never intended to settle, there was too a settled community—mainly British—decent and hard working, and capable of voicing its grievances The feeling entertained towards the president was shown in an unfortunate incident when he visited Johannesburg in 1890 The Transvaal flag flying over the *landdrost's* house was pulled down by the mob Kruger was greatly incensed, and for years he quoted it as a reason against granting *uitlander* claims

First Reform Movement.—Representations made to the Government at Pretoria in the year 1890 were unavailing, and by 1892 the *uitlanders* felt that to obtain redress both for their political and economic grievances they must resort to combined action. What became known as the first reform movement was then started The Transvaal National Union was formed by mercantile and professional men and artisans The chairman was J Tudhope, an ex-minister of Cape Colony, and its most prominent members Charles Leonard and his brother James Leonard, ex-attorney-general of Cape Colony Both the Leonards, as well as many of their followers, were South Africans by birth They, in common with the great bulk of the *uitlanders,* recognized that the State had every right to have its independence respected But they asserted that a narrow and retrogressive policy, such as Kruger was following, was the very thing to endanger that independence The legitimacy of *uitlander* aspirations were recognized by a few Boer officials at Pretoria But Kruger, in reply to seven delegates from the National Union, in Sept 1892, told Charles Leonard to "go back and tell your people that I shall never give them anything I shall never change my policy And now let the storm burst"

In 1894 British subjects in the Transvaal were commandeered to suppress a native rising This brought a sharp and effective remonstrance from the high commissioner, Sir Henry Loch, who came up to the Transvaal, his visit to the Rand being made the occasion of a "jingo" demonstration highly offensive to the Boers and insulting to the president Then at a banquet in Jan 1895 in honour of the German emperor's birthday Kruger referred in glowing terms to the friendship of Germany for the Transvaal, in May 1895 the Boer road to the sea was finally blocked by the proclamation of a British protectorate over Tongoland (which included Kosi bay) The Transvaal Government had failed to fulfil the conditions under which it might have secured Kosi bay, the definite loss of the port made the Boers angry. The really remarkable thing was that Great Britain should for so long have left open to Boer or German adventurers so tempting a harbourage.

Railway politics played their part in the drama. The goal of the railways was the Rand and it was Kruger's policy to favour Delagoa bay. Nevertheless until the railways were complete the Natalians with their ox-transport service got most of the trade. But there was much delay in building the Portuguese section of the Delagoa line and through-rail connection between the Rand and the Cape ports came first (Sept. 1892) However, less than two years later—in May 1894—the Netherlands Railway Company (of which the Transvaal Government took 85% of the profits) had at last connected the Rand with Delagoa bay Efforts made by the Cape Government to keep a fair share of the traffic failed, and to encourage trade to Delagoa bay prohibitive rates were imposed on the 30m. of the line to Cape ports within the Transvaal The Cape retaliated by unloading goods at certain drifts (fords) over the Vaal and sending them on thence by wagon to Johannesburg This was in Sept. 1895; in October, Kruger closed the drifts The Cape Government appealed to the British Government, and under an almost direct threat of war the Transvaal gave way and the drifts were reopened in Nov 1895 Kruger had broken the London Convention in closing the drifts and knew he was in the wrong While this dispute was still unsettled the railway from Durban reached the Rand Natal, it had been agreed, was to get a third of the Rand traffic

At this time—1895—the *uitlanders,* according to a well informed member of that community, owned half the land and nine-tenths of the property of the country, a statement which partly explains Kruger's determination to prevent the "stifling" of Boer nationality which he held would follow the grant of the franchise to the *uitlander* But there were many burghers who held enlightened views and who saw that the admission of *uitlanders* to the franchise—many taking up citizenship would have been South Africans—would in reality preserve the republic These men had chosen Piet Joubert as reform candidate for the presidency in the election which occurred in 1893 All the liberal elements in the Transvaal supported Joubert, the official figures (not, it is believed, the true figures) gave Kruger a majority of 700 out of some 15,000 burghers voting Kruger ignored protests and retained office Henceforth he kept power, aided by the Hollander advisers he had gathered round him, of whom Dr W J Leyds, State secretary, was the most prominent By 1895 the great majority of the *uitlanders,* who had neither the wealth of the mine owners nor any civic rights, were growing desperate Many felt that, as Kruger expected, "the storm would burst"

(F. R C)

The Jameson Raid.—At this juncture (Oct 1895) came overtures to the leading *uitlanders* from Cecil Rhodes, then prime minister of Cape Colony, and from Dr Jameson, leading to the Jameson Raid. To one or two men this scheme, subsequently known as the Jameson Plan, had been revealed in the previous June, but to the majority even of the small group of leaders it was not known till Oct or Nov 1895 The proposition came in a tempting hour Between them it was arranged that Jameson should gather a force of 800 men on the Transvaal border, that the *uitlanders* should continue their agitation; and that, should no satisfactory concession be obtained from Kruger, a combined movement of armed forces should be made against the Government The arsenal at Pretoria was to be seized, the *uitlanders* in Johannesburg were to rise and hold the town Jameson was to make a rapid march to Johannesburg Meanwhile, in order to give Kruger a final chance of making concessions with a good grace, and for the purpose of stating the *uitlander* case to the world, Charles Leonard, as chairman of the National Union, issued a manifesto, which concluded as follows —

> What do we want? We want (1) the establishment of this republic as a true republic, (2) a *grondwet* or constitution which shall be framed by competent persons selected by representatives of the whole people and framed on lines laid down by them—a constitution which shall be safeguarded against hasty alteration, (3) an equitable franchise law and fair representation, (4) equality of the Dutch and English languages, (5) responsibility of the legislature to the heads of the great departments, (6) removal of religious disabilities, (7) independence of the courts of justice, with adequate and secured remuneration of the judges, (8) liberal and comprehensive education, (9) efficient civil service, with adequate provision for pay and pension, (10) free trade in South African products That is what we want

The Jameson conspiracy fared no worse and no better than the great majority of conspiracies in history Jameson did not obtain more than 500 men Johannesburg had the greatest difficulty in smuggling in and distributing the rifles with which the insurgents were to be armed. The scheme to seize the Pretoria fort had to be abandoned, as at the time fixed Pretoria was thronged with Boers Finally, Jameson, becoming impatient of delay, in spite of receiving direct messages from the leaders at

Johannesburg telling him on no account to move, marched into the Transvaal.

The policy of delay in the execution of the plot which the *uitlander* leaders found themselves compelled to adopt was determined by a variety of causes. Apart from the difficulty of obtaining arms, a serious question arose at the eleventh hour which filled some of the *uitlanders* with mistrust The reform leaders in the Transvaal, down to and including the Johannesburg rising, had always recognized as a cardinal principle the maintenance of the independence of the State From Cape Town it was now hinted that the movement in which Jameson was to co-operate should, in Rhodes's view, be carried out under the British flag. A meeting of *uitlander* leaders was hastily summoned on Dec. 25 Two messengers were that night despatched to interview Rhodes, who then gave the assurance that the flag question might be left to a plebiscite of the inhabitants of the Transvaal (see *Blue-book,* 1897, 165, p 21) It was determined nevertheless to postpone action; however, on Dec 29, Jameson started, and the news of his having done so reached Johannesburg from outside sources. A number of leading citizens were at once formed into a reform committee In the absence of Charles Leonard, who had been sent as one of the delegates to Cape Town to interview Rhodes, Lionel Phillips, a partner in Messrs. Eckstein and Company, the largest mining firm on the Rand, was elected chairman Under the supervision of the reform committee, such arms as had been smuggled in were distributed, and Col Frank Rhodes was given charge of the armed men A large body of police was enrolled, and order was maintained throughout the town On Jan 2, 1896, Jameson, who found himself at Doornkop in a position surrounded by Boers, surrendered Jameson and his men were conveyed to Pretoria as prisoners, and subsequently handed over to the high commissioner (Sir Hercules Robinson, who had succeeded Sir Henry Loch in June 1895)

Years later, speaking at Durban (Aug 9, 1910), Jameson declared that the raid was not racial in the sense usually understood, but an effort towards federation Had the raid succeeded it was proposed to make Gen Lukas Meyer (d. 1902) president. He subsequently explained, however, that they had had no communication with Meyer on the subject.

The Kaiser's Telegram.—Significant of the attitude of Germany—whose "flirtation" with the Transvaal has been noted—was an open telegram sent by the emperor William II the day after the surrender of Jameson, congratulating Kruger that "without appealing to the help of friendly Powers" he had repelled the raiders. The British Government rejoined by commissioning a flying squadron and by calling attention to the London Convention In Johannesburg meanwhile the Kruger government regained control The members of the reform committee (except a few who fled the country) were arrested on a charge of high treason and imprisoned in Pretoria In April, at the trial, the four leaders—Lionel Phillips, Frank Rhodes, J H. Hammond and George Farrar, who in conjunction with Charles Leonard had made the arrangements with Jameson—were sentenced to death, the sentence being after some months' imprisonment commuted to a fine of £25,000 each. The rest of the committee were each sentenced to two years' imprisonment, £2,000 fine or another year's imprisonment and three years' banishment This sentence, after a month's incarceration, was also commuted The fine was exacted, and the prisoners, with the exception of Woolls Sampson and W D (Karri) Davies, were liberated on undertaking to abstain from politics for three years in lieu of banishment Sampson and Davies, refusing to appeal to the executive for a reconsideration of their sentence, were retained in prison for over a year

After the Raid.—Hercules Robinson reached Pretoria on Jan 4 He had no sooner learnt of the raid in Cape Town than he issued a proclamation through Sir Jacobus de Wet, the British resident at Pretoria, warning all British subjects in Johannesburg or elsewhere from aiding and abetting Jameson. This was freely distributed among the public of Johannesburg While in Pretoria the high commissioner in the first instance addressed himself to inducing Johannesburg to lay down its arms He telegraphed to the reform committee that Kruger had insisted "that Johannesburg must lay down arms unconditionally as a precedent to any discussions and consideration of grievances." On the following day, Jan. 7, Sir Hercules telegraphed again through the British agent, who was then at Johannesburg, saying that "if the *uitlanders* do not comply with my request they will forfeit all claims to sympathy from Her Majesty's Government and from British subjects throughout the world, as the lives of Jameson and the prisoners are now practically in their hands." The 2,000 odd rifles which had been distributed among the *uitlanders* were then given up. After the Johannesburg disarmament Kruger had 64 members of the reform committee arrested, announcing at the same time that his motto would be "Forget and forgive" In 1897 Hercules Robinson was succeeded in the high commissionership by Alfred (Lord) Milner.

In the period which intervened between the Jameson raid and the outbreak of the war in Oct. 1899 President Kruger's administration deteriorated The Aliens Expulsion and Immigration Laws, as well as the new Press Law, were passed in the latter part of 1896. In 1897 a decision of Chief Justice Kotze was overruled by an act of the *volksraad* This led to a strong protest from the judges of the high court, and eventually to the dismissal of the chief justice, who had held that office for over 20 years, and had shown himself an able and upright judge An industrial commission appointed during this year by President Kruger fared no better than the high court had done It made several sensible proposals which would have helped both the mining industry and the administration, but to very little purpose All remonstrances, all warnings from the Dutch-speaking people of the Cape were unheeded

Second Reform Movement.—In March 1899 the *uitlanders*, hopeless of ever obtaining redress from President Kruger, weary of sending petitions to the *raad* only to be jeered at, determined to invoke intervention if nothing else could avail, and forwarded a petition to Queen Victoria This petition, the outcome of the second *uitlander* movement for reform, was signed by 21,000 British subjects, and stated the *uitlander* position

In response to this appeal, Chamberlain, in a despatch dated May 10, proposed a conference at Pretoria Six days before Sir Alfred Milner had telegraphed to London a summary of the situation, comparing the position of the *uitlanders* to that of helots and declaring the case for intervention to be overwhelming Neither of these despatches was made public at the time But on the day Chamberlain wrote his despatch the friends of the Transvaal Government in Cape Colony and the Orange Free State invited Milner to meet Kruger at Bloemfontein, hoping to be able to exert pressure on both parties and to arrange a settlement as favourable as possible to the Transvaal. The conference opened on May 31 and closed on June 5 It no sooner opened than it was evident that Kruger had come to obtain, not to grant, concessions. He offered, it is true, a seven years' franchise law in place of the five years' franchise which Sir Alfred Milner asked for. But this seven years' franchise was only to be given on certain conditions, one of which was that all future disputes between the Transvaal and the Imperial Government should be referred to a court of arbitration, the president of which should be a foreigner. Milner urged the home Government to insist upon a minimum of reform, and primarily on the five years' franchise (this had the full support of the *uitlanders* and of the majority of whites throughout South Africa); and Chamberlain, backed by the cabinet, adopted the policy of the high commissioner.

(X)

The Eve of War.—Each side had committed itself to a position from which a peaceful issue was unlikely The most stupid explanation of the impasse is that which attributes the forcing of the hands of the British Government to Rand "magnates" who desired to seize the gold fields. It is more true to say the quarrel was racial; it is certain that Kruger and his advisers fully understood that the grant of political rights to the *uitlanders* meant the doom of their rule; and they vastly underrated the military power of Great Britain.

After the Bloemfontein Conference the tactics of the Boer executive were simply directed towards putting off a crisis till the

beginning of October, when the grass would be growing on the veld, and meanwhile towards doing all they could in their despatches to put the blame on Great Britain. At last they drafted, on Sept. 27, an ultimatum to the British Government. For military rather than diplomatic reasons it was not until Oct. 9 that the ultimatum was presented to Conyngham Greene, the British agent at Pretoria. The scheduled demands were —

"(*a*) That all points of mutual difference shall be regulated by the friendly course of arbitration, or by whatever amicable way may be agreed upon by the Government with Her Majesty's Government. (*b*) That the troops on the borders of this republic shall be instantly withdrawn (*c*) That all reinforcements of troops which have arrived in South Africa since June 1, 1899, shall be removed from South Africa within a reasonable time, to be agreed upon with this Government, and with a mutual assurance and guarantee on the part of this Government that no attack upon or hostilities against any portion of the possessions of the British Government shall be made by the republic during further negotiations within a period of time to be subsequently agreed upon between the Governments, and this Government will, on compliance therewith, be prepared to withdraw the armed burghers of this republic from the borders. (*d*) That Her Majesty's troops now on the high seas shall not be landed in any part of South Africa" To these demands the Transvaal Government required an answer within 48 hours

There could be only one reply, and on Wednesday, Oct 11, 1899, at five o'clock P M, a state of war existed between the British Government and the two Boer republics, for the Free State threw in its lot with the Transvaal

FROM ANNEXATION TO UNION: AND AFTER

The course of the war is described in detail in the article SOUTH AFRICAN WAR On July 4, 1900, a month after the occupation of Pretoria, a commission was issued to Lord Roberts authorizing him to annex the Transvaal. The proclamation of annexation was dated Sept 1. Lord Roberts held the post of administrator of the colony until his departure for England in the December following, when he was succeeded by Milner, the high commissioner It was not, however, until March 1901 that Milner, who resigned his governorship of Cape Colony, arrived at Pretoria to inaugurate a civil administration Hostilities were still proceeding, but in the areas under control Lord Milner (who was raised to the peerage in May) speedily set the machinery of government in motion.

Reconstruction.—Some of the gold mines were permitted to restart crushing in May 1901 In November following the main body of the *uitlanders* were allowed to return to the Rand and in June 1902 a tax of 10% on the profits of gold mining was imposed The administration was equally alive to the needs of the country districts and a land board was established in Dec 1901 Another department taken in hand was that of education; and here remarkable success was achieved

After the signature of the articles of peace the work of reconstruction was accelerated The end of the military government was signalled by the assumption, June 21, 1902, by Lord Milner of the title of governor of the Transvaal and by the creation of an executive council With the proceeds of a loan of £35,000,000, guaranteed by the British Government, the debt of the South African Republic was paid off, the Transvaal and the Orange River Colony railways were bought by the State, and new railways and other public works were undertaken. The £3,000,000 granted by the articles of peace, and other considerable sums, besides £7,000,000 from the loan, were expended on repatriation and compensation.

The efforts made by the administration to restore the Boers to the land, to develop the material resources of the country, and to remove all barriers to the intellectual and moral development of the people, were soon, however, hampered by severe commercial depression.

Chinese Labour.—The commercial depression was due to many causes; of these the most apparent was the shortage of labour at the Rand mines. When work restarted after the war, the mine owners offered the native workmen little more than half the wages paid in 1898, but this effort at economy was abandoned, and the old rates of pay were restored in Jan 1903 Nevertheless, the labour available continued to be very much below the needs of the mines The consequent small gold output meant a serious decrease of revenue, which was not compensated for by the heavy tax levied on the output of the Premier diamond mine, where operations began in 1903 Finally, to enable them to work their mines to their full capacity, the Rand houses asked for leave to import Chinese labourers. Milner, anxious above everything else to obtain sufficient revenue to carry on his work of reconstruction, gave his consent to the experiment The home Government concurred, and during 1904–06 over 50,000 Chinese were brought to the Rand on three years' indentures In the Transvaal all parties agreed that no new racial or economic complications should be permitted. and these were guarded against by the restriction of the coolies to unskilled labour in the gold mines and by their compulsory repatriation By the introduction of the Chinese the gold output from the mines was greatly increased, with the result that the Transvaal suffered less than any other part of South Africa from the restriction of commerce, which lasted for several years.

The discussions in the legislative council on the Chinese coolie question had been accompanied by a demand on the part of the Boers that such an important step should not be taken "without the constitutional approval of the white people of the Transvaal", and after the importation of the coolies had begun, the agitation for the grant of representative institutions grew in volume. The British Government was also of opinion that the time was near for the setting up of such institutions, and the pending grant of a constitution to the Transvaal was announced in parliament in July 1904. Meantime the existing (nominated) legislative council was dealing with another and a vital phase of the Asiatic question There were in the Transvaal some 10,000 British Indians, whose right to "enter, travel or reside" in the country was secured by the London Convention of 1884 Under republican rule these Indians—who were mainly small shopkeepers, but included some professional men of high standing—had suffered many restrictions, and their cause had been espoused by the British Government. Nevertheless, under British rule their situation was in no way improved, and a determination was shown by the European inhabitants of the Transvaal, both British and Boer, further to restrict their privileges and at the same time to stop the immigration of other Indians Alfred Lyttelton (who had succeeded Chamberlain as secretary of State for the colonies) endeavoured to meet the wishes of the Transvaal by sanctioning legislation which would greatly restrict the immigration of Indians, but he would allow no tampering with the rights of Indians already in the colony

Self-government.—A constitution for the Transvaal on representative lines was promulgated by letters patent on March 31, 1905; but there was already an agitation for the immediate grant of full self-government, and on the accession to office of the Campbell-Bannerman administration in Dec 1905 it was decided to accede to it New letters patent were issued (Dec 12, 1906), and the first general election (Feb 1907) resulted in the return of a majority belonging to *Het Volk*, a Boer organization formed for political purposes. Lord Selborne, who had during 1905 succeeded Lord Milner as high commissioner and governor of the Transvaal, entrusted Gen Botha with the formation of a ministry. Botha chose as colleagues Gen. J C. Smuts and other men of progressive, in some respects democratic, views, and thus showed his determination not to be dominated by the "back veld" Boers He was strengthened in his attitude by the firm action of the Progressive (*i.e.*, the ex-*Uitlander*) Party, which secured 21 seats (out of a total of 69) in the legislative chamber, entirely in the Rand and Pretoria districts, and was led by Sir George Farrar and Sir Percy Fitzpatrick The Government announced that there would be no wholesale repatriation of Chinese The men left gradually as the licences expired, and by Feb 1910 all the Chinese coolies had returned home. At the same time successful efforts were made by the ministry to increase the supply of native labour

for the mines On the education question an agreement satisfactory to both the British and Dutch-speaking communities was reached.

One of the first problems which confronted the Botha ministry was the attitude to be adopted towards the other British colonies in South Africa. Milner, by various measures, had endeavoured to pave the way for federation, and Chamberlain when he visited South Africa in 1903 had also put forward federation as the desired goal On economic as well as political grounds, the leaders of both parties in the Transvaal were prepared to consider favourably the proposals put forward by Dr. Jameson at the close of 1906 for a closer union of all the self-governing colonies, and the first direct step to that end was taken at an inter-colonial conference held in May 1908. The history of this movement, which resulted in the establishment of the Union of South Africa on May 31, 1910, is given under SOUTH AFRICA, UNION OF. Apart from this movement the most notable events in the Transvaal at this period were the development of agriculture, the gradual revival of trade (the output of the gold mines in 1909 totalled £30,925,000, and at the end of the year 156,000 native labourers were employed), and the continued difficulty with regard to British Indians On this last point the Botha ministry sought to enforce registration of Indians, and, for failing to register, M V Gandhi and other leaders were imprisoned in 1908 and large numbers of Indians were deported However, the establishment of the Union of South Africa removed from the competence of the Transvaal provincial council all legislation specially or differentially affecting Asiatics.

The Union.—When the Union was established Gen Botha became prime minister, two of his colleagues, Smuts and Hull, also joining the Union ministry A fourth minister—Johann F. B Rissik—was appointed first administrator of the Transvaal province, a post he held until 1917, when A G Robertson succeeded, and remained administrator till 1924 Much of the energy of the provincial council was given to education, in which many bold experiments were made

A considerable number of Boers in the western Transvaal took part in the rebellion of 1914, but the influence of Gens Botha and Smuts kept most burghers loyal to the British connection The disturbances on the Rand in 1913–14 and the revolt of 1922 were not on racial lines, though the majority of the white miners had by this time become Dutch-speaking But feelings were strongly marked in the provincial council, as was shown by agitations against officials because of their nationality or their politics Thus, after the general election in June 1924, when the Nationalist and Labour parties gained the victory, there was an agitation to remove the newly appointed administrator, J. H Hofmeyr, because he belonged to the South African party, an agitation which Gen Hertzog, the prime minister, refused to heed In the flag controversy of 1926–27 the Dutch burghers followed Tielman Roos, then minister of justice and leader of the Transvaal Nationalists, who supported the compromise by which both the Vierkleur and the union jack formed part of the flag. Both political and economic questions had however largely ceased to be kept within provincial lines.

The respective claims of Durban and Lourenço Marques (Delagoa bay) to the trade of the Rand had been settled in 1909 by an agreement, known as the Mozambique Convention, signed by the Transvaal and Portuguese authorities This convention also permitted the recruitment of Portuguese natives for work in the Transvaal mines Difficulties arose and the convention lapsed in 1923 though a *modus vivendi* was reached in respect of native labour. In the negotiations for a new solution the question of the control of Lourenço Marques gave much trouble Eventually on Sept. 11, 1928, a new convention was concluded at Pretoria between the Union Government and the Portuguese.

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TRANSVERSE RIB or CROSS RIB, in architecture. (*See* VAULT)

TRANSYLVANIA, a former principality (*Grossfürstentum*) occupying, until 1918, the extreme eastern portion of the kingdom of Hungary, but then added to Rumania, since when the Rumanian name Ardeal has become the official one. It has an area of 22,312 sq m and a population of 2,678,367.

Transylvania has the form of an irregular circle, and is a high plateau of a mean altitude of 1,000–1,600 ft above sea-level, surrounded on all sides by the Transylvanian mountains (*q v*), the south-eastern continuation of the Carpathian system On the west side there are easy passes, but on the east and south frontiers the lofty mountains give Transylvania the aspect of a huge natural fortress.

The Latin name appears first after the 12th century, and signifies "beyond the woods," *i e*, from Hungary; the Hungarian and Rumanian names both mean "forest land ' The German name is usually derived from the seven principal fortified towns or "burgs," founded by the German colonists, though some authorities prefer to connect it with the Cibin mountains on the south frontier Until 1848 political rights belonged only to the Hungarian and the closely-related Szekler and the Saxon inhabitants, the Rumanian majority having no recognition These privileged elements formed rather more than 40% of the population, the Hungarians being Roman Catholics or Unitarians and the Germans Protestants. A gipsy element has long been important The chief town is Cluj (Kolozsvár). (For further geographical details *see* RUMANIA and TRANSYLVANIAN MOUNTAINS) (H J. F.)

HISTORY

After A D. 103 Transylvania formed part of the Roman province of Dacia (*q.v.*), and long supported a large Roman or Romanized population. After Aurelian withdrew his legions (A D 271) its history remains a blank for many centuries It was occupied or overrun by various Germanic (Goths, Gepidae), Ural-Altaic (Huns, Avars, perhaps Bulgars, Petchenegs), and probably also Slavonic tribes The debated question whether a Roman population survived these storms is discussed elsewhere (*see* VLACHS) The very few early documents on Transylvania mention Vlachs first in 1222, and then as shepherds; but they appear soon after as settled peasants; Vlach "nobles" are specifically mentioned in the 13th and 14th centuries, after which they apparently became Magyarized, and at this period the Vlach population in Transylvania, the Banat and Maramures, was certainly considerable and increasing.

Hungarian Conquest.—In 1003 King Stephen of Hungary incorporated Transylvania in his domains under a voivode, also granting fiefs to certain nobles. The early Hungarian administration was probably somewhat shadowy, but it was consolidated at an early date by settlements of the Széklers (*q.v.*) in the south-east, probably as a frontier guard, and of the "Saxons" (Germans from Luxembourg and the Rhine) for the same purpose in the 12th and 13th centuries Both Saxons and Széklers were free, self-governing communities under the king The Saxons especially, who founded numerous cities, were a great civilizing influence. The chief of their many privileges was the charter granted them in 1224 by Andrew II. As organized in the 14th century, they formed the communities of the "Sieben Stuhle" round Hermannstadt (Sibiu), the "Zwei Stühle" (Medias), the Burzenland (Kronstadt, Rum. Brassó), and the Nösnerland (Bistritz, Rum. Bistrita)

In spite of various invasions, the chief being the Mongol of 1241, the early prosperity of Transylvania was considerable and its communal life active. Its diet met at least as early as 1222:

and when the power of Hungary began to decline, and Turkish invasions harassed the frontiers, the dominant classes took steps to defend their own position A rising of the Magyar and Vlach peasants in 1437 caused the Saxons, Széklers, and nobles to meet at Kápolna on Sept. 14 of that year and conclude a "Brotherly Union," by which they swore fealty to the king of Hungary, promised to support each other against the peasants and the Turks, and agreed to settle disputes between themselves by arbitration. This union was renewed in 1438 and 1459, and in 1506 a supreme court of justice was established for all three communities, then referred to as "nations" This third union formed henceforward the basis of the Transylvanian local constitution, relations with the serfs being regulated by the "codex tripartitum" introduced in Hungary in 1515, after the peasant rising of the previous year

Transylvania a Principality.—After the defeat of the Hungarian forces by the Turks at Mohács (1526), John Zápolya, voivode of Transylvania, who had arrived too late for the battle, was left the strongest power in Hungary and elected king by the anti-Hapsburg party (Nov. 10, 1526) He was recognized as king of Transylvania and part of Hungary by Ferdinand I. of Austria (1538); and on his death in 1540 the Estates, instead of joining Austria, as had been stipulated, elected Zápolya's son, cut themselves loose from Hungary, and became tributary to the sultan Under the dynasties of Zápolya and Báthory the princes of Transylvania were able to preserve practical independence by playing off the sultan against the emperor, and to play an important part in international affairs, especially under Stephen Báthory (1576–86), who was also king of Poland.

The chief internal event of the 16th century was the triumph, after a severe struggle, of the Reformation The Saxons were converted to the Lutheran Church, the majority of the Magyars to the Calvinist, and another party, including most of the Széklers, to the Unitarian A certain party, usually identified with the Hapsburg cause, remained Catholic The diet, by a series of resolutions (1557, 1568, 1571, Compilation of 1669), declared the Calvinist, Catholic, Lutheran, and Unitarian religions to be alone "received" and entitled to free exercise and equal rights for all time By this means it bound another shackle on the Rumanian peasantry, who were Greek Orthodox and controlled by a patriarch in Wallachia. The backbone of the national movement was formed by the various Protestant creeds, and the efforts of the Catholic Báthorys, assisted by the Jesuits, to carry through the Counter-Reformation were a main cause of the confused wars which filled the last years of the century, in the course of which a fourth party in the person of Michael, voivode of Wallachia (1593–1601), unexpectedly intervened and for a year (1600) actually united Moldavia, Wallachia, and Transylvania in a national Rumanian state, for which, however, he did homage to the emperor He was murdered in 1601 by order of General Basta, and in 1604 the emperor Rudolph secured Transylvania; but the persecutions indulged in by the imperial troops under General Basta, and the proselytizing fury of the Jesuits, provoked a speedy rebellion On April 5, 1605, the diet elected as prince Stephen Bocskai (*q v.*), who, by the Peace of Vienna (June 23, 1606), forced the emperor to recognize him as prince of an enlarged Transylvania and secured the confirmation of all traditional liberties; while by the Truce of Zsitvatorok (Nov. 1606) he negotiated a 20 years' truce between the emperor and the sultan. Unfortunately, Bocskai died on Dec 29, 1606 Gabriel Báthory (1608–13) was the most tyrannical ruler Transylvania ever had; but the reign of Gabriel Bethlen (1613–29) restored the principality's former glories and is generally regarded as its golden age.

Under Bethlen and George Rákóczy I. (1631–48) Transylvania was again a power of international importance and the chief bulwark of Protestantism in Eastern Europe The emperor, distracted by the Thirty Years' War, was obliged to treat with the princes of Transylvania as equals, while the Turkish empire, for the time, was unable to interfere with its nominal vassal. Only when George Rákóczy II. (1648–57) was defeated in an unlucky campaign against Poland did the reviving Porte again intervene, depose Rákóczy, and, after six princes had died violent deaths within three years, appoint a Székler, Michael Apafi (1661), who ruled as a mere vassal of the Turks, and Transylvania sank again into extreme misery

When the Turks were defeated before Vienna (1683), and their power again declined, the Estates opened secret negotiations with the emperor Leopold I, whose suzerainty they recognized under the Treaties of Vienna (1686) and Blasendorf (Blaj) (1687) Apafi died in 1690, being succeeded by his son, Apafi II. On Dec 4, 1691, the emperor Leopold, after long negotiations, issued the diploma which regulated relations between him and his subjects

Period of Hapsburg Rule.—By this most important document the emperor swore to uphold the constitution of Transylvania, which was again considered *de jure* a part of Hungary, confirmed the privileges and liberties of the three "nations" and four "received religions," and agreed that the diet should meet annually, but also imposed a tribute on Transylvania, stationed a garrison in it, and put it under a "gubernium," directed after 1694 from the *Siebenburgische Hofkanzlei* in Vienna. In 1697 Apafi was induced to abdicate The Porte recognized the situation under the Peace of Karlovitz (1699). In Transylvania itself the resistance to the imperial troops and the Jesuits ceased only after the Peace of Szatmár (1711) In 1721 the Transylvanian diet accepted the Pragmatic Sanction

During the succeeding century the pressure of Catholic and bureaucratic rule gradually broke down the old individuality of Transylvania, which was promoted, in compensation, to the title of a Grand Principality in 1765 The privileges of the Széklers had already almost vanished in the 16th century and many of them had sunk into serfdom. In the 18th the Saxons were in danger of following suit, but were saved by their great minister, Brukenthal. Some of the Rumanians, on the other hand, emerged for the first time from serfdom when Maria Theresa extended the system of the Military Frontier (*q v*) to three Wallach districts in Transylvania in 1766 They had already acquired a measure of religious liberty under the union of 1698–99, which allowed any Orthodox priest in Hungary immunities equal to those of the Catholics conditional on his accepting certain dogmas The creation of the Uniat Church was probably not meant as an attempt to play off the oppressed against the dominant classes; but the Rumanians, who were largely reinforced during the 18th century by refugees from the Phanariot régime in Wallachia and Moldavia, were at last able to develop a national consciousness The visits of Joseph II. to Transylvania (1773, 1783) gave rise to a rumour that the serfs were to be liberated and armed against their masters In 1785 the Rumanian peasants, led by Nicola Horea, rose and had massacred many Magyar nobles before the revolt was suppressed. On Joseph's death, after recanting his reforms in Hungary, the Rumanians submitted to his successor, Leopold II, the ***supplex libellus Valachorum***, in which they prayed to be set on an equality with the other nationalities and inaugurated the "Vlach controversy" in modern politics by appealing to their "ancient rights" as the autochthonous inhabitants of Transylvania The document was passed by Leopold to the Transylvanian diet of 1790–91, which, itself busily engaged in reaffirming its position after the disturbing Josefinean interlude, rejected it decisively and restored the old constitution. Actually, however, under Francis I and Ferdinand II there was little liberty for any party. Meanwhile, the wave of the Magyar national revival swept through Transylvania, bringing with it a strong demand among the Magyars for full union with Hungary and creating a corresponding antagonism among the non-Magyars.

On the outbreak of the revolution of 1848 the Magyars petitioned for union with Hungary, promising the Rumanians the abolition of serfdom and other reforms in return for their support. The Rumanians, however, rejected the alliance, and at the "Field of Liberty" of Blaj (Blasendorf) declared themselves a free nation, forming an integral part of Transylvania, and swore fealty to the Hapsburgs (May 15). A political programme, based on "the principles of fraternity and liberty," was drawn up, but rejected by the diet at Klausenburg (Cluj), which proclaimed the union with Hungary, the Saxon representatives accepting this decision by a majority, and declared the new Hungarian laws to be sufficient guarantee that all necessary reforms would be granted—

a conclusion also reached by a commission of the Hungarian parliament In the subsequent fighting between the Hungarian and the Austro-Russian troops, much of which took place in Transylvania, both Saxons and Rumanians took up arms against the Magyars, and a very bitter racial war resulted. The Austrian constitution of 1851, which abolished both the Military Frontier and the Saxon privileges, treated all nationalities with equal severity, and the reaction affected all equally heavily The diploma of Oct 20, 1860, restored the old constitution and the Hofkanzlei, but these were abolished when Transylvania became an integral portion of Hungary under the Austro-Hungarian Compromise of 1867. In the following year it was reorganized in "comitats" with the rest of Hungary

From 1868–1918 Transylvania was dominated by the Magyar racial policy. The basic Nationalities Law of 1868 was in theory extremely liberal, but in practice remained almost a dead letter The Saxons, in view of their numerical inferiority, confined themselves to building up a close organization for the defence of their social and religious individuality. In spite of this they lost ground, especially after their ancient national status was abolished in March 1876. The Rumanian national movement was more active. In past centuries it had been essentially social rather than national. The idea of uniting all Rumanians in one body politic had, indeed, been mooted, but so long as the Danubian provinces remained under Turkish suzerainty the suggestion most commonly put forward, even by Rumanian rulers, *e g*, Michael the Brave and Matthew Bassarab, had been for a Rumanian state under Habsburg rule. Austria, however, lost her last chance of acquiring Moldavia and Wallachia through her unskilful diplomacy during the Crimean War; by the Compromise with Hungary she sealed the alienation of her Rumanian subjects. The immediate social struggle was ended by the abolition of serfdom in 1853–54; the agitation for a land reform dated chiefly from the 20th century The national struggle proper occupied the chief attention of the new Rumanian intelligentsia and middle-classes. A Rumanian irredenta, though invited by the creation of an independent Rumanian kingdom, never assumed the proportions of the Serb, owing to the discouragement given it by King Charles of Rumania, who was allied with Austria-Hungary, but in the last years before the World War it was increasingly furthered by nearly all educated elements in Rumania; and the severity of the measures taken in Transylvania during the War by the Hungarian Government and military, especially after the Rumanian advance into Transylvania in 1916, showed that practically all Rumanians desired the dissolution of Austria-Hungary.

Union with Rumania.—In Oct 1918 the Rumanians of Transylvania announced their decision to direct their own destinies. On Oct. 27 a National Council was established at Arad; and on Dec 1 a Convention assembled at Alba Julia and proclaimed the union of Transylvania with the kingdom of Rumania, at the same time promising to respect the rights and liberties of the other nationalities. The Saxons adhered to this resolution on Jan. 21, 1919; the representatives of the Magyars not till 1921, and then under protest. The union was thus carried through without calling on the secret treaty of Aug. 17, 1916, under which the Allies had promised Transylvania to Rumania The final frontier was determined by the Treaty of Trianon (June 4, 1920). The effect was to leave a western fringe with a very considerable Magyar population; it represented the results of a difficult endeavour to reconcile very conflicting ethnical and other claims The Rumanian Minorities Treaty guaranteed the rights of the non-Rumanian population; but, for all that, the transference of the administration from Magyar to Rumanian hands was accompanied by considerable friction. In part this was due to the discontent prevalent in Hungary on account of the new frontier, in part to certain undeniable weaknesses in the new régime, aggravated by the confusion of the post-war period. In particular, complaints were brought forward by the Magyar landowners, and supported by the Hungarian Government, regarding the application of the land reform, which had deprived the large landowners of their estates against a compensation which had been fixed in nominal Rumanian lei, no account being taken of the depreciation of the currency. It was also very widely alleged that the law was being applied in a manner detrimental to the non-Rumanian nationalities. The controversy, which aroused great bitterness, came before the League of Nations in April 1923 and Sept. 1927, each disputant showing great determination to frustrate or repudiate any decision, unless favourable to itself.

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TRANSYLVANIAN MOUNTAINS. This is an inclusive name for the mountainous region which abuts against the south-eastern end of the Carpathian range south of the Jablonica pass. In the east they form a continuation of this range but across the rest of the tract the mountains are arranged in scattered groups, in broken connection with one another, the land between forming the Transylvanian basin Formed in Tertiary times, they are part of the eastern arm of the Alpine fold-system which passes in a wide arc through the Carpathians, turns abruptly westward at Pietrite Fetei into the Transylvanian Alps, again turns almost as abruptly southward at Reteizat through the Szretinye mountains and across the Danube at Iron Gates to turn eastward into the Balkan mountains

The eastern mountains, the Moldavian Carpathians, are divided parallel to their trend by the upper valleys of the Mureşul and the Oltu, separating the outer (eastern) ranges which consist of highly folded *Flysch* (Cretaceous, Eocene and Oligocene) lying upon an (inner) crystalline massif of plutonic rocks, gneisses and schists with Carboniferous, Permian and Triassic rocks The western of these two ranges, the Harghitei complex of Tertiary volcanic rocks (andesites, andesitic tuffs, etc.), forms the eastern boundary of the Transylvanian basin and through it break the rivers Oltu and Mureşul. The Transylvanian basin seldom rises above 1,600 ft. in altitude and is covered by Miocene deposits The southern boundary is formed by the Transylvanian Alps which consist almost entirely of a crystalline massif of gneiss, schist and granite with a very narrow and broken fringe of *Flysch* on its southern (outer) edge. This forms the most continuous range in the region and contains the highest peak (Negoiul, 8,320 ft.).

The mountains of the south-west and west, which do not form a continuous range but are isolated by wide valleys, have a more complex structure than the Transylvanian Alps, for around crystalline massifs, which beneath the covering rocks are probably continuous with that of the latter chain, are Triassic, Rhaetic, Jurassic and Cretaceous beds and to a less extent Carboniferous and Permian Here are three main masses, the Szretinye mountains, the Transylvanian Ore-mountains and the Bihor mountains. Here, as well as in the Nagybánya district in the north, are Tertiary volcanic rocks of andesitic composition associated with which are important gold and silver lodes. Some of the mines (*e.g.*, Roşia-Montană [Verespatak]) have been worked since Roman times and the district still contains the most valuable gold deposits in Europe These volcanic rocks are probably associated with north to south faulting which occurs in this region. The northern boundary is less well defined and comprises a low range in the west with the higher range, the Ródna Hegység, farther east.

There are evidences of past glaciation amongst the highest peaks which nowhere reach 9,000 ft, so that none of them are permanently snow-capped. Precipitation in the Transylvanian basin averages 24 in. and great extremes of temperature are experienced This basin cannot be called a plateau for it does not possess extensive plains but is cut up by a network of valleys formed by mountain streams that drain into it from the peripheral ranges The three main streams are the Great Sameşul, which, draining the northern half of the basin, flows north-west to join the Theiss; the Mureşul, which crossing from east to west enters the Hungarian plain along the southern scarp of the Transylvanian Ore-mountains and also joins the Theiss; and the Alt

which breaks through the Transylvanian Alps by the Turnul-Ros pass to join the Danube. Other passes in this range, all of which are followed by railways, are the Bodza, Tömös, Vulcan and Teregova, whilst those in the Moldavian Alps are the Prislopul, Rodna, Borgo, Tölgyes, Békás, Gyimes and Oitoz passes, several of which are used by railways. (*See* RUMANIA)

TRAP, a mechanical device for snaring or catching anything, and especially wild animals. The term trap is also used to designate a wooden instrument, shaped something like a shoe, used in playing trap-ball; a machine used for throwing clay pigeons or balls into the air; a bent or partitioned chamber, as in a drain pipe (*see* PLUMBING), in which the liquid forms a seal to prevent the passage of sewer gas, etc.; and the term has been used colloquially to designate a light horse carriage.

Trap is derived from O.E *treppe* or *traēppe,* properly a step, as that on which an animal places its foot and is caught, *cf.* Ger. *Treppe,* a flight of stairs Traps for animals are of great antiquity and no savage people has ever been discovered, whatever its culture, that did not possess some variety of snare.

In the most primitive form of wild animal trap no mechanism need be present, *e g.*, a cavity into which the animal walks, as the pitfall of the Arabs and Africans or the snow-hole of the Eskimos. Dr O. T Mason has divided traps into three classes. *enclosing* traps, which imprison the victim without injury; *arresting* traps, which seize the victim without killing it, unless it be caught by the neck or round the lungs; and *killing* traps, which crush, pierce or cut to death.

Enclosing traps include the pen, cage, pit and door-traps. Pen-traps are represented by the fences built in Africa into which antelopes and other animals are driven, and by fish-seines and pound-nets. Among cage-traps may be mentioned bird-cones filled with corn and smeared with bird-lime, which adhere to the bird's head, blinding it and rendering its capture easy; the fish-trap and lobster-pot; and the coop-traps, of which the turkey-trap is an example This consists of a roofed ditch ending in a cul-de-sac into which the bird is led by a row of grains of corn Over the further end a kind of coop is built, the bird, instead of endeavouring to retrace its steps, always seeks to escape upward and remains cooped Pitfalls include not only those dug in the earth, at the bottom of which knives and spears are often fixed, but also several kinds of traps for small animals. One of these consists of a box near the top of which a platform is hung, in such a way that, when the animal leaps upon it to secure the bait it is precipitated into the bottom of the box, while the platform automatically swings back into place.

The door-traps range in size from the immense cage with sliding door in which such beasts as tigers are caught, to the common box-trap for mice or squirrels, the door of which falls when the spindle upon which the bait is fixed is moved Four classes of arresting traps are: the mesh, the set-hook, the noose and the clutch. The mesh-traps include the mesh and thong toils used of old for the capture of the lion and other large game, and the gill-net in the meshes of which fish are caught by the gills To the set-hook division are reckoned the set-lines of the angler, several kinds of trawls and the toggle or gorge attached to a line, which the animal, bird or fish swallows only to be held prisoner. The noose-trap class is a very extensive one. The simplest examples are the common slip-noose snares of twine, wire or horsehair, set for birds or small mammals either on their feeding grounds or runways, the victim being caught by the neck, body or foot as it tries to push through the noose. When the noose is used with bait it is generally attached to a stout sapling, which is bent over and kept from springing back by some device of the "figure-4" kind. This is constructed of three pieces of wood, one the horizontal spindle on which the bait is placed, one the upright driven into the ground, and the third the connecting cross-piece, fitted to the others so loosely that only the strain of the elastic sapling keeps the trap together When the victim tries to secure the bait he dislodges the cross-piece and is caught by the noose, which is spread on the ground under the bait or is so arranged as to encircle the neck

Besides the figure-4, several other very effective trigger devices are in use. There are two widely different types of clutch-traps: bird-lime and other tenacious substances, and jaw and clap-traps The simplest form of the first is adhesive fly-paper Some examples of the clap-trap are the clap-net, consisting of two nets laid flat on the ground and attached to cords in such a manner that they fly up and close when the draw-cord is pulled by a concealed trapper; and the various other spring-traps used by bird-catchers The jaw-traps are the most important class of device for the capture of fur-bearing animals Steel-traps consist of two jaws, with or without teeth, which are worked by powerful single or double springs and are "sprung" when the victim steps upon the "pan," which is placed between the jaws and attached to a lever They are made in many sizes, from the smallest, designed for rats, to the "Great Bear Tamer," weighing over 40 lb , with jaws of 16in in which lions, tigers and grizzly bears are trapped The steel-trap is set and concealed in such a manner that the animal must step on its pan in passing over it to secure the bait During recent years many types of traps, designed to reduce suffering and to displace the ordinary steel-trap, have been put out, but are not yet in general use

With the clutch-traps must also be reckoned the oldest form of steel-trap, now to be seen only in museums, the man-trap, which was used first about the middle of the 18th century when the systematic preservation of game rendered protection against poachers a necessity Such a trap, from Gloucestershire, is over 6ft. long, has 19in serrated jaws and weighs 88 pounds Another form of man-trap, the spring-gun, belongs to the next category, the killing traps, which are divided into traps of weight, point and edge. The most important of the weight class is the dead-fall, of which the typical form consists of a pen over whose narrow entrance one or more logs are laid across a lighter log, which is balanced upon a spindle necessarily struck by the entering animal, causing the logs to fall upon its back In some cases the bait is attached to the spindle itself The dead-fall was always the favourite trap of the American Indians, and is in use among many aboriginal tribes in Africa and South America A slab of stone is often used as a weight The common mouse-trap which kills either by a blow or strangulation is a variety of dead-fall Of point-traps may be mentioned those of the impaling and the missile classes An example of the former is the stake or spear placed by Arab and African tribes at the bottom of pitfalls for big game Another impaling trap common in Africa is the harpoon down-fall, generally used for the hippopotamus It consists of a heavily weighted harpoon suspended in such a way that the animal, passing beneath, breaks a cord and precipitates the harpoon upon itself. Another example of impalement is the hawk-trap, consisting of a circle of stout sharp wires, in the centre of which a live fowl is placed. A bird of prey attempting to secure the fowl is impaled upon the wires Of missile-traps the most universal are the ancient spring-bow and its modern representative the spring-gun This is fixed upon stakes, or against a tree, with a line attached to the trigger and stretched immediately in front of the muzzle An animal pressing against the string pulls the trigger and discharges the piece into its own body An arrangement of sticks holding the bait in front of the muzzle is sometimes substituted for the string Of edge-traps a curious example is the wolf-knife of Western America, which consists of a very sharp blade embedded in frozen fat One of the wolves, licking the fat, cuts its tongue and a flow of blood ensues, with the result that not only the wolf itself but its companions become infuriated by the smell and taste, and the wounded beast, and often many of the others, are killed and devoured The Alaskan knife-trap for large game consists of a heavy blade attached to a lever, which, when released by the animal biting at the bait, moves over and strikes the victim

See *Shifts and Expedients of Camp Life,* by W. B. Lord (1871); *Camp Life and the Tricks of Trapping,* by W. H. Gibson (1902); O. T. Mason, "Traps of the American Indians," *Annual Report,* Smithsonian Institution, for 1901, *The Story of the Trapper,* by A. C. Laut (1903).

TRAPANI (anc. *Drepanum*), a city and episcopal see of Sicily, capital of the province of the same name, situated on the west coast, 3 m W of the Monte San Giuliano, which rises above it, 121 m. W by S of Palermo by rail, and 47 m direct. Pop. (1921) town 56,625, commune 61,174. The ancient Drepanum

(δρέπανον, a sickle, from the shape of the low spit of land on which it stands) was originally the port of Eryx. It is represented by Virgil in the *Aeneid* as the scene of the death of Anchises. It was an important Carthaginian naval station in the First Punic War (260 B.C), part of the inhabitants of Eryx being transferred thither. Near Drepanum the Roman fleet was defeated in 250 B C., while the struggle to obtain possession of it ended in the decisive Roman victory off the Aegates Islands in 241, which led to the conclusion of peace (*See* PUNIC WARS) Under the Norman kings, at the time of the first crusade, it became a place of importance; it was a residence of the Aragonese kings. In the 16th and 17th centuries it was strongly fortified

There are some fine Gothic and baroque palaces, and a few churches with interesting details. Trapani has a harbour of some importance There are also large salt-pans to the south of the city, extending along the coast as far as Marsala.

TRAPPISTS, Cistercian monks of the reform instituted by Armand J. le B de Rancé (*q v*), abbot of La Trappe, 1664 La Trappe was a Cistercian abbey near Soligny, in the diocese of Sées, in Normandy, founded 1140. It suffered grievously from the English wars and from commendatory abbots. Armand Jean de Rancé became commendatory abbot at the age of ten, 1636; and on his conversion from a worldly life he began to interest himself in his abbey and conceived the project of restoring the monastic life therein, 1662 With this object he visited La Trappe, but the monks were recalcitrant and threatened his life, through the intervention of Louis XIV he was able to pension them off: they were replaced by a community of Cistercians of the strict observance, and the monastic buildings, which had fallen into ruin, were repaired at de Rancé's expense. He himself then entered the novitiate in one of the reformed Cistercian abbeys, and came to La Trappe as regular abbot, 1664. He persuaded his community to adopt a manner of life beyond Cistercian practice, and far beyond St Benedict's rule. The Trappist régime is probably the most penitential that has ever had any permanence in the Western Church Yet it attracted vocations in such numbers that de Rancé had 300 monks under him Through age and ill health he resigned his abbacy in 1695, and died five years later.

During the 18th century La Trappe continued faithful to de Rancé's ideas, but the observance spread only into two monasteries in Italy It was the dispersal of the community at the French Revolution that turned the Trappists into a congregation in the Cistercian order and finally into a separate order. Dom Augustine de Lestrange, the novice-master at the time of the suppression in 1790, kept twenty of the monks together and obtained permission for them to settle at Val-Sainte in Fribourg, Switzerland Here they made their life still stricter than that of La Trappe, and postulants flocked to them in such numbers that in two years' time colonies went forth to establish Trappist monasteries in England, Belgium, Piedmont, Spain and Canada, and in 1794 Dom Augustine was named by the Holy See Father Abbot of all these foundations, thus formed into a congregation. In 1817 they returned to La Trappe, many new foundations were made, and by Dom Augustine's death in 1827 there were in all some seven hundred Trappist monks. In the course of the century three or four congregations arose—a Belgian, an Italian, and two in France—each with a vicar subject to the general of the Cistercians In 1892 these congregations were united into a single Order of Reformed Cistercians, or of Strict Observance, with an abbot-general resident in Rome and independent of the general of the Cistercians of the Common Observance In 1898 the Trappists recovered possession of Citeaux, the mother-house of the Cistercians, secularized since the Revolution, and it was declared to be the mother house of the Reformed Cistercians.

The Trappists are a thriving and vigorous order, represented in all the countries of western Europe; also in the United States and in Canada. Besides they have a house in China, one each in Japan, Asia Minor, Palestine, Bosnia and Dalmatia, and four in various parts of Africa. In heathen countries the Trappists now give themselves up to missionary work

The first Trappist nunnery was the abbey of Les Clairet, near Chartres, which de Rancé persuaded to adopt his reforms Dom Augustine de Lestrange established another in 1796, and now there are fifteen with 350 choir nuns and 500 lay sisters. One is in England at Stapehill, near Wimborne, founded in 1802.

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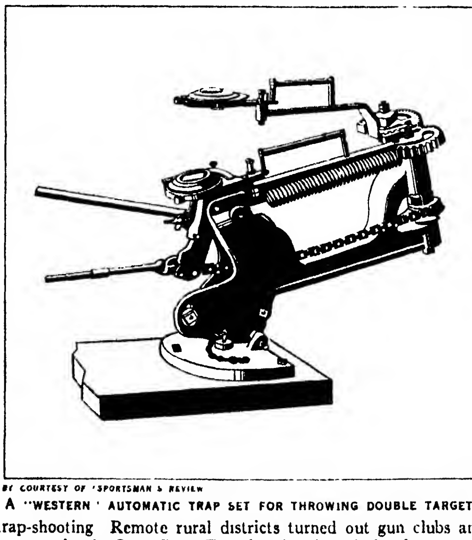
TRAP-SHOOTING, shooting at live or clay birds released from traps In Great Britain shooting at live birds prevails, but is widely condemned In the United States the sport is almost wholly confined to shooting artificial birds. Trap-shooting began in America in 1825.

Cincinnati, O , is the recognized home of organized trap-shooting in the United States, a club having been established there in 1831 Glass balls were the first inanimate targets, with an improvement later in the form of feathers inside the globes which gave an impression of game when struck Spring-board traps catapulted the targets into the air Keen shots began club organization over the country and regular competitions ensued New model traps were invented and with them trap-shooting passed from the glass ball stage to the mechanism which tossed off the first saucer-shaped clay disc or "brittle pigeon" The Ligowski trap and bird, the latter equipped with a sort of flipper which the machine engaged and slung to various tangents, were pioneers These earlier traps were set in rows behind earth ramparts Poor trap delivery, small rotation imparted to targets, slower powders and tough composition of the "birds" caused the lower scores of those days. But with the advent of smokeless powders, chilled shot, better targets and traps and above all better choke-boring of guns, scores mounted and with them nation-wide interest in



BY COURTESY OF "SPORTSMAN & REVIEW"

A "WESTERN" AUTOMATIC TRAP SET FOR THROWING DOUBLE TARGETS

trap-shooting Remote rural districts turned out gun clubs and, as a result, the Inter-State Trapshooting Association became the governing body of the sport in the United States

Subsequently came the American Trapshooting Association with which were connected, more or less as financial backers, the gun and ammunition interests of the country. The American Trapshooting Association was in turn passed over to the Amateur Trapshooting Association in 1923. With the formation of the latter association, control and direction of trap-shooting in the United

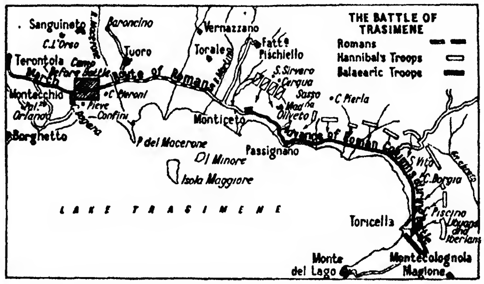
States (with Canadian affiliation) passed directly into the hands of the amateurs as distinguished from gun and ammunition firms having a commercial interest in the sport. Amateur control has resulted in the foundation at Vandalia, O, of a permanent trap-shooting home and club grounds which is probably the most elaborate layout of its kind in the world Here, usually in late August, is decided, after a week of steady firing, the Grand American Handicap programme, culminating in the main event of that name, the "Grand American."

Trap-shooting in the United States has shown a gratifying increase since passing into the hands of the Amateur Trap-shooting Association. A conservative estimate of the number of targets fired at in a season's trap-shooting in the United States and Canada, approximates 75,000,000, at least a million of which are thrown during one week's programme of the Grand American The world's record long run at single targets is held by a Californian, A J. Stauber of Los Angeles—694 straight kills. Stauber, in 1927, also compiled in his class shooting the highest percentage ever recorded in trap-shooting, breaking 1,461 targets out of 1,475 or an average of 99 05%. Mark Arie, of Champaign, Ill, broke the world's record for shooting double targets (two thrown simultaneously at different angles) in 1926 at Denver, Colo, breaking 168 consecutively 198 out of 200 for the high score An outstanding feature of the year 1927 was the breaking of 455 straight targets during the Grand American Handicap programme by Guy Dering, president of the American Trapshooting Association Notable among women trap-shooters who have won national recognition are Mrs Frank Butler (the late Annie Oakley) and Mrs Adolph Topperwein who achieved feats in trap-shooting which should last for years

TRASIMENUS, LAKE, a lake of Umbria, Italy, 12m W from Perugia, 843ft above sea-level, 50m in circumference, and 8m to 14m across (Lat. *Trasumenus Lacus;* Ital *Lago Trasimeno*). Having no natural outlet, it was formerly subject to sudden rises, which occasioned inundations, and these in turn malaria. An artificial outlet was completed in 1898 from the south-east corner of the lake to the Caina, a small tributary of the Tiber The locality was the scene of the second great defeat suffered by the Romans during the Second Punic War.

In the early spring of 217 B C Hannibal left the winter quarters (probably near Modena or Bologna) to which he had withdrawn after the victory of the Trebia (*q v*) and crossed the Apennines, continuing his march by a shorter route than the usual one, a route which obliged him to march through an inundated and marshy district for four days and three nights. Which pass it was that he took has been much discussed, but it is most likely that he followed the modern route from Bologna to Bagni della Porretta, and thence went by the Collina pass to Pistoia From here he passed through the (at that time) marshy district between Pistoia and Florence, and after resting his troops advanced towards Cortona and Lake Trasimenus, his object in taking this route being, as Polybius tells us, to move onto the rear of the consul Flaminius, who was at Arretium (Arezzo) and, by this strategic surprise, gain an opportunity to fight with the advantage. Fulfilling Hannibal's calculation, Flaminius, on hearing that Hannibal was plundering the countryside, hastily started in pursuit, while the other consul Servilius, who was at Ariminum, marched along the Via Flaminia, their object doubtless being to attack him from two sides before he could reach Foligno But Flaminius advanced rapidly and without taking the most elementary precautions of scouting. He probably reached the lake in a single day's march from Arezzo, in any case late in the evening, and encamped by it, probably to the east of Monte Gualandro and west of Tuoro, and started early on the following morning along the north side of the lake, which was covered with a thick mist.

Hannibal, as he marched along the shores of the lake, had not failed to notice the exceptionally good opportunities of surprise which the terrain afforded. From the hill of Montigeto, a little to the west of Passignano, to Torricella, where the road to Perugia and Foligno leaves the lake and climbs some 300ft. in half a mile to the pass of Montecolognola over the hills which surround it, is a distance of some six or seven miles. For the greater part of this the road runs along a narrow level strip of ground completely commanded by the hills which rise from the lake, while the ascent to the pass is shut in by hills in front and on each side, with the lake behind; so that it corresponds extremely well with the description of Polybius Even without the mist, which was of course an added advantage, Hannibal would have been able to conceal the greater part of his troops behind hills or in dead ground at a comparatively short distance away



PLAN OF BATTLE BETWEEN THE CARTHAGINIANS AND THE ROMANS

from the road Flaminius, on the other hand, was in an exceptionally unfavourable situation for resistance, there were three points at least at which his army of some 30,000 men (which, marching in column, would have formed a length of some ten m) could be easily split up by an attack, the narrow strip of land along the shores of the lake afforded them no room for retreat nor to rally, and there was no point where they could easily break through to the north

Hannibal therefore encamped on the pass, from which he could command a view of the defile as far back as Passignano, and kept his heavy Spanish and African troops under his own command to hold the pass, while the light troops were placed on the left, behind Montecolognola itself, and the Gauls and cavalry formed the right wing, which extended along the hills above the lake as far as Montigeto, the cavalry being placed at the beginning of the defile, and concealed behind the hill of Montigeto, so as to be able to close the defile as soon as the last units of Flaminius' army had entered it. So the Romans marched on to their doom; and when the head of their column came into contact with the troops in the centre at the pass of Montecolognola, concealment was neither possible, nor indeed necessary, and Hannibal gave the signal for a general attack. The greater part of the army was already in the trap and was attacked on all sides from the higher ground, so that, we are told, the centurions and tribunes could not even understand the situation, still less do anything to help it, and the Romans were mostly slain in their marching formation, without having any opportunity of defending themselves, or realizing what was to be done Many of them were driven into the lake and met their death there.

The head of the column, however, which was naturally more prepared to offer effective resistance, to a number of some 6,000 men, rallied and advanced against the pass They succeeded in piercing through the light troops on Hannibal's left in a southerly direction, and only when they had done so found that there were no other troops opposed to them From the high ground they had reached, they were able, now that the mist had cleared, to see the full extent of the disaster, but as they were unable to offer any assistance they marched off to an unnamed Etruscan village, where they surrendered to Maharbal on the following day, in the vain hope of being set free if they laid down their arms; but with the rest of the prisoners (another 10,000 or so) they were all thrown into chains. The number of killed was about 15,000; while the Carthaginian losses were only about 1,500

It is the only instance in history of a general lying in ambush with the whole of a large army and accounting for practically the whole of the troops opposed to him, and it was, thanks to the favourable nature of the ground, the carelessness of Flaminius and

the fortunate circumstance of the morning mist, a brilliant success. Kromayer's account of the battle, which we have followed, fits in with the account of Polybius and with the actual terrain better than any of the rival theories which have been advanced. Of these, the only one deserving of consideration is that which asserts that the battle took place a good deal farther to the west, in the valley of Montigeto, near the village of Tuoro But here there is no long defile where an army on the march could be attacked—only a quite short one at Borghetto, close to the shore of the lake and too narrow for the passage of an army.

Immediately after this terrible defeat the Romans suffered a minor discomfiture Servilius, who was hastening to his colleague's assistance, had sent his cavalry, some 4,000 men, under C. Centenius, ahead of his main body. Hannibal sent Maharbal with the light troops and part of his cavalry against him, and an engagement followed in which, according to Polybius, the Romans lost half their forces, while the rest sought shelter on a hill, but were surrounded and taken prisoners the next day. (*See* CALLICULA)

See J Kromayer, *Antike Schlachtfelder*, iii. 1, 148 *sqq.* (1914). (T. A)

TRASS, the local name of a volcanic tuff occurring in the Eifel, where it is worked for hydraulic mortar. It is a grey or cream-coloured fragmental rock, largely composed of pumiceous dust, and may be regarded as a trachytic tuff It much resembles the Italian puzzolana and is applied to like purposes Mixed with lime and sand, or with Portland cement, it is extensively employed for hydraulic work, especially in Holland; whilst the compact varieties have been used as a building material and as a fire-stone in ovens Trass was formerly worked extensively in the Brohl valley and is now obtained from the valley of the Nette

TRAUN, OTTO FERDINAND, COUNT VON ABENSPERG UND (1677–1748), Austrian field marshal, was born at Oldenburg on Aug 27, 1677, of a noble family In 1693 he left the University of Halle to serve with the Prussian forces in the Low Countries After seeing much service in the War of the Grand Alliance, he entered the imperial army.

In the War of the Spanish Succession, Traun served with distinction in Italy and on the Rhine till 1709, when he became lieutenant-colonel and aide-de-camp to Field Marshal Count Guido Starhemberg (1654–1737) in Spain A year later, he was made colonel, and in 1712 chief of a regiment of foot At Francavilla in Sicily (June 20, 1719) he received a severe wound He was promoted General-Feldwachtmeister in 1723 In 1727 he became governor of Messina, and in 1733 lieutenant field marshal.

In 1734 he won a European reputation by his defence first of the pass of S. Germano and then of the half-ruined fortress of Capua. He was promoted Feldzeugmeister and employed in a semi-political command in Hungary, then as commander-in-chief in north Italy and interim governor-general of the Milanese. In 1741 he was made a field-marshal In the War of the Austrian Succession (*q.v.*) he commanded in Italy till 1743, when, on the death of Field Marshal Count Khevenhüller (*q v*), he was made the principal military adviser of Prince Charles of Lorraine (*q.v*), commanding the Austrians in Bohemia and on the Danube, whose successful operating he inspired. Traun's last active service was the command of an army sent to Frankfurt to influence the election of a successor to Charles VII. He died at Sibiu (Hermannstadt), Feb. 18, 1748

See *Biographien k k Heerfuhrer, herausgegeben v d Direktion des k. und k. Kriegsarchiv;* Thurheim, *F M. Otto Ferdinand, Graf v. Abensperg und Traun*

TRAUTENAU: *see* TRUTNOV.

TRAVANCORE, a state of southern India Area, 7,625 sq m. In 1921 the population was 4,006,062. The state stands seventeenth among the native states of India in area and third in population Travancore extends more than 150 m. along the west coast as far as Cape Comorin, the southernmost point of the peninsula. The Western Ghats, rising to an elevation of 8,000 ft and clothed with forests, throw out spurs towards the coast, along which there is a belt of flat country of about 10 m. in width It is covered with coco-nut and areca palms, which to a great extent constitute the wealth of the country. The whole surface is undulating, and presents a series of hills and valleys traversed from east to west by many rivers, the floods of which, arrested by the peculiar action of the Arabian sea, spread themselves out into lagoons or backwaters, connected here and there by artificial canals, and forming an inland line of smooth-water communication for nearly the whole length of the coast. The chief river is the Periyar, 142 m in length. Other important rivers are the Pambai and its tributary the Achenkoil, the Kallada, and the Western Tambraparni, on which there is a reservoir irrigating about 70,000 acres Mica, monazite and lignite occur. Elephants, bison, etc., are still found in the Cardamom hills Travancore has an abundant rainfall. The principal ports are Alleppi, Quilon and Paravur; but there is no real harbour. The Cochin-Shoranur and the Tinnevelly-Quilon railways pass through the state. The Periyar irrigation project conducts water through the Ghats in a tunnel to irrigate the Madras district of Madura, for which compensation of Rs. 40,000 is annually paid to Travancore. Rice is the staple crop. Other products are pepper, tapioca, coco-nuts, cardamoms, coffee, tea and rubber in the hills Trade is large, the chief exports being copra, coir and other coco-nut products, pepper, tea, rubber, fish, etc. Cotton is woven and matting made. The capital is Trivandrum The tribute is £53,333, and there is a military force of about 1,500 The maharaja of Travancore claims descent from Cheraman Perumal, the last Hindu monarch of united Malabar, whose date is variously given from A D. 378 to 825. Though he is a Kshatriya, the succession follows the local custom of inheritance through females; consequently his *sanad* of adoption authorizes him to adopt sisters' sons For some generations the rulers have been men of education and character, and the state is conspicuous for good administration and prosperity There is a popular assembly, with women on an equal footing with men as voters and members, and a legislative council, remodelled in 1921 Primary education is free The state came into direct relations with the British government in 1923 Native Christians, chiefly of the Syrian rite, form nearly one-fourth of the population

TRAVELLER'S TREE, a remarkable tree, native of Madagascar and Réunion, with a straight stem reaching 30 ft in height and bearing at the top a number of large long-stalked leaves which spread vertically like a fan The leaf has a large sheath at the base in which water collects in such quantity as to yield a copious supply—hence the popular name. The plant is known botanically as *Ravenala madagascariensis.*

TRAVERSE CITY, the county-seat of Grand Traverse county, Michigan, U S A , on Grand Traverse bay (Lake Michigan), 150 m. N of Grand Rapids, at the mouth of the Boardman river, which widens here into a lake. It is on Federal highways 31 and 131, and is served by the Manistee and North-Eastern, the Pennsylvania and the Pere Marquette railways, motorbus lines and lake steamers The population was 10,925 in 1920 (85% native white) and was estimated locally at over 13,000 in 1928 The city has various manufacturing industries, with an output in 1925 valued at $3,460,882. It is the seat of the Northern Michigan Hospital for the Insane (1885). It was settled in 1847, incorporated as a village in 1881, and chartered as a city in 1895.

TRAVERSER. A long very shallow structure running on a number of wheels, and used to transfer locomotives, carriages, and wagons from one line of rails to another. The vehicle is hauled on to the rails which are fixed to the platform of the traverser, and the latter is then moved on its several sets of rails, by hand, steam, or electric power, until the vehicle comes into line with the desired position. There are two types, ***surface*** traversers for carriages and wagons, and ***pit*** traversers for locomotives, carriages and wagons. The surface type has the traverser tracks and the vehicle tracks at the same level, enabling through ways to be provided at any position across the traverser track. The pit design has the traverser rails sunk at a lower level, and is used chiefly in or between shops manufacturing or repairing rolling-stock. The vehicle rails are level with those from which the stock is taken and replaced, so that running on and off is simple The surface machine must have a certain depth of con-

struction, hence the rails upon which it receives the carriage must be at some distance above the ground rails, and to enable the stock to mount the traverser, ramps (inclined rails) have to be provided at the ends.

The Stokes surface traverser is built up of steel plates and girders in such a manner that the distance between the respective heights of the rails can be as little as four inches. This is important on account of the large amount of bogie stock now used, the six or eight inches difference in ordinary surface traversers being too great to enable these to mount without seriously straining or damaging the bogie and its parts. Another style, the Bowtell, has the traverser vehicle rails ramped for a short distance from the ends. Thus when the back wheels of the bogie begin to mount the ordinary ramps not on the traverser, the front wheels are mounting those on the traverser By this means a vehicle may mount a traverser which has deep construction, without injury, the angle of tilt being no greater than that which occurs when mounting the Stokes shallow type above mentioned.

TRAVERTINE, a calcareous deposit formed by springs. (*See* SINTER.)

TRAVIÈS DE VILLERS, CHARLES JOSEPH (1804–1859), French painter and caricaturist, was born at Winterthur, Switzerland, on Feb. 21, 1804 He studied first in Strassburg and later at the École des Beaux Arts in Paris He began as a portrait painter but later devoted himself almost entirely to caricature, finding that his greater talent was in that direction He was a founder of *Charivari* and later of *La Caricature* and a prolific contributor to both journals. His numerous humorous sketches appearing in the latter magazine were later gathered into such volumes as *La galerie des épicuriens, Les contrastes, Tableaux de Paris, La vie littéraire* and *Comme on dine à Paris* These burlesque studies of Parisian life, remarkable for the observational powers shown and full of wit, were immensely popular The series was continued in *Les Français peints par eux-mêmes, Les rues de Paris, Le miroir grotesque* and, doubtless the most notable of all, *Mayeux* From 1848 to 1855 he assisted in the illustration of Balzac's novels His large painting "Jésus et la Samaritaine" (1853) was acquired by the State He died in Paris on Aug 13, 1859

His brother EDWARD TRAVIÈS, also a painter, was known for his still life and his excellent animal studies

TRAVNIK, known till the 18th century as Lašva, a town in Bosnia, Yugoslavia Pop (1921) 6,334 It is built round a steep mass of rock, with the tempestuous Lašva at its base, and crowned by an old Turkish citadel. Travnik is very picturesque, with its minarets and narrow lanes, bordered by quaint old wooden houses, and its busy bazaar. There are some good modern barracks and public buildings, a tobacco factory, a State stud farm and horticultural school, and an English establishment for woodwork. Sheep rearing is the principal occupation on the surrounding heights, and some horse breeding is also carried on Many Roman remains are found in the district During the 15th century the town was the stronghold of the Bogomils, and from 1686, after the downfall of the Turks in Hungary, to 1850, it superseded Banjaluka as the capital of Bosnia.

TRAY, a flat receptacle with a raised edge used for a variety of purposes, chiefly domestic. The tray takes many forms—oblong, circular, oval, square—and is made in a vast number of materials, from papier mâché to the precious metals The tea-tray is the most familiar form; next to it comes the small round tray, usually of silver or electroplate, chiefly used for handing letters or a glass of wine. When thus employed it is usually called a "waiter." The English tea-trays of the latter part of the 18th century were usually oval in shape and sometimes had handles; mahogany and rosewood were the favourite materials Sheraton and Shearer, among other cabinet-makers of the great English period, are credited with trays of this type. These were succeeded in the early and mid-Victorian period by trays of japanned iron, which possessed no charm but had the virtue of durability. Sheffield plate snuffer-trays of satisfying simplicity were made in large numbers, and are now much sought after.

TRAY-LANDSCAPE. For discussion of various aspects *see* the articles BON-SEKI; BON-KEI; HAKO-NIWA.

TRAZ, ROBERT DE (1884–), French author, was born in Paris on June 14, 1884 He studied law in his native city and afterwards lived in England and Italy, establishing himself finally in Geneva, Switzerland, where in 1920 he founded *La Revue de Genève*. He first won notice as a novelist by his *Au temps de la jeunesse* (1908) He has since published a series of novels and short stories which have received liberal critical praise, among them *Vivre* (1910), *Les désirs du coeur; L'homme dans le rang; Complices* (1924); *L'écorche* (1927), and *La puritaine et l'amour* (1928). They indicate a writer possessed of a pleasant narrative turn, unusual observational powers, and a fine sensitiveness. He has travelled widely and his essays collected in *Dépaysments* (1923) and *Le dépaysments de l'Orient* (1926) are of more than ordinary interest

TRAZ-OS-MONTES, an ancient frontier province in the extreme N.E of Portugal, bounded on the N and E. by Spain, S by the river Douro which separates it from Beira, and W by the Gerez, Cabreira and Marão mountains, which separate it from Entre-Minho-e-Douro Pop (1920) 405,801, area, 4,163 sq.m. For administrative purposes Traz-os-Montes was divided in 1833 into the districts of Braganza (*q v.*) and Villa Real (*q.v*).

TREACLE, the thick viscid syrup obtained in the early processes of refining sugar, the uncrystallizable fluid obtained in the process of procuring refined crystallized sugar being known as "golden syrup" and the drainings from the crude sugar as "molasses" (*see* SUGAR. *Manufacture*) The word was properly and first used for a medical compound of varying ingredients which was supposed to be a sovereign remedy against snake bites or poison generally. A well-known specific was Venice treacle, *Theriaca Andromachi*, a compound of a large number of drugs reduced to an electuary, a medicinal compound prepared with honey, which dissolves in the mouth. The old French *triacle*, of which "treacle," earlier "triacle," is an adaptation, is a corruption of *thériaque*, Latin *theriaca*, Greek θηριακά (*sc.* φάρμακα), literally drugs used as an antidote against the bite of poisonous or wild animals (θήριον, dim. of θήρ, wild beast). The word "triacle" came to be used of any remedy or antidote The composition of electuaries with honey or syrup naturally transferred the name to the most familiar syrup, that obtained from the drainings of sugar.

TREADMILL, a penal appliance introduced by Sir William Cubitt in 1818 and intended by him as a means of employing criminals usefully It was a large hollow cylinder of wood on an iron frame, round the circumference of which were a series of steps about 7½in apart. The criminal, steadying himself by hand-rails on either side, trod on these, his weight causing the mill to revolve and compelling him to take each step in turn.

By the Prison Act, 1865, every male prisoner over 16, sentenced to hard labour, had to spend three months at least of his sentence in labour of the first class This consisted primarily of the treadmill, or, as an alternative, the crank The latter consisted of a small hand-wheel, like the paddle-wheel of a steamer revolving in a box. Both treadmill and crank were in time made to subserve useful purposes, but both have gradually been abolished; in 1895 there were 39 treadmills and 29 cranks in use in English prisons, and these had dwindled down to 13 and five respectively in 1901. They are now disused.

The fundamental idea of Cubitt's invention, *i.e.*, procuring rotary motion for industrial purposes by the weight of men or animals, is very old. "Tread-wheels," of this type, usually consist of hollow cylinders, round the inner surface of which a horse, dog or man walks, foothold being kept by slabs of wood nailed across at short intervals.

TREASON, a general term for the crime of attacking the safety of a sovereign State or its head. The law which punishes treason is a necessary consequence of the idea of a State, and is essential to the existence of the State. Most, if not all, nations have accordingly, at an early period of their history, made provision by legislation or otherwise for its punishment.

The law of England as to treason corresponds to a considerable extent with Roman law; in fact, treason is treated by Blackstone

as the equivalent of the *crimen laesae maiestatis* The history of the crime in the two systems agrees in this that in both the law was settled by legislation at a comparatively early period, and subsequently developed by judicial construction In both, too, there were exceptional features distinguishing this crime from other offences Treason was the subject of legislation in many of the pre-Conquest codes The laws of Alfred and Aethelred punished with death any one plotting against the life of the king The *Leges Henrici Primi* put anyone slaying the king's messenger in the king's mercy The crime was shortly defined by Glanvill, and at a greater length by Britton, and by Bracton, who follows Roman law closely

The offence of high treason was not precisely defined by the common law (1 Hale, 76), and until the passing of the Treason Act 1351 depended much on the opinions of the king and his judges That statute appears to be the answer to a petition of the Commons in 1348 (1 Hale, 87), praying for a definition of the offence of accroaching royal power, a charge on which several persons—notably Gaveston and the Despensers—had suffered The offences made high treason by the statute which still remain are these (1) to compass or imagine the death of the king, the queen or their eldest son and heir, (2) to violate the king's companion, or his eldest daughter unmarried, or the wife of his eldest son and heir, (3) to levy war against the king in his realm, or be adherent to the king's enemies in his realm, giving them aid and comfort in the realm or elsewhere, (4) to slay the chancellor, treasurer or the king's justices of the one bench or the other, justices in eyre, or justices of assize, and all other justices assigned to hear and determine, being in their places doing their offices In all cases of treason not specified in the statute the justices before whom the case came are to tarry without going to judgment until the cause has been showed and declared before the king and his parliament whether it ought to be judged treason or felony The statute, so far as it defines the offence of high treason, is still law

The statute also treated as high treason forgery of the great or privy seal, counterfeiting the king's coin and importing counterfeits thereof, and this was the law until 1832 These offences are now felonies under the Coinage Offences Act 1861 and the Forgery Act 1913 It also defined petty treason (now merged in wilful murder by s 8 of the Offences against the Person Act 1861) as the slaying of a master by his servant, a husband by his wife, or a prelate by a man secular or religious owing him allegiance Between 1351 and 1553 many new offences were made treason, but most of the Acts creating these new treasons were repealed at the earliest opportunity by parliament The reign most prolific in statutory additions to the law of treason was that of Henry VIII The Acts of this period were repealed in 1553 and the Act of 1351 was then made the standard of the offence

Besides the Acts of 1351 and 1553 the following statutes are still in force with respect to the substantive law of treason By a statute of 1495 persons serving the king *de facto* in war are not to be convicted of treason against the king *de iure* By an Act of 1702 it is treason to endeavour to hinder the next successor to the crown from succeeding, and by the Succession to the Crown Act 1707 it is treason maliciously, advisedly and directly by writing or printing to maintain and affirm that any person has a right to the crown otherwise than according to the Acts of Settlement and Union, or that the Crown and parliament cannot pass statutes for the limitation of the succession to the crown By the Treason Act 1796, made perpetual in 1817, the definition of treason is extended so as to include plots within or without the realm to cause the death or destruction, or any bodily harm tending to the death, destruction, maiming or wounding, imprisonment or restraint of the king, his heir or successors, if such plots are expressed by publishing any printing or writing, or by any overt act or deed Since that date no new forms of treason have been created.

Punishment.—The punishment of treason at common law was barbarous in the extreme The sentence in the case of a man was that the offender be drawn on a hurdle to the place of execution, that there he be hanged by the neck but not till he be dead, and that while yet alive he be disembowelled and that then his body be divided into four quarters, the head and quarters to be at the disposal of the Crown Until 1790 at common law a woman was drawn to the place of execution and there burned. In that year hanging was substituted for burning in the case of female traitors In 1814 the part of the sentence relating to hanging and to disembowelling was altered to hanging until death supervened. Drawing and beheading and quartering after hanging were abolished in 1870 The Act of 1814 in the case of men enables the Crown by warrant under the sign manual, countersigned by a secretary of State, to change the sentence to beheading Attainder and forfeiture for treason are abolished by the Forfeitures Act 1870, except where the offender has been outlawed

Trials for treason in Great Britain and Ireland were at one time frequent and occupy a large part of the numerous volumes of the *State Trials* Some of the more interesting may be mentioned Before the Statute of Treasons were those of Gaveston and the Despensers in the reign of Edward II on charges of accroaching the royal power After the statute were those (some before the peers by trial or impeachment, most before the ordinary criminal courts) of Empson and Dudley, Fisher, More, the earl of Surrey, the duke of Somerset, Anne Boleyn, Lady Jane Grey, Sir Thomas Wyatt, Cranmer, Mary Queen of Scots, Sir Walter Raleigh, Strafford, Laud, Sir Henry Vane and other regicides, William Lord Russell, Algernon Sydney, the duke of Monmouth, and those implicated in the Pilgrimage of Grace, the Gunpowder, Popish, Rye House and other plots Occasionally the result of a trial was confirmed by statute In some of these trials, as is well known, the law was considerably strained in order to ensure a conviction Since the Revolution there have been the cases of those who took part in the risings of 1715 and 1745, Lord George Gordon in 1780, Thomas Hardy and Horne Tooke in 1794, the Cato Street conspirators in 1820, Thomas Frost in 1840, Smith O'Brien in 1848

Recent Trials.—Most of the early treason trials are reported in Howell's *State Trials* and the *New Series of State Trials* There are, however, two recent trials for high treason which may be referred to A case arising out of the South African War was the trial at bar of Arthur Lynch for high treason in 1903 (*Rex* v *Lynch,* 20 Cox C C 468) It was there decided that the Naturalization Act 1870 does not permit naturalization in a foreign State at war with Great Britain, and therefore a British subject who renounces his allegiance and attempts to procure himself to be naturalized in an enemy's country in time of war is guilty of high treason It was ruled that a person cannot become naturalized in a State with which his country is at war, for the act of becoming naturalized under such circumstances is itself an act of treason The accused was sentenced to death, but the sentence was afterwards commuted and he subsequently received a pardon The most important case dealing with high treason in recent years was that of *Rex* v *Casement,* the trial at bar being reported 25 Cox C C 480, and the decision of the court of criminal appeal in the same volume on p. 503 Sir Roger Casement was charged with high treason during the World War, and it was there held by the court of criminal appeal, affirming the decision of the king's bench division at the trial at bar, that if a man is adherent to the king's enemies in his realm by giving to them aid and comfort in the realm, or if he is adherent to the king's enemies elsewhere, that is, by giving them aid and comfort elsewhere, he is in either case adherent to the king's enemies, and commits the offence declared to be high treason by the Treason Act 1351 It was also held by the king's bench division that if a man—a British subject—does any act which strengthens or tends to strengthen the enemies of the king in the conduct of a war against the king, or if he does any act which weakens or tends to weaken the power of the king and of the country to resist or attack the enemies of the king and the country, he commits the offence of giving aid and comfort to the king's enemies, and is guilty of high treason Sir Roger Casement was convicted, sentenced to death, and executed

No amount of residence abroad exempts a British subject from the penalty of treason if he bears arms against the king, unless he has become naturalized as the subject of a foreign State before the

outbreak of the war in which he bears arms. To become naturalized as the subject of an enemy during a war is (as decided in *Rex* v. *Lynch*) in itself an act of treason It is well established that an alien resident within British territory owes local allegiance to the Crown and may be indicted for high treason, and there are numerous instances of prosecution of foreigners for treason, the most recent being *de Jager* v. *Attorney-General of Natal* (1907, A.C. 326).

Court of Trial.—Four modes of trying high treason still remain, viz., impeachment, trial of a peer by his peers, trial by court-martial, and trial by jury on indictment before the High Court (generally at bar) or a court of assize or a special commission The offence is not triable at quarter sessions At common law and under the Act of 1543 a peer, and, by an Act of 1441, a peeress in right of her husband, are triable for treason before the House of Lords, or, when parliament is not sitting, in the court of the lord high steward.

Procedure.—In certain cases of treason the procedure on the trial is the same as upon a charge of murder Those cases, which are statutory exceptions from the statutory procedure prescribed for the trial of high treason and misprision thereof, are (*a*) Assassination or killing of the king, or any heir or successor of the king, or any direct attempt against his life or any direct attempt against his person whereby his life may be endangered or his person may suffer bodily harm (1800, 1817), (*b*) attempts to injure in any manner the person of the king (1842)

In all other cases of treason the procedure is regulated by Acts of 1695, 1708 and 1825 A copy of the indictment must be delivered to the accused ten days at least before his arraignment, with a list of the witnesses for the prosecution (1708) and a list of the petty jury, except in the High Court, where the petty jury list is to be delivered ten days before the trial (1825) The accused is entitled to be defended by counsel, and on application to the court may have two counsel assigned to him (1695), a right extended in 1746 to impeachments for treason Witnesses for the defence have since 1702 been examinable upon oath The accused may by the Criminal Evidence Act 1898 consent to be called as witness for the defence It is doubtful whether the wife or husband of the accused is a compellable witness for the Crown (*Archb Crim Pleading*, 27th ed, 477)

Prosecutions for treason must be begun within three years of the offence, except in cases of attempts to assassinate the king The rules as to the indictment are stricter than in the case of felony and misdemeanour much of the modern statutory power of amendment not extending to indictments for the graver offence No evidence may be given of any overt act not expressly stated in the indictment The accused is entitled to peremptory challenge of 35 of the jurors summoned for the petty jury, but they need not now be freeholders The accused can be convicted only on his own confession in open court, or by the oath of two witnesses either both to the same overt act charged, or one to one overt act and the other to another overt act of the same treason. If two or more treasons of different kinds are charged on the same indictment, one witness to prove one treason and another to prove another are not sufficient for a lawful conviction Persons charged with treason are not admitted to bail except by order of a secretary of State or by the High Court (k b d) or a judge thereof in vacation. Witnesses for the defence are examined on oath and their attendance is secured in the same way as that of witnesses for the Crown (1695)

Finally it must be noted that there can be no accessories before or after the fact to treason Every person who incites, aids or abets treason is a traitor, and must be indicted as a principal

Misprision of Treason.—This consists in the concealment or keeping secret of any high treason This offence was in 1552 declared to be high treason, but the former law was restored in 1553–54 It is an indictable common law misdemeanour, not triable at quarter sessions, and the procedure for the trial of misprision of treason is the same as in the case of high treason The punishment is imprisonment for life and forfeiture of the offender's goods and of the profits of his lands during his life The forfeitures are not abolished by the Forfeitures Act 1870 There is no case of prosecution of this offence recorded during the last century

The necessity of prosecutions for treason has been greatly lessened by a series of statutes beginning in 1744 which provide for the punishment as felonies of certain acts which might fall within the definition of treason, *e g*, piracies (1744), incitement to mutiny (1797), unlawful oaths, including oaths to commit treason (1797, 1812), and aiding the escape of prisoners of war (1812) By the Treason Act 1842 it is a high misdemeanour, punishable by penal servitude for seven years, wilfully to discharge, point, aim or present at the person of the king any gun or other arms, loaded or not, or to strike at or attempt to throw anything upon the king's person, or to produce any firearms or other arms, or any explosive or dangerous matter, near his person, with intent to injure or alarm him or to commit a breach of the peace The offence is one of the few for which flogging may be awarded

By the Treason Felony Act 1848, s 1, it was made a felony punishable by penal servitude for life within or without the United Kingdom to plot (*a*) to deprive or depose the king from the style, etc, of the imperial crown of the United Kingdom, (*b*) to levy war against the king in any part of the United Kingdom in order by force or constraint to change his measures or counsels or to put force or constraint on or to intimidate or overawe either or both houses of parliament, (*c*) to move or stir any foreigner with force to invade the United Kingdom or any of the king's dominions The plot to be within the Act must be expressed by publishing in printing or writing or by an overt act or deed For other offences more or less nearly connected with treason reference may be made to the articles LIBEL, OATHS, PETITION; RIOT, SEDITION

The Act of 1848 does not abrogate the Treason Act of 1351, but merely provides an alternative remedy But with the exception of the case of Lynch in 1903 and of Casement in 1916 all prosecutions in England for offences of a treasonable character since 1848 have been for the felony created by the Act of 1848 The procedure in the case of all the offences under the Act of 1848 is governed by the ordinary rules as to the trial of indictable offences, and the accused may be convicted even though the evidence proves acts constituting high treason. Principals in the second degree and accessories before the fact are punishable as principals, and accessories after the fact by two years' hard labour

(W F C; W DE B H)

UNITED STATES

The extent to which the crime of treason had been warped in early English history played an important part in restricting the character of the crime in America by constitutional means The United States Constitution expressly forbids Congress and the States from passing bills of attainder or ex post facto laws It further defines the crime of treason as follows "Treason against the United States shall consist only in levying war against them, or in adhering to their enemies, giving them aid and comfort No person shall be convicted of treason unless on the testimony of two witnesses to the same overt act, or on confession in open court. The Congress shall have power to declare the punishment of treason, but no attainder of treason shall work corruption of blood, or forfeiture except during the life of the person attainted" This definition embraces only treason against the United States Treason against a State is also possible and as such is governed by State laws or constitutions Treason against a State, however, usually involves an attempt to withdraw the State from the Union and thereby prevent the exercise of national sovereignty within the limits of the State and thus becomes merged in treason against the United States Consequently the crime of treason against a State is little known in American law

The constitutional definition of treason is, in part, taken from the old English Statute of 25 Edw. III Congress in 1790 and 1862 provided for its punishment by prescribing the death penalty as a maximum and a minimum penalty of five years' imprisonment and a $10,000 fine, provisions which have been carried forward into the existing laws (*U S Code, Tit 18*, §2) Congress has no power to enlarge the constitutional definition, though it may make other

offences which are treasonous in character felonies and punishable as such Thus misprision of treason, or the failure to disclose knowledge of the commission of acts of treason, is made a felony. (*U S. Code, Tit. 18, §3*), trading with the enemy, seditious utterances, insults to the flag, obstructing recruiting, and like offences have been made Federal crimes. None of these, however, carries the death penalty

The question of what acts constitute treason was brought to the forefront in the heated trial of Aaron Burr for treason in 1807 The opinion of Chief Justice Marshall in this case of *U.S.* v. *Burr*, 4 Cranch 470, 25 Fed Cas 2, sitting as circuit judge in the circuit court of Virginia, remains the landmark of American law upon the subject of treason Under the principles there laid down, levying war must comprise more than a conspiracy to make war or an intention to go to war. There must be an actual going to war, proved by open deed. The employment and exhibition of force thus becomes necessary. A secret furtive assembly without the appearance of force nor in a condition to make war, however treasonable its purpose, cannot constitute treason. It is not essential that any blow be struck provided that the assemblage be in a condition to use force and have the intention to carry out their purpose by violence A procurement to commit treason is also treason, for the American law accepts the English principle that what will make a man an accessory in felony makes him a principal in treason But in such a case it is the act of procurement of the treasonous assemblage, not the acts of the assemblage, which is the overt act of treason that must be testified to by two witnesses in order to convict him. The difficulty of proving the procurement in this manner, as procurement is generally a secret transaction, has made conviction for procurement of treason a practical impossibility. This ruling of Chief Justice Marshall, severely criticized at the time, was responsible for Burr's acquittal upon the charge of treason

The second element in the constitutional definition of treason, adhering to the enemies of the United States and giving them aid and comfort has caused less difficulty Furnishing the enemy with such facilities as are needed for the prosecution of war, such as ammunition, supplies, and means of transportation, constitutes treason. The acts which constitute treason need not be done by a citizen of the United States, but inasmuch as any alien temporarily resident within the United States and under the protection of the sovereign owes it a duty of allegiance so long as he remains within the United States, his breach of allegiance can constitute treason *Carlisle* v *United States*, 16 Wall 147 (1872).

Prosecutions for treason, as any Federal crime, are cognizable solely by the Federal courts Such prosecutions occurred mainly during three periods in American history During the American Revolution they were cognizable only by the State courts, no Federal courts for the trial of criminal cases being in existence at the time. The Whiskey Rebellion in Pennsylvania, shortly after the organization of the Federal Government, brought forth a few cases. The opposition of the New England States to the War of 1812 brought to pass additional prosecutions for treason The Civil War, of course, was most prolific of treason, but the President's proclamation of 1868 of pardon and amnesty brought all treason prosecutions to an end The World War developed no treason cases, though numerous prosecutions for seditious utterances and conduct were initiated under the Espionage and Trading with the Enemy Acts. The most famous cases of treason concerned Aaron Burr, John Brown of Harper's Ferry fame, and Jefferson Davis, president of the Confederate States Brown was convicted and hanged; the President's proclamation of pardon reprieved Davis before he came to trial (J M. LA.)

TREASURE TROVE, the legal expression for coin, bullion, gold or silver articles, found hidden in the earth, for which no owner can be discovered (*See* CORONA)

As feudalism spread over Europe and the prince was looked on as the ultimate owner of all lands, his right to the treasure trove became, according to Grotius, *jus commune et quasi gentium*, in England, Germany, France, Spain and Denmark In England for centuries the right to treasure trove has been in the Crown, who may grant it as a franchise It is the duty of the finder, and indeed of any one who acquires knowledge, to report the matter to the coroner, who must forthwith hold an inquest to find whether the discovery be treasure trove or not. Concealment is an indictable offence In the statute *De officio coronatoris* 1276 the coroner is enjoined to inquire as to treasure trove, and the Coroners Act of 1887 continues this power as heretofore In Scotland the law is similar. Such articles are presumed to have once had an owner, and, in his absence, they belong, not to the finder but to the King. Their concealment is not a criminal offence unless accompanied by intent to appropriate In India the Treasure Trove Act (16 of 1878) defines treasure as "anything of value hidden in the soil" The finder has three-fourths and the owner of the land one-fourth.

In the United States the common law, following English precedent, would seem to give treasure trove to the public treasury, but in practice the finder has been allowed to keep it In Louisiana one-half goes to finder and one-half to owner of land. Modern French law is the same, as it is also in Germany, Italy and Spain.

See Blackstone's *Commentaries;* J. Chitty, *Prerogatives of the Crown* (1820), J. Rankine, *Landownership* (new ed., 1909); J. Murray, *Archaeological Survey of the United Kingdom* (1896), containing copious references to the literature of the subject, R. Henslowe Wellington, *The King's Coroner* (1905–06).

TREASURY DEPARTMENT: *see* GOVERNMENT DEPARTMENTS

TREATIES. A treaty is a contract between two or more States The word is derived, through the French *traité* (Fr *traiter*, to negotiate) from the Latin *tractatus*, the term which from the end of the 17th century began to be used in diplomacy instead of the older technical terms *conventio publica* and *foedus* According to modern diplomatic usage the term "treaty" is confined to the more important international agreements, those of lesser or subordinate importance being embodied in "conventions" There is, however, no difference in structure between a treaty and a convention, and for the purposes of this article they may be treated as the same thing

Form.—In making a treaty it is not essential to employ any special form, and it need not on the face of it even appear to be a contract, but may take the form of a joint declaration or of an exchange of notes (as in the case of the "gentlemanly agreement" between Great Britain and the United States, in 1818, for mutual disarmament on the Great Lakes). It is, however, customary to draw up all important treaties on a fixed plan. First comes the preamble, giving the names and styles of the high contracting parties, a statement of the general objects which they have in view, the names and official designations of the plenipotentiaries charged with the negotiation, and a statement that their full powers have been verified Then follow the articles containing the stipulations agreed upon If the treaty is concluded for a definite period, this is next stated or, if it be in form perpetual, there may be a provision inserted that either party may "denounce" (*i e*, give notice to terminate) the treaty Next follows an article providing for ratification and for the time and place for the exchange of ratifications At the end is a clause stating that "in witness whereof (*en foi de quoi*) the respective plenipotentiaries have affixed their names and seals." The signatures follow, with the place and date.

Nearly all conventions likewise begin with a preamble, and in all other respects are similar to treaties. To both treaties and conventions "Additional Articles" are often appended and signed by the plenipotentiaries, with the declaration that they have the same force and value as if they had been included in the body of the treaty or convention.

Classification of Treaties.—International jurists have classified treaties on a variety of principles. For instance, a distinction has been drawn between those which represent a definite transaction such as a cession of territory (*Rechtsgeschäft*) and those which seek to establish a general rule of conduct, such as the "renunciation of war" (*Rechtssatz*). They may be classified in a more practical way according to their object, as follows: 1) political, such as treaties of peace, of alliance, of cession of territory, for arbitration, etc.; 2) commercial, including consular

and fishery conventions, and slave trade and navigation treaties; 3) social, such as the conventions establishing the international telegraphic union (1865), the universal postal union (1874), the international bureau of weights and measures (1875) and the railway traffic union (1890); 4) relating to criminal justice, *e.g.*, extradition (*q.v.*); 5) relating to civil justice, *e g*, the protection of trade-marks (Paris, 1883) and copyright (Bern, 1886), the execution of the judgments of foreign courts, etc.; 6) treaties embodying rules of international law hitherto observed, if at all, only by custom, such as methods for the peaceful settlement of international disputes (Hague Convention, 1899) or the humane conduct of war (Geneva Conventions, 1864 and 1906). In practice, however, it is of course often impossible to assign a particular treaty to any one of these classes

Requisites.—1) A treaty, like a contract in private law, is only valid when made between competent parties, *i.e*, sovereign states. This rule still holds good, though since the World War the issue has been somewhat obscured by the rather loose use of the words "sovereign" and "treaty" Thus the Articles of Agreement between the British Government and the "representatives of Southern Ireland" are commonly spoken of as the "treaty," and this has been in some quarters taken as implying the recognition of the sovereignty of the Irish Republic. The "sovereignty" now admitted in the British dominions is, however, so far as external relations are concerned, limited by agreement. The dominions are, in fact, what is known as "semi-sovereign," since they can only conclude conventions with foreign States on matters within their own competence. Moreover, this apparent departure from the accepted rule is more apparent than real, since the sovereign power is still theoretically vested in the king, in whose name all such conventions are executed The question where the treaty-making power resides in each State is answered by the municipal law in that State. In Great Britain it resides in the executive. In the United States treaties are negotiated by the President and the State Department, but can only be concluded "with the advice and consent of the Senate," and in practice the Senate shows itself very jealous of its right to amend treaties before ratification. In many countries, on the other hand, the treaty-making power is shared between the executive and the legislature only for certain purposes; in France, *e.g*, treaties of peace, treaties of commerce, those involving financial obligations or relating to the rights of French citizens in foreign countries are not valid until ratified by a majority in both chambers

2) A treaty, to be valid, must be the expression of an agreement. Unlike a private contract, however, it is not voidable on proof that one of the parties to it was subject to duress, but only if it can be proved that the individual negotiator has been so subject. Thus a treaty imposed by the victor upon the vanquished remains valid, though signed under pressure of force.

3) In modern practice a treaty, though executed by agents with full powers, is not valid until it has been ratified. Ratification, though formerly not thought to be necessary for "declarations," such as the Declaration of Paris in 1856, was expressly stipulated in those of the conferences of 1899 and 1907.

4) The question of the language employed in treaties at one time caused trouble In the 16th century all international treaties were drawn up in Latin, more rarely in French, and it was not till the 18th century that the latter was generally accepted (except by the pope and the emperor) as the language of diplomacy (the Anglo-French commercial treaty of April 11, 1713 was in Latin). The present practice is that, when treaties or conventions are concluded between more than two Powers they are drawn up in French, but when between two Powers only, there are usually two texts, one in each language, both of which are signed by the plenipotentiaries of the two parties. Such bi-lingual treaties are sometimes accompanied by a third version in French, to be decisive in case of a difference of opinion arising as to the precise meaning of the language of the other texts.

5) The making of a treaty is sometimes accompanied by acts intended to secure its due performance, *e.g.*, the occupation of the German Rhine Provinces by the Allied Powers pending the payment of the reparations imposed by the Treaty of Versailles.

6) Art XVIII of the Covenant of the League of Nations lays down that every treaty or international agreement entered into after the signature and ratification of the Treaty of Versailles by any member of the League shall be forthwith registered with the Secretariat and shall as soon as possible be published by it; and that no such treaty or international agreement shall be binding until so registered.

Duration of Treaties.—The question of when, and in what circumstances, the obligations incurred under treaties, nominally perpetual, come to an end has been the subject of much debate. A treaty may lapse naturally by the destruction of one of the States party to it, or by the object of the agreement ceasing to exist; or it may be denounced by one of the parties under powers reserved in the treaty itself Treaties are also in most cases suspended, if not terminated, by war between the contracting parties, and are therefore usually revived in express terms in the treaty of peace. More debatable is the proposition upheld by certain jurists, *e.g*, Bynkershoek, that the condition *rebus sic stantibus* is implicit in every treaty. This is laid down by Bismarck, in his *Reminiscences*, as self-evident, and he adds that "treaties are only valid so long as they are reinforced by the interests of the parties to them." In practice this was certainly often the case and—as is pointed out in the latter part of this article—no alteration was made in this respect by the London Protocol of 1871, which laid down the principle that "no Power can liberate itself from the engagements of a treaty, nor modify the stipulations thereof, unless with the consent of the contracting Powers, by means of an amicable agreement" Art. XIX. of the Covenant is an attempt to meet the difficulty It lays down that "the Assembly may from time to time advise the reconsideration by members of the League of treaties which have become inapplicable" This provision, though it suggests no more than advice backed by combined moral pressure, may be open to the objection that it tends to keep alive the agitation among the peoples discontented with the settlements made under certain treaties, by suggesting that these are not to be considered as final On the other hand, it may be argued that it provides a safety-valve for discontent by holding out the hope of a revision otherwise than by war.

The Inviolability of Treaties.—Since the whole structure of international relations, as regulated by law, is based upon treaties, it follows that anything that tends to weaken men's faith in, and respect for treaties must loosen this structure. For this reason it is all-important that treaties, once made, should be kept in the letter and in the spirit; and this again involves the principle that nothing should be included in a treaty which the parties to it are not reasonably sure that they and their successors will be able to carry out in any circumstances This was a principle firmly maintained by British statesmen during the 19th century, from Pitt and Castlereagh onwards, and led them to avoid commitments "for eventual exertion" in circumstances which could not be foreseen. For the same reason, in the days of the old diplomacy, there was in the language of treaties of peace, and of diplomatic intercourse generally, a studied avoidance of anything that might keep open old sores by any unnecessary wounding of the feelings of the vanquished Thus, while the preambles to treaties of peace were perhaps apt to lay overmuch stress on the complete cordiality of the restored relations, and so be open to the charge of being "false-friendly," they at least made it clear that the articles of the treaty which followed were the conditions on which old scores would be completely wiped out In this respect the Treaty of Versailles of 1919, *e.g.*, compares unfavourably with the Treaty of Versailles of 1783. In the former the defeated nation was compelled to confess its "war-guilt," whether it believed itself guilty or not, and the terms of the penance which was to be the price of its restoration to the communion of nations were built into the very foundations of the new international organization This has rankled in the minds of the Germans, and so has neither made for peace nor for that respect for treaty-obligations on which peace is based The framers of the treaty of 1783 were wiser. Art I. of the treaty ends with the words: "There shall be complete oblivion of and amnesty for all that may have been done or committed before or during the war which has now

come to an end."

Many treaties containing what were technically known as "transitory conventions" with reference to recognition, boundaries or cessions of territory have become, as it were, the title-deeds of the nations to which they relate This may be said to date from the treaties of Osnabrück and Munster (Westphalia) in 1648, which were the work of the first international congress, and were recognized as giving a new juridical basis to the territorial system of Europe Although, in the 18th century, treaties were more honoured in the breach than the observance, it was considered expedient to veil even the most flagrant acts of aggression under legal forms, as in the case of the three partitions of Poland which, as Gentz observed, set an unhappy precedent for the aggressions of Revolutionary France The treaties concluded between the Powers after the downfall of Napoleon (I Paris, 1814, Vienna Final Act, 1815, II Paris, 1815, and Frankfurt, 1819), represented an attempt to reorganize the European territorial system on a sound basis, by endowing the reconstituted States with unimpeachable title-deeds and ensuring their stability by establishing a balance of power between them Other treaties —the treaty of Chaumont in March 1814, and the treaty of alliance of Nov. 20, 1815 which was based upon it—provided for the continuance of the Quadruple Alliance for the purpose of watching over and safeguarding the settlement thus made And, though this "federal system" for Europe broke down for various reasons (*see* EUROPE), the idea of "the treaties" as the foundation of the European system, and of the "Concert of Europe" as their guardian, survived long enough to secure an unprecedented period of peace The principle that the treaties could not be altered without the consent of "Europe" was also more or less effectively asserted. effectively in the case of the treaties of 1831 and 1839 which separated Belgium from the Netherlands, ineffectively in the protests of France and Great Britain against Russia's violation of the terms of the Treaty of Vienna by her treatment of the Poles in 1830 and 1863

The principle of the solidarity of Europe in the matter of territorial changes was even extended to the questions arising out of the disintegration of the Ottoman empire, which had been excluded from the treaties of 1815; and the Concert of Europe survived in the Eastern Question (*q.v.*) long after the results of the Italian war of 1859 and of the wars of 1864, 1866 and 1870–71 had blown the Vienna settlement to pieces Thus the partition of Turkey was regulated by the great Powers, or some of them, in the treaties of London, 1832, 1863, 1864, and of Constantinople, 1881, with reference to Greece; and by the treaties of Paris 1856, London 1871, Berlin 1878, London 1885, with reference to Montenegro, Rumania, Serbia, Bulgaria and the navigation of the Danube As the result of the World War, these settlements have undergone very extensive and important changes; but they still have an effective existence, as the ultimate title-deeds of the Balkan States

In general, the history of treaties and treaty-making during the century that followed the Congress of Vienna showed a notable advance in the sense of international obligation as compared with the standpoint of the 18th century That the system evolved was very far from satisfactory was proved all too clearly by the World War. The League of Nations, although based on the somewhat unstable foundations of the Treaty of Versailles, is a bold attempt to substitute for 19th century methods a system better calculated to preserve peace (W. A. P.)

POST-WAR DEVELOPMENTS

The question of the sanctity or renewal of treaties is always a very serious one at the close of a war. But before the World War many great authorities held the opinion, which was expressed by some (*e g*, Professor Oppenheim) actually during the War, that the apparent "breaking-up of laws," which takes place in war is usually succeeded by a stronger emphasis upon them when peace is attained

The sanctity of treaties is a dogma open to several interpretations. For instance, many international jurists, including Bethmann-Hollweg, hold that Germany committed a breach of international law in invading Belgium in defiance of the treaty of 1839. Others, among whom is Sir Ernest Satow, an authority on both the theory and practice of diplomacy, would maintain that Germany by violating Belgium merely gave any other guaranteeing State the right to attack her. In other words, Germany risked her existence but did not specifically break international law. The difference between these two views is that the first relies upon custom, etc, to establish the sanctity of treaties, and the latter upon force The difficulty of the first view lies in the fact that custom may change For instance, it was thought to have been established in 1871 that no great Power which had joined with other great Powers in signing a treaty could violate the provisions of that treaty without the consent of the other signatories, *i.e.*, without a European conference. But in 1908 Austria-Hungary violated Article 25 of the Treaty of Berlin (1878) by annexing Bosnia and Hercegovina, and refused the demand for a conference There can be little doubt that this principle had been abandoned before 1914 The peacemakers of 1919 therefore tried to set up a state of things whereby the sanctity of treaties would be upheld by the general co-operation of all states President Wilson condensed this aspiration into a single sentence. "What we seek is the rule of law sustained by the organized opinion of mankind."

League and Regional Guarantees.—Some treaties which had proved impotent to guard certain countries, as, *e g*, those neutralizing Belgium and Luxembourg, were abrogated altogether (*cf* Articles 31, 40–1 of the German, Article 83–4 of the Austrian and Articles 67–8 of the Hungarian Treaties) The League of Nations Covenant, however, attempted to give a general guarantee of territorial integrity and independence to all the members of the League. This general guarantee, embodied in Article 10 of the Covenant (*see* LEAGUE OF NATIONS), has, on the whole, been rather watered down in its interpretation It has, in fact been succeeded by a system of special or regional guarantees Thus in the Treaty of Locarno (signed Dec 1, 1925), the demilitarization of the Rhineland, enacted by the Treaty of Versailles, Articles 42–44, was guaranteed by France, Great Britain, Germany and Italy This guarantee became effective on the admission of Germany to the League of Nations In case of need Great Britain guarantees France against the unprovoked attack of Germany, and *vice versa* Similar regional guarantees are given by France to Poland and to Czechoslovakia. The "Little Entente Treaties" (of which the first was signed Aug. 4, 1920) constitute a system of regional and special guarantees between Czechoslovakia, the Serb-Croat-Slovene kingdom and Rumania to preserve the territorial limits laid down in the treaties of St Germain, Trianon and Neuilly (*see* LITTLE ENTENTE) Similarly it was recognized in Article 26 of the Covenant that the Monroe Doctrine was "a regional understanding," which meant a practical admission by the principal Powers that the United States guaranteed other states on both American continents against the aggression of non-American neighbours.

There can be no doubt that many smaller States now enjoy greater advantages under the Covenant and special and local guarantees than did the neutralized States of the 19th century The Covenant was successfully invoked by Great Britain on behalf of Albania against the Serb-Croat-Slovene kingdom in 1921, and by Greece against Italy in the matter of Corfu in 1923. Also the inclusion of Germany in the League has in itself strengthened the system

Compulsory Arbitration.—It is a singular and interesting fact that many smaller Powers have signed the compulsory jurisdiction clause in the protocol establishing the Permanent Court of International Justice. If both litigating Powers have signed the compulsory clause a peaceful settlement can be imposed by the court. There can be no doubt that such smaller Powers as cannot depend on the guaranteed protection of larger ones feel that they are safest in this way. And it is an interesting fact that Denmark is the first State in Europe since the War to propose the reduction of her armed forces to the level of mere police. and to trust to the justice and opinion of the world for support in time of need

If it continues, the Permanent Court will in time create a standard of international justice which it can impose upon all those who have signed the compulsory clause. Were it possible, or certain, that the principal Powers would also sign the compulsory clause the peace of the world could be reasonably assured.

Abrogation or Renewal of Treaties After War.—Highly technical points are raised by this question which, though less generally interesting than those already mentioned, are none the less of some importance for the future of diplomacy. Treaties are of two kinds, bilateral between two states, multilateral between several states It is clear that in the case of bilateral treaties when State A can force State B to sign a treaty of peace after the war, A can renew or refuse to renew with B all the pre-war treaties that she chooses Germany did not question this right in bilateral treaties In the case of multilateral treaties the Allies claimed the right to refuse permission to Germany and to the enemy Powers to keep in force treaties with states not actually then engaged in the War, as, *e g*, Soviet Russia, or with neutrals who had not been in the War at all though they had severed diplomatic relations with Germany, as, *e g*, Peru and Ecuador In reply to the German protests, the Allies maintained and inserted in the German and other treaties their right to "reapply" all "multilateral treaties which seemed to them to be compatible with the new conditions arising out of the War," and "to indicate which of these treaties with Germany they intend to revive or allow to be revived" The Allies particularly insisted on making Germany grant for limited periods to the Allies themselves, or to some of them, certain terms already granted to her friends or neutrals. But they did not demand that Germany should be prevented from negotiating new instruments with states other than the Allies *after certain limited periods* had passed; *e g*, Article 268, of German Treaty Nor did Germany fail to avail herself of her power After having been compelled to abrogate the treaties of Brest-Litovsk with Soviet Russia, she negotiated the Treaty of Rapallo with them on April 16, 1922 This step evoked much protest from the Allies, and it was contended that Germany had not the right to do it

The use of power by the victor to enforce on his defeated antagonist the abrogation of treaties with neutrals is not in itself desirable; but it does not appear, on the whole, that such power, even if abused at the moment of victory, is likely to be abused for very long The special grievances or difficulties thus created by any abuses in 1919 will be well compensated for if the settlement of Europe has in fact brought a greater sense of security and permanence, whether through the agency of the League, of regional guarantee or of the Court of International Justice *See* also COMMERCIAL TREATIES (H W V T)

BIBLIOGRAPHY —L Oppenheim, *International Law*, 3rd ed (1920); Sir E M Satow, *Diplomatic Practice*, 2nd ed (1922) Each of the Peace treaties of 1919 contains a section headed "Treaties" The passages on Treaties in the *German Observations* on the draft Treaty and the *Allied Reply* are quoted in H W. V Temperley, ed *History of the Peace Conference of Paris*, vol 6 (Institute of International Affairs, 1924), 322–326, and these are authoritative expositions of the rival points of view *See* also U S A Congress, Library of, *List of References on the Treaty-Making Power* (Washington, 1920); D. F. Myers, *Manual of Collections of Treaties and of Collections relating to Treaties* (Harvard, 1922), C. Saavedra Lamas, *Traités internationaux de type social* (1924), A. Goellner, *La Revision des traités sous le régime de la Société des Nations* (1925).

RENUNCIATION OF WAR

The most important general treaty concluded since that of Versailles is the Pact of Paris or "Kellogg Pact," a multilateral treaty for the renunciation of war as an instrument of national policy (*see* OUTLAWRY OF WAR), signed at Paris by the representatives of many nations on Aug 27, 1928, and ratified by the American Senate on Jan. 15, 1929 Under this instrument the signatory Powers renounce war "as an instrument of policy" and "condemn" it as a means for settling international differences.

Whatever the moral force of such a declaration of principle may have, its practical value must not be exaggerated. It does not —as Professor Shotwell has pointed out—involve the "outlawry" of war, since it provides no sanctions. The sovereign "right" to make war is not renounced, and the right to conduct a war of defence is safeguarded, which—in the absence of any definition of "aggression"—leaves a loophole for the evasion of the obligations imposed by the treaty. Nor can the claim be admitted that the treaty introduces a new principle into international law Essentially, the Pact is much the same thing as the Act of the Holy Alliance in 1815 or the Declaration of Aix-la-Chapelle in 1818, namely, a solemn undertaking by the Powers to ensure peace The only difference is that the renunciation of war as an instrument of policy, which was implicit in the earlier acts, is explicit in the Pact.

It must be remembered, too, that though the sovereign State was regarded by the old jurists (*e g*, Vattel) as the sole judge of its own actions, it did not follow that wars of mere aggression were looked upon as legitimate This is made clear by the French jurist Jean Domat in his *Les lois civiles* (1689), where he distinguishes between wars which are, so to speak, ordeals by battle waged by the sovereigns of two nations who, "being independent of one another and having no judges in common, do justice for themselves by force of arms, when they cannot or will not have mediators to make peace between them," and wars "which are the outcome of pure violence and of the aggressions of princes or states upon their neighbours."

That this distinction was recognized by sovereigns as well has been pointed out above (*Inviolability of Treaties*) Even Napoleon, the arch-aggressor, declared solemnly, in the *Memoirs* dictated at St. Helena, that all his wars were defensive It may be suggested, then, that the importance of the Pact of Paris lies less in the enunciation of a principle than in the practical considerations which inspired it; namely, that in modern conditions war is too dangerous to use as an instrument of policy and too expensive and uncertain to employ as a method of international litigation

See J T Shotwell, *War as an Instrument of National Policy* (New York and London, 1929)

TREATY, COMMERCIAL: *see* COMMERCIAL TREATIES

TREBIA (mod *Trebbia*), a river of Cisalpine Gaul, a tributary of the Padus (Po), into which it falls some 4m west of Placentia (Piacenza) Its valley is followed past Bobbio by the modern high road from Piacenza to Genoa (88m) It is remarkable for the victory gained on its banks by Hannibal over the Romans in 218 B C Kromayer's investigations make it clear that Polybius's account, according to which the battle took place on the left bank of the river, is to be preferred to that of Livy (see *Antike Schlachtfelder*, iii 1 [Weidmann, 1914], 47 *sqq*) T Frank in *Journal of Roman Studies*, ix 202 (1919), suggests that the Placentia referred to in both accounts lay west of the river, *i e*, some 15 miles west of the later Placentia, refounded in 190.

Scipio (the father of Scipio Africanus) had advanced to meet Hannibal two days' march west of Pavia, but was defeated in a cavalry engagement, and in a forced night march recrossed the Ticinus and the Padus (probably at Placentia itself) and then took up a new position near Clastidium on the south bank of the latter river, about 20m west of Placentia while Hannibal, finding himself unable to cross the Ticinus, marched westward up the Padus until he could cross it, and so came up with the Romans and offered battle, which was, however, not accepted, and he therefore encamped five miles away from them Scipio, however, in consequence of the desertion of over 2,000 of his Gaulish auxiliaries, retreated to the further bank of the Trebia, where he was joined by Sempronius, the other consul, who had brought his army from Ariminum Hannibal followed them and encamped once more about 4m. from them: and as a decisive victory was imperative, in order that he might win over the Gauls to his side, and he had about 40,000 men, or as many as the two armies together, he did nothing to prevent their junction A successful cavalry skirmish with the Carthaginian foragers encouraged Sempronius to overcome his colleague's objections to a general engagement, and the Romans marched across the Trebia. The battlefield was almost flat, but on the south was rising ground traversed by a number of fairly deep, broad stream-beds, in one of which Hannibal concealed a force of 2,000 men under his young brother Mago, which was to have a decisive effect on the fortunes of the day At the same time he sent his 8,000 light troops out to cover the advance

of his main body of infantry, consisting of 20,000 Iberians, Celts and Libyans, while his cavalry (over 10,000, including his Celtic allies) were placed on the wings, with the elephants in advance of them. The Roman cavalry was soon driven back, and the Carthaginian light troops, Numidian cavalry and elephants attacked the Roman infantry on the flanks, so that the wings were put to flight and driven into the river, while Mago's force suddenly fell on the rear of the Roman centre and worked destruction on the rear ranks. The front ranks of the Roman centre, on the other hand, to a number of some 10,000 men broke through the Carthaginian centre with great slaughter, but seeing that the wings had been completely driven back, they took no further part in the battle, but marched in good order into Placentia, where they were joined by the cavalry. The greater part of the rest of the army, entirely surrounded by superior numbers, met its death in the river itself. The battle has been rightly described as a Cannae on a small scale, and the similarities are certainly striking, as will be seen by a comparison of the two accounts. (T. A.)

TREBIZOND (Gr. *Trapezus*), a city of Asia Minor, situated on the Black Sea, near its south-eastern angle. From the time of its foundation as a Greek colony to the present day it has always been a considerable emporium of commerce, and it was for two centuries and a half the capital of an empire. Its importance is due to its command of the point where the chief trade route from Persia and Central Asia to Europe, over the table-land of Armenia by Bayezid and Erzerum, descends to the sea Its safety also was secured by the barrier of rugged mountains (7,000 to 8,000 ft.) which separates its district from the rest of Asia Minor. So complete is the watershed that no streams pass through these ranges, and there is hardly any communication in this direction between the interior of Asia Minor and the coast. For the same reason, together with its northern aspect, the climate is humid and temperate, unlike that of the inland regions, which are exposed to great extremes of heat in summer and cold in winter. The position which was occupied by the Hellenic and mediaeval city is a sloping table of ground (whence the original name of the place, Trapezus, the "Table-land"), which falls in steep rocky precipices on the two sides, where two deep valleys, descending from the interior, run parallel at no great distance from one another down to the sea. The whole is still enclosed by the Byzantine walls, which follow the line of the cliffs and are carried along the sea-face; and the upper part of the level, which is separated from the lower by an inner cross wall, forms the castle; while at the highest point, where a sort of neck is formed between the two valleys, is the keep which crowns the whole. On each side, about half-way between the keep and the sea, these ravines are crossed by massive bridges, and on the farther side of the westernmost of these, away from the city, a large tower and other fortifications remain. The area of the ancient city is now called the Kaleh; eastward of this is an extensive quarter, and beyond this again a low promontory juts northward into the sea, partly covered with the houses of a well-built suburb, which is the principal centre of commerce. The harbour lies on the eastern side of this promontory, but it is an unsafe roadstead, being unprotected towards the north-east and having been much silted up, so that vessels cannot approach within a considerable distance of the shore. From here the caravans start for Persia. The population in 1927 was 60,975.

History.—The city of Trapezus was a colony of Sinope, but it first comes into notice at the time of the Retreat of the Ten Thousand, who found repose there. Alexius Comnenus escaped into Asia, and, having collected an army of Iberian mercenaries, entered Trebizond, where he was acknowledged as the legitimate sovereign, and assumed the title of Grand Comnenus. The empire thus founded continued to exist until 1461, when the city was taken by Mohammed II Trebizond was able to defy both the Seljuks and the Ottomans, and to maintain its independence against the emperors of Nicaea and Constantinople. The imperial family were renowned for their beauty, and the princesses of this race were sought as brides by Byzantine emperors of the dynasty of the Palaeologi, by Western nobles, and by Mohammedan princes; and the connections thus formed originated a variety of diplomatic relations and friendly or offensive alliances. The palace of Trebizond was famed for its magnificence, the court for its luxury and elaborate ceremonial, while at the same time it was frequently a hotbed of intrigue and immorality. The Grand Comneni were also patrons of art and learning. From time to time the emperors of Trebizond paid tribute to the Seljuk sultans of Iconium, to the grand khans of the Mongols, to Timur the Tatar, to the Turkoman chieftains, and to the Ottomans, but by means of skilful negotiations they were enabled practically to secure their independence. We find them also at war with many of these powers, and with the Genoese, who endeavoured to monopolize the commerce of the Black Sea. The city was several times besieged, the most formidable attack being that which occurred in the reign of Andronicus I., the second emperor, when the Seljuks, under the command of Melik, the son of the great sultan Ala-ed-din, first assaulted the northern wall in the direction of the sea, and afterwards endeavoured to storm the upper citadel by night. They failed, however, in both attempts; and in the latter, owing to the darkness, and to the occurrence of a violent storm which suddenly swelled the torrents in the ravines, their force was thrown into inextricable confusion, and they were compelled to abandon their camp and make the best of their escape from the country. So great was the strength of the fortifications that Mohammed II. might have experienced much difficulty in reducing it, had it not been for the pusillanimous conduct of David, the last emperor, who surrendered almost unconditionally

Ancient Memorials.—Several interesting monuments of this period remain at Trebizond in the form of churches in the Byzantine style of architecture. One of these is within the area of the old city, viz, the church of the Panaghia Chrysokephalos, or Virgin of the Golden Head, a large and massive but excessively plain building, which is now the Orta-hissar mosque On the farther side of the eastern ravine stands a smaller but very well proportioned structure, the church of St. Eugenius, the patron saint of Trebizond, now the Yeni Djuma djami, or New Friday mosque. Still more important is the church of Haghia Sophia, which occupies a conspicuous position overlooking the sea, about 2 m. west of the city. The porches of this are handsomely ornamented, and about 100 ft. from it rises a tall campanile, the inner walls of which have been covered in parts with frescoes of religious subjects, though these are now much defaced. But the most remarkable memorial of the middle ages that exists in all this district is the monastery of Sumelas, which is situated about 25 m from Trebizond, at the side of a rocky glen, at a height of 4,000 ft above the sea Its position is most extraordinary, for its occupies a cavern in the middle of the face of a perpendicular cliff 1,000 ft high, where the white buildings offer a marked contrast to the brown rock which forms their setting. It is approached by a zigzag path at the side of the cliff, from which a flight of stone steps and a wooden staircase give access to the monastery An antiquity of 1,500 years is claimed for the foundation of the monastery, but it is certain that the first person who raised it to importance was the emperor Alexius Comnenus III. of Trebizond who rebuilt it in 1360

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TRÉBUCHET, a mediaeval siege engine, employed either to batter masonry, or to throw projectiles over walls It was developed from the post-classical Roman *onager* (wild ass), which derived its name from the kicking action of the machine. It consisted of a frame placed on the ground to which a vertical frame of solid timber was rigidly fixed at its front end. Through the vertical frame ran an axle, which had a single stout spoke; on the extremity of the spoke was a cup to receive the projectile. In action the spoke was forced down, against the tension of twisted ropes or other springs, by a windlass, and then suddenly released. The spoke thus kicked the crosspiece of the vertical frame, and the projectile at its extreme end was shot forward. In the trébuchet

the means of propulsion was a counter-weight. The axle which was near the top of a high strutted vertical frame served as the bridge of a balance, the shorter arm of which carried the counterweight and the longer arm the carrier for the shot. An alternative name for the trébuchet is the mangonel (*mangonneau*). (*See* also ENGINES OF WAR.)

TREDEGAR, an urban district of Monmouthshire, England, on the Sirhowy, 7 m. E.N.E. of Merthyr Tydfil; on the G.W R. and L.M S with a station Pop. (1921) 25,110 It stands about 1,000 ft. above sea level and owes its existence to the establishment in the beginning of the 19th century of important iron works. With the use of coal for smelting purposes the region developed industrially. Since the beginning of the 20th century, remoteness from the sea has affected the iron industry and coal exporting became more important, although this was seriously affected by the trade depression following the World War.

TREE, SIR HERBERT BEERBOHM (1853–1917), English actor and manager, was born in London, on Dec. 17, 1853, the son of Julius Beerbohm, a London merchant of German parentage; his half-brother, Max Beerbohm (*q v.*) became well known as a writer and caricaturist. Taking the stage name of Beerbohm Tree he made his first professional appearance in London in 1876 He made a striking success in 1884 as the curate in *The Private Secretary.* In September 1887 he became lessee and manager of the Haymarket theatre, London, where his representations of melodramatic "character" parts, as in *Jim the Penman, The Red Lamp* and *A Man's Shadow,* were highly successful. He played in many modern dramas, such as H A Jones's *Dancing Girl,* but also in romantic parts such as Gringoire, and in the production of so essentially a literary play as Henley's *Beau Austin;* and in classic parts his ability as a comedian was shown in *The Merry Wives of Windsor,* in which he played Falstaff, and as a tragedian in *Hamlet;* his presentations of Shakespeare carried further forward the improvements in staging inaugurated at the Lyceum under Irving In 1897 Tree moved to the new Her Majesty's theatre, where his chief successes were in Stephen Phillips's poetical dramas, and in his splendid revivals of Shakespeare (especially *Richard II.* and the *Merchant of Venice*) The magnificence of the mounting, the originality and research shown in the "business" of his productions, and his own versatility in so many different types of character, made his management memorable in the history of the London stage In the year 1907 Tree established a school of dramatic art, for the training of actors, in London; and in this and other ways he was prominent in forwarding the interests of the stage He was knighted in 1909 In 1913 he published *Thoughts and Afterthoughts,* a book of essays Tree died in London on July 2, 1917.

See Max Beerbohm, *Herbert Beerbohm Tree* (1920); Lady Tree, *Herbert and I* (1920).

TREE. The species to which the name "tree" can be given are treated under their individual titles, *e.g*, oak, ash, elm, etc.; the articles FIR and PINE treat of two large groups of conifers; general information is provided by the articles PLANTS and GYMNOSPERMS; tree cultivation will be found under FORESTS AND FORESTRY and HORTICULTURE; and the various types of tree whose wood is useful under TIMBER.

TREE-BEAR, a name given in west Africa to the tree hyrax (*Dendrohyrax*). *See* HYRACOIDEA.

TREE BURIAL. Among the Andamanese, burial upon a platform placed in a tree is an honourable form of burial, and adopted only in the case of a man or woman dying in the prime of life. It is not clear whether this honour is reserved for those who have had children—the point may be significant. A tree sometimes used for this purpose is *Ficu Laccifera,* and the belief of the natives is apparently that the souls of unborn children live in the Ficu trees, and that if a baby dies before it has been weaned its soul goes back to the tree. (*See* A. R Brown, *The Andaman Islanders* [1922].)

In Australia tree burial is forbidden to those who violate the law of exogamy—who are thereby excluded from reincarnation. In Indonesia "the position with regard to tree burial may be put in this way, that wherever a myth of origin exists which states that the first men came from trees or bamboos, then it will generally be found that the dead are placed in trees or disposed of in a way derived from tree disposal" (W. J. Perry, *Folklore,* xxvi., pt. 2, p 147) There are cases of tree burial in Central India among the primitive Gonds—the semi-Hinduized Gonds in Bengal tie the corpses of adult males to a *malua* tree previous to burial The Oraons "revere the tamarind and bury their dead in its shade One special rite among the Dravidian races is the *imli ghoutna* or 'the grinding of the tamarind' when the mother of the bridegroom grinds on the family curry stone some pods of the tamarind" (W Crooke, *Popular Religion of Northern India,* vol. 1, p 109).

TREE-CREEPER, one of the smaller British birds, and generally distributed. It is *Certhia familiaris,* and is remarkable for the stiffened shafts of its long and pointed tail-feathers, aided by which, and by its large feet, it climbs the trunks or branches of trees, proceeding upwards or outwards, generally in a spiral direction, as it seeks the small insects that are hidden in the bark and that form its chief food It never climbs head-downwards like the nuthatch (*q v*). Inconspicuous in its upper plumage of brown mottled with white, buff and tawny—for the silvery white of its underparts is not usually visible—the tree-creeper is more common than the incurious suppose; though a shy singer, its song is loud and sweet The nest is placed behind a half-detached piece of bark and a mass of material is used to give a sure foundation for the tiny cup, in which are laid from six to nine eggs of a translucent white, spotted or blotched with rust-colour.

The tree-creeper inhabits almost the whole of Europe as well as Algeria and has been traced across Asia to Japan It is an inhabitant of the greater part of North America. On the European continent a second species, *C brachydactyla,* is found. This is hardly to be distinguished from *C. familiaris* in appearance but has a quite different song, and lives in gardens and parks rather than in woodland

Allied to the tree-creeper, but without its stiff tail-feathers, is the genus *Tichodroma,* the single member of which is the beautiful wall-creeper (*T muraria*) of the Alps and some other mountainous parts of Europe and Asia. It is occasionally seen in Switzerland, fluttering up the face of a rock, conspicuous from the scarlet-crimson of its wing-coverts and its white spotted primaries Its bright hue is hardly visible when the bird is at rest, and it then presents a dingy appearance of grey and black. It is a species of wide range, extending from Spain to China.

The passerine family *Certhiidae* contains a number of genera of birds to which the general name "creeper" is applied; they occur in North America, Europe and Asia, the greater part of Africa, and Australia and New Guinea

TREE-CULTS. Primitive man, observing the growth and death of trees, the elasticity of their branches, the sensitiveness and the annual decay and revival of their foliage, anticipated in his own way the tendency of modern science to bridge the gulf between the animal and the vegetable world Sober Greek philosophers (Aristotle, Plutarch) thought that trees had perceptions, passions and reason. The beliefs of primitive man were part of a small stock of fundamental ideas which persist in one form or another over a large portion of the world, and have found a place in the higher religions.

Trees and Human Life.—Numerous popular stories reflect a firmly rooted belief in an intimate connection between a human being and a tree, plant or flower. Sometimes a man's life depends upon the tree and suffers when it withers or is injured, and we encounter the idea of the *external soul,* already found in the Egyptian "Tale of the Two Brothers" of some 3,000 years ago Here one of the brothers leaves his heart on the top of the flower of the acacia and falls dead when it is cut down Sometimes, however, the tree is an *index,* a mysterious token which shows its sympathy with an absent hero by weakening or dying, as the man becomes ill or loses his life These two features easily combine, and represent a mysterious sympathy between tree- and human-life, which, as a matter of fact, frequently manifests itself in recorded beliefs and customs of historical times Thus, sometimes a new-born child is associated with a newly planted tree

with which its life is supposed to be bound up; or, on ceremonial occasions (betrothal, marriage, ascent to the throne), a personal relationship of this kind is instituted by planting trees, upon the fortunes of which the career of the individual depends Sometimes, moreover, boughs or plants are selected and the individual draws omens of life and death from the fate of his or her choice. Again, a man will put himself into relationship with a tree by depositing upon it something which has been in the closest contact with himself (hair, clothing, etc).

The custom of transferring disease or sickness from men to trees is well known Sometimes the hair, nails, clothing, etc, of a sickly person are fixed to a tree, or they are forcibly inserted in a hole in the trunk, or the tree is split and the patient passes through the aperture Where the tree has been thus injured, its recovery and that of the patient are often associated. In India when a man is supposed to be tormented by a demon, ceremonies are performed to provide it with a tree where it will dwell peacefully without molesting the patient so long as the tree is left unharmed Such ideas do not enter, of course, when the rite merely removes the illness, but endangers the health of those who approach the tree Again, sometimes it is believed that man's personality is mystically united with some healthy and sturdy tree, and in this case we may often presume that such trees already possessed some appropriate reputation Again hair, nail-clippings, etc, are hung upon a tree for safety's sake lest they fall into the hands of an enemy

Spirits in Trees.—Among the Arabs the sacred trees are haunted by angels or by *jinn;* sacrifices are made, and the sick who sleep beneath them receive prescriptions Here, as frequently elsewhere, it is dangerous to pull a bough This dread of damaging special trees is familiar. Cato instructed the woodman to sacrifice to the male or female deity before thinning a grove (*De re rustica,* 139), while in the Homeric poem to Aphrodite the tree nymph is wounded when the tree is injured, and dies when the trunk falls Early Buddhism decided that trees had neither mind nor feeling and might lawfully be cut, but it recognized that certain spirits might reside in them, and this the modern natives of India firmly believe. Propitiation is made before the sacrilegious axe is laid to the holy trees; loss of life or of wealth and the failure of rain are feared should they be wantonly cut; and there are even trees which it is dangerous to climb The Talein of Burma prays to the tree before he cuts it down, and the African woodman will place a fresh sprig upon the stump as a new home for the spirit. In the Gold Coast the silk-cotton and odum (poison) trees are especially sacred as the abode of the two deities, who are honoured by sacrifices—even of human victims, these can be felled only after certain purificatory ceremonies. In general, sacred trees must not be injured unless they (*i e*, their spirits) have been appeased, or means taken to provide the occupant with another abode That the difference between the sacred *object* and the sacred *occupant* was not always clearly drawn is quite intelligible from those beliefs of much less rudimentary religions which confuse the unessential with the essential.

Forms of Cult.—Often the tree is famous for oracles One of the best known is the oak of Dodona tended by priests who slept on the ground. The tall oaks of the old Prussians were inhabited by gods who gave responses, and the old Hebrews had their "terebinth of the teacher" (Gen. xii 6), and "terebinth of the diviners" (Judg ix 37) Sacred trees are also the object of pilgrimage, one of the most noteworthy being the branch of the Bo tree at Ceylon brought thither before the Christian era Again, tree-spirits will hold sway over the surrounding forest or district, and the animals in the locality are sacred and must not be harmed Thus, the pigeons at the grove of Dodona, and the beasts around the north European tree-sanctuaries, were left untouched, even as the modern Dyak allows no interference with the snake by the side of the bush which enshrines a dead kinsman. Sacred fires burned before the Lithuanian Perkuno and the Roman Jupiter; both deities were closely associated with the oak, and, indeed, according to Frazer, the oak seems to have been very commonly used for the perpetual holy fires of the Aryans

The powers of the tree-deities, though often specially connected with the elements, are not necessarily so restricted, and the sacred trees can form the centre of religious, and sometimes, also, of national life. Such deities are not abstract beings, but are potent and immediate, and the cultus is primarily as utilitarian as the duties of life itself. They may have their proper ministrants: the chief sanctuary of the old Prussians was a holy oak around which lived priests and a high priest known as "God's mouth"; in Africa there are sacred groves into which the priest alone may enter, and among the Kissil-Bashi (or Kizilbashes) of the Upper Tigris and Euphrates, the holy tree of the village stands in an enclosure to which only the father-priest has access The trees may be the scene of religious festivals and of periodical fairs and markets Among the Lousiade group in British New Guinea the religious feasts are held under the sacred tree and a portion is laid aside for the spirit-occupants That the invisible spirit naturally enjoyed only the *spiritual* part of the offerings is a belief which has been shared by others than the African negro (Tylor ii. 216). Human sacrifice is known on the Slave Coast and in the Punjab, it was practised among the Druids, and at Odin's grave at Uppsala It is also said that the pollution of old Prussian sacred groves and springs by the intrusion of Christians was atoned for by human victims

Development of Ideas.—As ideas advanced, the spirits associated with trees were represented by posts, idols, or masks, altars were added, and the trunk was roughly shaped to represent the superhuman occupant There is reason to believe that the last-mentioned transformation has frequently happened in the development of iconography Indeed, the natives of the Antilles suppose that certain trees instructed sorcerers to shape their trunks into idols, and to instal them in temple-huts where they could be worshipped and could inspire their priests with oracles When the tree-spirit was conceived to be of human shape the numerous stories which associate trees with men or deities of flesh and blood would easily arise; and just as Indian natives have gods which are supposed to dwell in trees, so in higher religions we find a Zeus or a Dionysus *Endendros,* gods, "occupants of trees," who have been identified with one or other of the leading members of a recognized pantheon Syrian writers speak of a "king of the forest" and of a tall olive tree to the worship of which Satan seduced the people But these "trees of the demons" were hewn down by zealous Syrian Christians So also the caliph Omar cut down the tree at Hodaibaya visited by pilgrims, lest it should be worshipped, and the Council of Nantes (A D 895) expressly enjoined the destruction of trees which were consecrated to demons

Tradition has preserved some recollections of the overthrow of tree-cult in Europe. Bonifacius destroyed the great oak of Jupiter at Geismar in Hesse, and built of the wood a chapel to St Peter (A similar continuity was maintained near Hebron when Constantine destroyed the idols and altars beneath the oak or terebinth of Abraham at Mamre and replaced them by a basilica) On the Heinzenberg near Zell the Chapel of Our Lady stands where the old tree uttered its complaint as the woodman cut it down, and at Kildare (*cilldara,* church of the oak), "Saint" Brigit or Bridget built her church under an oak tree On the other hand, at Samosata, the sacred tree worshipped in Christian times was honoured as the wood of Christ's cross, and this growth of a new tradition to justify or at least to modify an old survival recurs in Palestine where the holy trees, whether adjoining a venerated tomb or not, are often connected with the names of saints or prophets and sometimes with appropriate traditions.

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TREE-FERN. In old and well-grown specimens of some of the familiar ferns of temperate climates the wide-spreading crown of fronds may be observed to rise at a distance often of a good many inches above the ground, and from a stem of considerable thickness. The male fern *Dryopteris Filix-mas* affords the commonest instance of this, higher and thicker trunks are, however,

occasionally presented by the royal fern (*Osmunda regalis*), in which a height of 2 ft. may be attained, and this with very considerable apparent thickness, due, however, to the origin and descent of a new series of adventitious roots from the bases of each annual set of fronds Some tropical members and allies of these genera become more distinctly tree-like, *e.g.*, *Todea*. *Oleandra* is branched and shrub-like, while *Angiopteris* and *Marattia* may also rise to 2 ft or more. But the tree-ferns proper are practically included within the family Cyatheaceae. This includes seven genera (*Cyathea, Alsophila, Hemitelia, Dicksonia, Thyrsopteris, Cibotium* and *Balantium*) and about 360 species, of which a few are herbaceous, but the majority arboreal and palm-like. reaching frequently a height of 50 ft. or more, *Alsophila excelsa* of Norfolk island having sometimes measured 60 to 80 ft The fronds are rarely simple or simply pinnate, but usually tripinnate or decompound, and may attain a length of 20 ft., thus forming a splendid crown of foliage.

The genera are of wide geographical range, mostly within the tropics; but South Australia, New Zealand, and the southern Pacific islands all possess their tree-ferns In Tasmania *Alsophila australis* has been found up to the snow-level, and in the humid and mountainous regions of the tropics tree-ferns are also found to range up to a considerable altitude The fronds may either contribute to the apparent thickness of the stem by leaving more or less of their bases, which become hardened and persistent, or they may be articulated to the stem and fall off, leaving characteristic scars in spiral series upon the stem The stem is frequently much increased in apparent thickness by the downgrowth of aerial roots, forming a black coating several inches or even a foot in thickness, but its essential structure differs little in principle from that familiar in the rhizome of the common bracken (*Pteris*).

Tree-ferns are cultivated for their beauty alone, a few, however, are of some economic applications, chiefly as sources of starch. Thus the beautiful *Alsophila excelsa* of Norfolk island is said to be threatened with extinction for the sake of its sago-like pith *Cyathea medullaris* also furnishes a kind of sago to the natives of New Zealand, Queensland and the Pacific islands The long silky or rather woolly hairs, so abundant on the stem and frond-leaves in the various species of *Cibotium* have not only been used as a styptic, but in the Sandwich islands furnish wool for stuffing mattresses and cushions

TREE-FROG. Many groups of tailless Amphibia (*see* FROG) are adapted to arboreal life, which is indicated by adhesive discs on the tips of the fingers and toes These discs adhere by rapid and intense pressure of the distal phalanx and special muscles upon the lower surface, which is also provided with glands producing a sticky secretion

The best-known European tree-frog is the little *Hyla arborea*, often kept in glass cylinders, with a ladder which it is supposed to ascend or descend according to the coming weather This frog rarely reaches 2in in length, its upper parts are smooth and shiny, normally of a bright grass-green, which may change rapidly to yellow, brown, olive, or black, some specimens lack the yellow pigment which contributes to form the green colour, and are sky-blue or turquoise blue, the lower parts are white. The commonest American species is *H versicolor*, green, grey, or brown, with a loud piping voice Tree-frogs in U S A are often called tree-toads

The family *Hylidae* is related to the *Bufonidae* or toads, being distinguished by the presence of teeth in the upper jaw and by the claw-like shape of the terminal phalanx of the digits It is a large family, with about 300 species, 250 of which belong to the genus *Hyla*, distributed over Europe, temperate Asia, North Africa, North and South America, Papua, and Australia. *Nototrema* of Central and South America, in the female, develops a broad dorsal pouch in which the young undergo their metamorphoses. *Phyllomedusa*, also from Central and South America, is quadrumanous, the inner finger and the toe being opposable to the others, and the foot being very similar to the hand These frogs deposit their spawn between the leaves of branches overhanging water, into which the tadpoles drop and spend their larval life

TREE KANGAROO, the name of certain arboreal marsupials, forming the genus *Dendrolagus* (*see* MARSUPIALIA) Three species are inhabitants of New Guinea and the fourth, Lumholtz's tree kangaroo (*D lumholtzi*), is found in North Queensland, in dense scrub high up on the mountains. They are arboreal in their habits and feed on bark, leaves, and fruit Their hinder limbs are shorter than in the true kangaroos and their fore limbs longer and more robust, with strong curved and pointed claws. The flesh of the Queensland species is much prized by the natives.

TREE MARRIAGE. In Chota Nagpur, the tribes who speak languages of the Munda group, and in Bengal, low castes such as the Rautias, Bagdis and Murmis, perform the rite of tree marriage as an integral part of the marriage service The nuptial pair are fastened to trees by thread The trees selected are either the *mahua* or the *mango*, the two most important and conspicuous trees in that area In the marriage rites for a number of castes in Mysore, whose language is Dravidian, the marriage is celebrated in a booth, one of the posts of which is called the milk post. This, so we are told, is to secure the continuity of the line, and it has to be cut by the maternal uncle—the male representative of an important social grouping A fig tree is here specified, while in parts of the Punjab, a branch of a jhand tree *Prosopis spicigera* is essential to the due performance of the marriage rites. Quite obviously, trees of such economic importance as the *mahua*, the *mango*, the *jhand* and the fig are selected as conspicuously, essentially fertile, but it is not a general fertility, but a specific fertility, that must be looked for as the reason for their selection They are associated with the beliefs of the people as to the fate of those who are destined or desired to return and be re-born In general, too, trees, notably the *peepul*, are in India associated with the spirits, and for this reason barren women walk round them in order that they may be fertilized by a spirit denizen of the tree In West Africa "nearly all Yoruba believe that souls about to be born live in or among trees, and it is for this reason that women so often pray to the tree spirits to send them children" (P A Talbot, *The Peoples of Southern Nigeria*, vol ii, p. 267)

There are cases where tree marriage affords a means of attaining the social status of marriage, as where a bachelor who seeks to marry a widow is obliged to marry a tree, which is then cut down He is then a widower, equal in status with his human bride It may be a substitute and intended to avoid the curse of widowhood, or to confer the status of married woman on a girl, and thus escape the social and religious penalties attaching to those whose daughters do not marry Lastly, there is the common practice in India of marrying a newly-constructed tank to a plantain tree for the purpose of blessing the tank

Tree marriage is part of a series of rites by means of which the continuity of the group life is secured

TREE PLANTING. The quality of the soil in which trees are planted exerts a considerable influence upon their development, but, given the best possible soil conditions they may fail through indifferent planting Where the soil is naturally deep and good, planting operations are less burdensome than in places where the soil is poor, but even then there are conditions that must be observed if the most satisfactory results are to be obtained Generally, the larger the trees to be planted, the greater should be the preparatory work and the greater the care in planting

If the natural water level in wet weather is within two feet of the surface of the ground some system of drainage should be adopted, otherwise the lower roots of the trees may be killed, particularly where the soil is heavy or of a clayey nature The quality of the subsoil should also be observed, for although there may be a depth of 12 or 15 in of good surface soil, a hard impervious pan of gravel or other material beneath is sufficient to check effectively the tree's growth Trees cultivated in nurseries are grown in well worked ground, and it is necessary to provide root conditions as nearly similar as possible to those existing in the nursery when they are transferred to permanent places All ground required for ornamental trees should be trenched to a depth of 2 to 3 ft. Where trenching over a wide area cannot be done, large holes should be dug When the natural soil is of good quality, holes 3 to 4 ft in diameter are large enough for small trees, but where the soil is poor, much wider holes are necessary. For

important trees, holes 6, 8 or 10 ft. across may be desirable. For the largest growing trees they should be made 3 ft. deep, for those of smaller size, 2 to 2½ ft In all cases it is advisable to break up the bottom, particularly if it is very hard During the digging, all the best of the soil should be saved, and the remainder substituted by the best soil obtainable It is not wise to use manure in the holes and if any is included in the filling it should be so placed that it will not come into contact with the roots of the trees As soon as the holes have been dug they should be refilled to within 9 in of the surface, care being taken, as the work proceeds, to tread or ram the soil firm Where possible, water may be run into the holes to help to firm the ground Planting should not take place for two or three weeks after the holes have been partially filled or until such time as the soil has settled into position; but should hurried planting be necessary, the lower soil must be well rammed or trodden before the trees are placed in position. Deep planting must be avoided, it is the cause of ill health and premature death of many trees Care must be taken to see that the upper roots are kept near the surface of the ground. A rod placed across the hole, at the natural level of the ground, proves a good guide; 1 in of soil placed above the top roots is usually sufficient Tree planting is two men's work; one man should hold the tree in position whilst the other fills in the soil and firms it about the roots. When placing a tree in position, spread the roots out to their widest extent and work fine soil amongst them. The soil may be made firm about the roots by means of a rammer or by well treading. On the completion of the work, a good watering will help to settle the soil

Some trees require staking after planting, the stakes being retained until the roots have become vigorous again The stakes must be driven well into the ground, but care must be taken not to pierce the roots A piece of rubber or textile material should be placed around the trunk in order to prevent the string from cutting the bark The string should be given a turn around the stake to prevent it slipping and the work completed by a secure tie. Several ties may be needed for a single tree. In the case of large trees it may be desirable to use a triangle of soft ropes secured to the trunk 5 or 6 ft from the ground and to short stakes driven into the ground 3 ft or so from the tree. Open ground should be maintained about the bases of young trees for a number of years, or until they are making vigorous growth, and only then should grass be allowed to grow close to the trunks. During dry weather, in the early years after planting, assistance may be given by applying a mulch of decayed manure and leaves to the ground above the roots, and should the leaves flag or begin to turn yellow, water should be provided Evergreen trees are usually more difficult to re-establish after transplanting than deciduous trees It is wise to remove some of the branches of evergreens at the time of transplanting in order to relieve the strain upon the injured roots, and it is better to carry out the work during late spring or early autumn than in winter If they are moved without soil more satisfactory results are obtained by transplanting them during September or early May Evergreens that are moved with considerable balls of soil attached to the roots may be transplanted during the winter Deciduous trees may be transplanted from October to March. Should the leaves of transplanted evergreens fall, no alarm need be felt; that is one of nature's ways of restoring the balance between injured roots and branches; if, however, the leaves wither and remain on the branches, recovery is not progressing and it will be necessary to cut the branches back to relieve the strain upon the roots Although trees are usually transplanted when comparatively young and small, it is possible to transfer well grown trees from place to place. By means of machinery, trees 30 to 40 ft. high, with a mass of earth attached to the roots, are often transplanted with excellent results. Such trees should be carefully watered during dry weather. (*See* also Arboriculture) (W. D)

TREE-SHREW, any of the arboreal insectivorous mammals of the genus *Tupaia.* There are about a dozen species, widely distributed over the east. It is held by many anatomists that forms of this type gave rise to the Primates (*q.v*) (*See* Insectivora)

TREE-TOAD: *see* Tree-Frog.

TRÉGUIER, a port of western France, in the department of Côtes-du-Nord, 36 m. N W. of St Brieuc by road. Pop. (1926), 2,494 Tréguier (*Trecorum*), which dates from the 6th century, grew up round a monastery founded by St Tugdual. In the 9th century it became the seat of a bishopric, suppressed in 1790. The port is situated about 5½ m from the English Channel at the confluence of two streams that form the Tréguier river; it carries on fishing and a coasting and small foreign trade The cathedral (14th and 15th centuries), has three towers over the transept, one of which is surmounted by a fine spire, and a 15th century cloister Ernest Renan was a native of the town

TREILHARD, JEAN BAPTISTE (1742–1810), French revolutionary, was born at Brives (Corrèze). In Paris he gained reputation as an avocat at the parlement. He was elected to the Constituent Assembly where he showed great capacity in dealing with the reorganization of the Church and the nationalization of ecclesiastical property Ineligible, as a member of the Constituent Assembly, for the Legislative Assembly, he became president of the criminal tribunal of Paris In the Convention he joined the Mountain; he was a member of the committee of public safety, and became president of the Convention on Dec. 27, 1792. Under the Directory he entered the Council of the Five Hundred (of which he was president during the month of Nivose, year IV), was a member of the Tribunal of Cassation, plenipotentiary at the Congress of Rastatt, and became a director in the year VI. After the *coup d'état* of 18 Brumaire he became president of the tribunal of appeal and councillor of State. He took an important part in drafting the civil code, the criminal code, the code of civil procedure and the commercial code He died on Dec 1, 1810, a senator and count of the empire.

See Guyot d'Amfreville, *Vie de J. B. Treilhard* (Limoges, 1879); Bonnal de Ganges, "Représentants du peuple dignitaires par Napoléon . . . Treilhard," in the *Revue du monde catholique* (7th series, vol. iii., 1900).

TREITSCHKE, HEINRICH VON (1834–1896), German historian and political writer, the son of a Saxon officer, was born at Dresden on Sept 15, 1834. Prevented by deafness from entering the public service, he studied at Leipzig and Bonn, where he was a pupil of Dahlmann. He established himself as a *Privatdozent* at Leipzig, lecturing on history and politics, and at once became very popular with the students, but his political opinions made it impossible for the Saxon government to appoint him to a professorship. He was at that time a strong Liberal; he hoped to see Germany united into a single state with a parliamentary government, and that all the smaller states would be swept away. In 1863 he was appointed professor at Freiburg, in 1866, at the outbreak of war, he showed his Prussian sympathies by removing to Berlin, became a Prussian subject, and was appointed editor of the *Preussische Jahrbücher.* After holding appointments at Kiel and Heidelberg, he was in 1874 made professor at Berlin; he had already in 1871 become a member of the Reichstag, and from that time till his death in 1896 he was one of the most prominent figures in the city. On Sybel's death he succeeded him as editor of the *Historische Zeitschrift.* He had outgrown his early Liberalism and become the chief panegyrist of the house of Hohenzollern.

Treitschke did more than any one to mould the minds of the rising generation, and he carried them with him even in his violent attacks on all opinions and all parties which appeared in any way to be injurious to the rising power of Germany He supported the government in its attempts to subdue by legislation the Socialists, Poles and Catholics; and he was one of the few men of eminence who gave the sanction of his name to the attacks on the Jews which began in 1878. As a strong advocate of colonial expansion he was a bitter enemy of Great Britain, and he was to a large extent responsible for the anti-British feeling of German Chauvinism during the last years of the 19th century. In the Reichstag he had originally been a member of the National Liberal party, but in 1879 he was the first to accept the new commercial policy of Bismarck, and in his later years he joined the Moderate Conservatives. He died at Berlin on April 28, 1896.

As an historian Treitschke confined himself to those periods

and characters in which great political problems were being worked out: above all, he was a patriotic historian, and he never wandered far from Prussia His great achievement was the *History of Germany in the Nineteenth Century* (Eng. trans. by E. and C. Paul, 7 vols., 1915–19). The first volume was published in 1879, and during the next sixteen years four more volumes appeared, but at his death he had only advanced to the year 1847.

The most important of the essays were collected under the title *Historische und politische Aufsätze* (4 vols., Leipzig, 1896); a selection from his more controversial writings was made under the title *Zehn Jahre deutscher Kampfe*; in 1896 a new volume appeared, called *Deutsche Kämpfe, neue Folge* After his death his lectures on political subjects were published under the title *Politik* (Eng. trans, 2 vols., 1916). He brought out also in 1856 a short volume of poems called *Vaterländische Gedichte*, and another volume in the following year His *Briefe*, ed. M. Cornicelius (3 vols., Berlin, 1859–96), were reprinted at Leipzig (1913–20).

See Schiemann, *Heinrich v. Treitschkes Lehr- und Wander-jahre, 1836–1866* (Munich, 1896); *Gustav Freitag und Heinrich v. Treitschke im Briefwechsel* (Leipzig, 1900); A. Hausrath, *Leben von Heinrich von Treitschke* (Eng. trans., with extracts from Treitschke's works, 1914), E. Barker, *Nietzsche und Treitschke* (1914); H. W. C. Davies, *The Political Thought of Heinrich von Treitschke* (1914); W. Rittinghaus, *Die Kunst der Geschichtschreibung Heinrich von Treitschkes* (1914); C. S. Terry, *Treitschke, Bernhardi and Some Theologians* (1915); L Lorenz, *Treitschke in unsere Zeit* (1916).

TRELAWNY, EDWARD JOHN (1792–1881), English sailor and friend of Shelley and Byron, was born in London on Nov 13, 1792, the son of an army officer After a short term in the navy and a naval school, he shipped for India, but deserted at Bombay. For several years he led an adventurous life in India, but about 1813 returned to England, married and settled down Early in 1822 he met Shelley and Byron at Pisa, and passed nearly every day with one or both of them until the drowning of Shelley (*q v*) and Williams on July 8 He superintended the recovery and cremation of the bodies, snatching Shelley's heart from the flames He added the lines from the *Tempest* to Leigh Hunt's "Cor Cordium", and, finally, he supplied the funds for Mrs. Shelley's return to England In 1823 he set out with Byron for Greece, to aid in the struggle for independence. Distressed by his companion's dilatoriness, Trelawny left him and joined the insurgent chief Odysseus and afterwards married his sister Tersitza While in charge of the former's fortress on Parnassus he was assaulted by two Englishmen and nearly killed Returning to England, he lived for a time in Cornwall with his mother and afterwards in London, where he became a great social favourite Permission having been refused him to write the life of Shelley, he began an account of his own life in the *Adventures of a Younger Son* (1835; new ed. by E. C Mayne, 1925), followed much later by a second part· *Recollections of Shelley and Byron* (1858), which was recast as *Records of Shelley, Byron and the Author* in 1878 (new ed by E Dowden 1906) This gives an admirable portrait of Shelley, and a less truthful one of Byron He married a third time, but the irregularity of his life estranged him from his wife. He died at Sompting, near Worthing, on Aug 13, 1881 The old seaman in Millais's picture, "The North-West Passage," in the Tate gallery, London, gives a portrait of him

See the *Letters of Edward J. Trelawny*, edited with Introduction by H. Buxton Forman, C.B. (1910).

TRELAWNY, SIR JONATHAN, Bart. (1650–1721), English prelate, was a younger son of Sir Jonathan Trelawny, bart. (1624–1685), and was born at Pelynt, Cornwall, on March 24, 1650. Educated at Westminster School and at Christ Church, Oxford, Trelawny took holy orders in 1673. His service to James II. during Monmouth's rebellion, was rewarded (Nov. 8, 1685) with the bishopric of Bristol He was loyal to King James until the first declaration of indulgence in April 1687, when, as a bishop, he used his influence with his clergy against the king, and, as a Cornish landowner, resisted the attempt to assemble a packed parliament. In May 1688 Trelawny signed the petition against the second declaration of indulgence, and in the following month was imprisoned in the Tower of London with Sancroft and five other bishops, sharing their triumphant acquittal. In spite of Burnet's assertion, it is probable that Trelawny did not sign the invitation to William of Orange, although he certainly welcomed his army into Bristol. James II. had nominated him to the see of Exeter, and the appointment was almost at once confirmed by William III. Trelawny took the oaths of allegiance to William and Mary; but he was soon estranged from the new king and sided with the princess Anne, who showed him some favour after she became queen. In 1707 Trelawny was appointed bishop of Winchester and became prelate of the Order of the Garter, but henceforward he took very little part in politics. He died at his residence at Chelsea on July 19, 1721, and was buried at Pelynt Trelawny is the hero, or one of the heroes, of the refrain of R. S. Hawker's (modern) ballad.

"And shall Trelawny die,
Here's twenty thousand Cornishmen
Will know the reason why."

TRELEASE, WILLIAM (1857–), American botanist, was born at Mt Vernon, N Y., on Feb. 22, 1857. He graduated at Cornell university in 1880 and continued botanical study at Harvard university (Sc D, 1884). He was professor of botany at the University of Wisconsin from 1883 to 1885 and at Washington university, St Louis, Mo, from 1885 to 1912 and director of the Missouri Botanical Garden in 1889–1912 In 1913–26 he was professor of botany in the University of Illinois

He edited (with Asa Gray) *The Botanical Works of George Engelmann* and translated Poulsen's *Botanical Microchemistry* and Salomonsen's *Bacteriological Technology* He wrote *Agave in the West Indies* (1913), *The Genus Phoradendron* (1916), *Plants Materials of Decorative Gardening* (1917), *Winter Botany* (1918). *The American Oaks* (1925) and numerous papers on botany and entomology. (*See* Botanical Garden)

TREMATODES (flukes), a class of Platyhelminthes (*q.v.*) in which the body is unsegmented and without a cellular epidermis or external cilia, and an alimentary canal is present. All the members of the group are parasitic

General Morphology.—The body is generally flattened and leaf-like or ribbon-like in shape, but may be relatively stout and oval or circular in transverse section One or more muscular suckers are usually present on the ventral surface. In general structure the Trematodes closely resemble the free-living Turbellaria (*q v.*) They differ from them in the development of suckers and other organs for attachment to the host, and in the absence (in the adult) of a ciliated epidermis

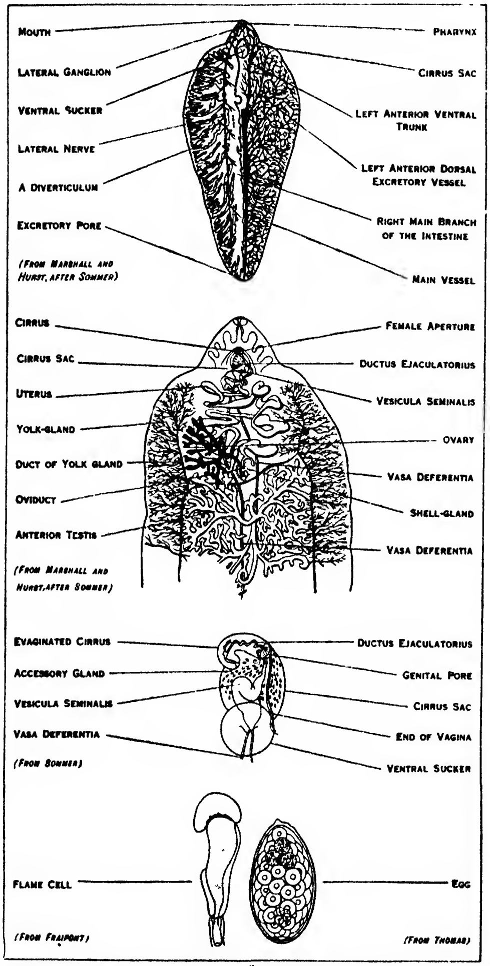
The external covering is a stout cuticle, often armed with spines, below which is a subcuticular layer containing unicellular glands The number and arrangement of the suckers are very variable Usually there is an anterior sucker or pair of suckers, and a posterior sucker, or a posterior disc-like organ of attachment provided with subsidiary suckers or with chitinoid hooks of various kinds The complex development of the posterior organ of attachment is characteristic of the ectoparasitic forms (Monogenea). In endoparasitic forms (Digenea) the posterior sucker is usually a simple muscular disc or cup, and may be situated at the posterior end of the body, but is more often displaced anteriorly so as to lie in front of the middle or even close behind the oral sucker.

Pigment is rare in Trematodes, but occurs in the parenchyma of certain species, more especially among the Monogenea The body of endoparasitic species may, however, appear more or less brightly coloured on account of the contents of the intestine and uterus, and the vitelline glands, showing by transparency

The musculature usually consists of an outer circular and an inner longitudinal layer of fibres. Oblique and dorso-ventral fibres are also frequently present.

Except in one family, the mouth is situated at or near the anterior extremity It may open through an anterior, or oral, sucker, or, in certain ectoparasitic forms, may be flanked by a pair of adoral suckers. The alimentary canal may be a simple, blind sac, but usually consists of a relatively short median anterior portion and two posterior branches arising by the bifurcation of the former These branches may be simple or secondarily branched, and may join again posteriorly, or may remain distinct.

In the great majority of forms they are without any posterior opening, but in one or two species they have been found to open to the exterior by one or a pair of pores The median anterior portion of the gut may be differentiated into a muscular sucking



AFTER (A, B, C) SOMMER IN "ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE," (ENGELMANN), (D) FRAIPONT IN "ARCHIVES DE BIOLOGIE" (MASON & CO.), (E) THOMAS IN "QUARTERLY JOURNAL OF MICROSCOPIC SCIENCE" (CLARENDON PRESS)

FIG. 1—FASCIOLA HEPATICA, SHOWING FROM ABOVE DOWNWARDS, VENTRAL ASPECT, ANTERIOR PORTION MORE HIGHLY MAGNIFIED, GENITAL SINUS AND OTHER PARTS, FLAME CELL FROM EXCRETORY APPARATUS, EGG

bulb, or pharynx, and a simple tubular portion between this and the bifurcation, called the oesophagus.

The whole of the space between the wall of the alimentary canal and the external cuticle is filled up with a spongy connective tissue, or parenchyma, in which the other organs are embedded, as in other classes of Platyhelminthes. The nervous system consists of a pair of central ganglionic masses (the "brain"), situated anteriorly and dorsally, and longitudinal nerve-cords (of which there may be as many as four pairs) running posteriorly throughout the body, and connected at intervals by transverse commissures. Eyes are present in some of the ectoparasitic forms, and in the larval stages of some endoparasitic species, but are absent in the adults of the latter There may also be "tactile cones" on the surface of the cuticle, consisting of small elevations surmounted by groups of stiff cilia.

The excretory system is composed, as in other Platyhelminthes, of branching canals whose smallest branches end in flame-cells. There are usually two main longitudinal canals, which may open independently, through a pair of excretory sacs, on to the dorsal surface, or may lead into a common posterior "bladder."

With few exceptions, the Trematodes are hermaphrodite. The complex system of genital organs is arranged on the same general plan as in other groups of Platyhelminthes, but is subject to much variation in details, and is of great importance from the taxonomic standpoint The testes are almost invariably paired, and are usually compact organs, though they may be deeply lobate or even elaborately branched. The male ducts unite and open through a muscular intromittent organ, or cirrus, which is usually contained in a special pouch (the cirrus-sac). The ovary is single, and, like the testes, may be compact or more or less branched The vitellaria generally consist of two lateral series of follicles, those of each side being connected by branching ducts with a main yolk-duct, and the two main ducts crossing the body to join in the median region, near the shell-gland

In ectoparasitic forms there is a vagina, opening to the exterior by a pore quite distinct from that of the uterus, or there may be a pair of such structures The uterus, in the Trematodes, is a continuation of the oviduct, and is a more or less convoluted tube usually opening side by side with the male duct, often into a common atrium In forms without a separate vagina it functions as a fertilization canal as well as a reservoir for eggs and a duct for their expulsion In some of the ectoparasitic Trematodes a "genito-intestinal canal" connects the oviduct with the intestine. In the endoparasitic forms (Digenea) this connection is lost, but a duct, known as Laurer's canal, springing from the oviduct and either opening on the surface of the body or ending blindly below the skin, is usually present The eggs, after being fertilized and supplied with yolk, are enclosed in a chitinoid shell of variable form, sometimes stalked or with terminal filaments, and very commonly provided with an operculum at one end

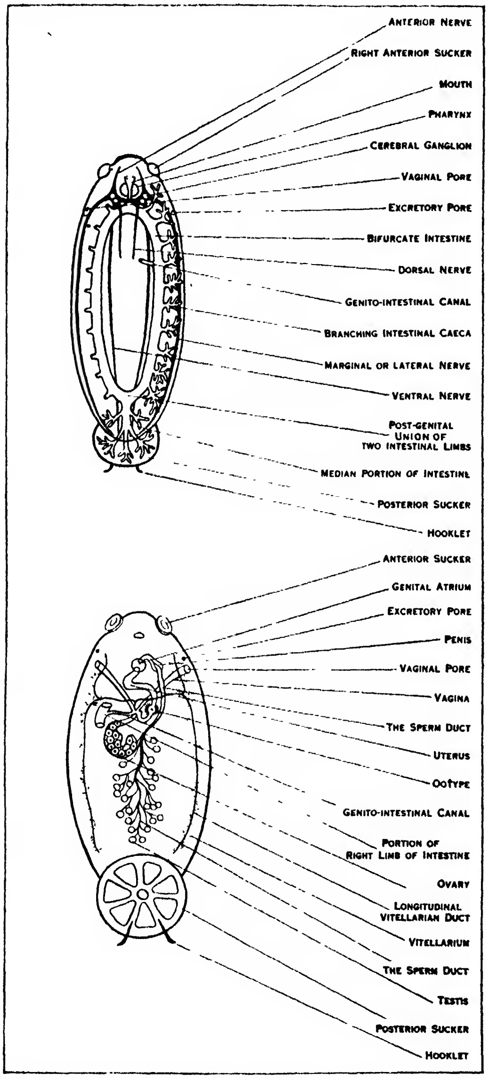
Classification.—The division of the class Trematoda into two orders, Monogenea and Digenea, proposed by van Beneden in 1858, is still accepted by modern authorities. These orders represent two well marked groups differing fundamentally in structure, habits and life-history

The order Monogenea comprises forms of almost exclusively ectoparasitic habit, without an alternation of generations in their life-history, and having the following structural peculiarities, among others The mouth is simple and is not surrounded by an oral sucker, though paired accessory suckers may be present in its neighbourhood. The posterior sucker may be single (but in this case is usually of complex structure and often provided with accessory chitinoid organs of attachment) or there may be a number of paired posterior suckers, which also have chitinoid armatures There is a vagina, or a pair of vaginae, distinct from the uterus, and there are usually paired excretory pores situated dorsally near the anterior end of the body.

These forms live mainly on the external surface or on the gills of fishes and other cold-blooded aquatic animals, and feed on mucus and other matter, or occasionally on the blood of the host. The order includes 13 families, among which are the Tristomatidae, Gyrodactylidae, Polystomatidae and Octocotylidae.

The order Digenea includes all the forms which live as endoparasites within the bodies of other animals. These have a complex life-history involving an alternation between a sexual phase and an asexual or parthenogenetic phase of multiplication. They have an oral sucker surrounding the mouth, and usually a posterior sucker which is a simple muscular organ without chitinoid armature There is no vagina, as distinct from the uterus, and the excretory pore is usually single and posterior. The adult forms occur in all classes of vertebrates, the larval forms in both vertebrates and invertebrates.

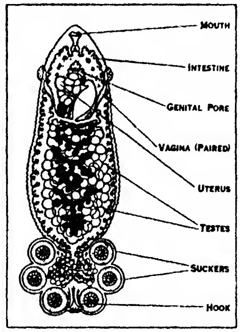
The suborder Gasterostomata includes a single family (Bucephalidae), in which the mouth is placed towards the middle of the ventral surface. All the other families (of which there are about 60) are placed in a second suborder, Prosostomata, in which the mouth occupies its normal anterior position The great majority of the forms in this suborder are placed in the



AFTER LANKESTER, "TREATISE ON ZOOLOGY" (A & C BLACK)

FIG. 2—SCHEMATIC FIGURE OF A MONOGENETIC TREMATODE, ILLUSTRATING STRUCTURE (AFTER BENHAM)

tribe Fascioloidae, and have a general resemblance in form to the well known liver-fluke (*Fasciola*). Among the best known families may be mentioned the Fasciolidae, Dicrocoeliidae, Lepodermatidae, Opisthorchidae, Cyclocoelidae (Monostomidae), Echinostomatidae, Schistosomatidae and Paramphistomidae. The remarkable genus *Aspidogaster*, parasitic in molluscs, differs from all other Prosostomata in the form of the posterior sucker, which occupies the greater part of the ventral surface, and is divided up into a number of partitions It was formerly placed in a separate order, but is regarded by Poche as forming a tribe, Aspidogastroidae of the Prosostomata

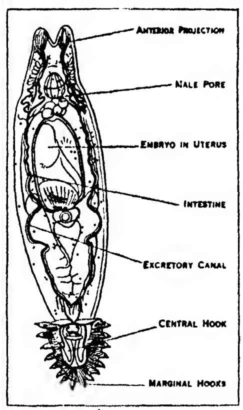


FROM "ZEITSCHRIFT FUR WISSENSCHAFTLICHE ZOOLOGIE" (ENGELMANN)

FIG 3—VENTRAL VIEW OF POLYSTOMUM INTEGERRIMUM (AFTER ZELLER)

Development and Life-histories.—The eggs of the Monogenea are either deposited in water or attached to the host by means of stalk-like processes. In some cases (*Gyrodactylus*, a parasite of the gills of minnows and other fishes) but a single egg is produced at a time, and this develops within the body of the parent into an embryo, within which another embryo is formed before its birth There may be a ciliated free-swimming larval stage, as in *Polystomum* (a form inhabiting the bladder of frogs and toads) The larva of this form invades the gill-chamber of tadpoles, and migrates by way of the alimentary canal to its definitive habitat *Diplozoon* (found on the skin of the minnow) also has a free-swimming stage, and is remarkable for the fact that two larvae (called *Diporpae*) unite, each holding the other by its ventral sucker, and fuse into a single X-shaped organism, the two original sets of genitalia becoming permanently interconnected In other cases there appears to be no free-swimming stage, and the larvae hatching from the eggs develop directly into the adult form

In the Digenea the development is indirect, and may involve one or more changes of host, and sometimes a free-swimming stage The life-history of the liver-fluke of the sheep and other animals may be taken as typical. This form, as an adult fluke, inhabits the bile-ducts of the vertebrate host The eggs are passed out of the host's body with the faeces, and hatch in a short time in the open if the conditions of moisture and temperature are suitable The embryo, on escaping from the egg, is a ciliated organism known as a *miracidium*, provided with a pair of eye-spots and an anterior boring organ It swims about until it meets with a suitable intermediate host (certain snails—in Europe, *Limnaea truncatula*). Boring its way into this through the skin, it sheds its ciliated coat and penetrates into the internal organs Here it grows into an irregular, sac-like body known as a *sporocyst*. Within this there are formed by budding numerous bodies called *rediae*. The redia has an oral sucker and a sac-like intestine Each redia gives rise, by internal budding, either to a further generation of rediae or to larvae of a different type, called *cercariae*. The cercaria is somewhat tadpole-like, having a broad body and a narrow tail It has two suckers and a bifurcate intestine. The cercaria escapes from the snail and swims or wriggles about in water, finally coming to rest on some solid body, such as a blade of grass, where it loses its tail and secretes



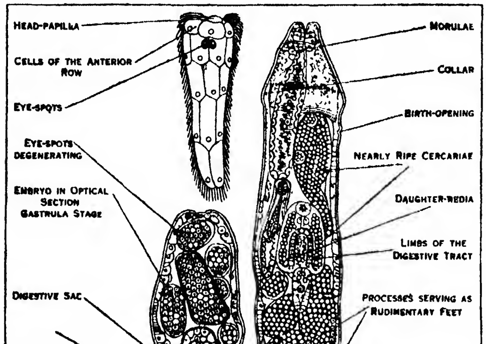
FROM "ARCHIV FÜR ANATOMIE, PHYSIOLOGIE UND WISSENSCHAFTLICHE MEDIZIN (DE GRUYTER & CO)

FIG 4—VENTRAL VIEW OF GYRODACTYLUS ELEGANS (AFTER WAGENER)

round itself a "cyst." Should this be swallowed by a suitable vertebrate animal, the cercaria is liberated from the cyst and migrates into the body-cavity and thence into the liver, where it grows into an adult fluke

An interesting modification of the life-history is found in the genus *Leucochloridium* The sporocyst of this form sends branches into the head and tentacles of its snail host. The branches are brightly coloured and capable of pulsating movements, making the snail conspicuous and particularly liable to the attacks of birds. The transference of the cercariae contained within the snail to suitable final hosts among the birds is thus ensured.

In some genera the cercariae, instead of remaining passive until swallowed, swim about in water and penetrate actively through the skin either of the final or of a second intermediate

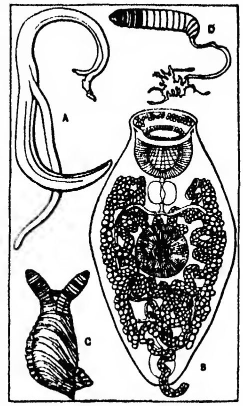


FROM THOMAS IN "QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE" (CLARENDON PRESS)

FIG. 5 —FIVE STAGES IN THE LIFE-HISTORY OF THE LIVER-FLUKE
Above, the miracidium; left centre, a sporocyst containing young rediae; right centre, adult redia containing daughter redia and two almost mature cercariae; left bottom, a young redia; right bottom, a free cercaria (all highly magnified)

host. The fork-tailed cercariae of the blood-flukes (*Schistosoma*) thus attack man and other warm-blooded vertebrates, and the adults inhabit the blood-vessels. The human lung-fluke, *Paragonimus,* leaves its first intermediate host (a mollusc) as a cercaria, and enters certain freshwater crabs and crayfishes, in which it becomes encysted. Human infection, in the Orient, is acquired by eating these animals. Several small flukes belonging to the genera *Opisthorchis, Clonorchis* and *Metagonimus* make use, in a similar manner, of freshwater fishes as second intermediate hosts, the first host being always, so far as is known, a snail.

Economic Importance.—Schistosomiasis (or Bilharziosis) is probably the most important of the human diseases caused by Trematodes In Egypt and many other parts of Africa two species of *Schistosoma, S haematobium* and *S. mansoni,* are prevalent The former also occurs in Asia, certain localities in the south of Europe, and Australia, and the latter in the West Indies and South America In the Far East their place is taken by a third species, *S. japonicum.* These flukes inhabit the mesenteric and portal veins, and their eggs cause obstruction and rupture of the capillaries either in the wall of the bladder or in that of the bowel, with consequent haemorrhage and ulceration.



AFTER (A) LEUCKART, "DIE PARASITEN DES MENSCHEN" (DE GRUYTER & CO) (B, C, D) ZELLER IN "ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE" (ENGELMANN)

FIG 6 —TYPES OF TREMATODES
A Schistosoma haematobium, male carrying the more slender female in the ventral groove, B. Leucochloridium macrostomum, adult form, C. Snail (Succinea) with sporocysts of Leucochloridium in its tentacles, D Sporocyst removed from tentacle of Succinea

The common liver-fluke (*Fasciola hepatica*) is an important parasite of sheep, sometimes causing serious and fatal outbreaks of the disease known as "liver-rot." As a human parasite this worm is rare, but certain smaller liver-flukes (*Opisthorchis* and *Clonorchis*) are not uncommon in eastern countries.

The lung-fluke, *Paragonimus westermani,* is a human parasite of some importance in the Far East, and occurs also in South America and Mexico. The various species of flukes which occur in the alimentary canal of man and domestic animals appear to be, on the whole, of relatively little economic significance (H A B)

TREMOLITE, a mineral of the amphibole (*q v*) group, of the composition $CaMg_3(SiO_3)_4$, and crystallizing in the monoclinic system Tremolite (named in 1796 from the Val Tremola, St Gotthard, where it was first found) always contains water in solid solution in amounts varying up to 2 5% and is not prepared from dry melts It is usually developed in fibrous and bladed crystals of white or grey colour Solid solutions of tremolite and the corresponding iron compound, $CaFe_3(SiO_3)_4$, are known as actinolite They are distinguished by their green colour Tremolite is a common mineral of metamorphosed carbonate sediments. Typical examples occur in the dolomite of Campolongo (Tessin) and in limestone at Russell, New York (C E. T.)

TRENCH, FREDERICK HERBERT (1865–1923), Irish poet and playwright, was born at Avoncore, Co. Cork, on Nov. 12, 1865. Educated at Haileybury and at Keble college, Oxford, he was elected a fellow of All Souls' college, and from 1891–1908 was an examiner in the Board of Education This appointment he gave up in 1908 in order to devote himself to literary work. In 1908 he became director of the Haymarket theatre, London, where he staged *King Lear* and Maeterlinck's *Blue Bird.* His first volume of poems, *Deirdre Wedded,* appeared in 1901. It was followed by further poems, notably "Apollo and the Seaman," included in *New Poems* (1907), and *Lyrics and Narrative Poems* (1911). Among his later publications were an *Ode from Italy in Time of War* (1915); *Poems: with Fables in Prose* (1918); and a poetic play *Napoleon* (1919), which was produced in London by the Stage Society in 1919 He died on June 11, 1923. His collected works, edited by H. Williams, were published in 1924, and a volume of selected poems in the same year.

See Abel Chevalley, *Herbert Trench: Notice sur sa Vie et ses Oeuvres* (1925).

TRENCH, RICHARD CHENEVIX (1807–1886), Anglican archbishop and poet, was born at Dublin on Sept. 9, 1807. He was educated at Harrow, and Trinity College, Cambridge. While incumbent of Curdridge Chapel near Bishops Waltham, Hants, he published (1835) *The Story of Justin Martyr and Other Poems*, which was favourably received, and was followed in 1838 by *Sabbation, Honor Neale, and other Poems*, and in 1842 by *Poems from Eastern Sources*. He became rector of Itchenstoke (1845), Hulsean Lecturer (1845–46) and professor of divinity at King's college, London In 1851 he wrote *The Study of Words*, followed by *English Past and Present* (1855) and *A Select Glossary of English Words* (1859) All have gone through numerous editions and have contributed much to promote the historical study of the English tongue His paper, read before the Philological Society "On some Deficiencies in our English Dictionaries" (1857), gave the first impulse to the great Oxford *New English Dictionary* His advocacy of a revised translation of the New Testament (1858) aided to promote another great national undertaking. In 1856 he published a valuable essay on Calderon, with a translation of a portion of *Life is a Dream* in the original metre In 1841 he had published his *Notes on the Parables*, and in 1846 his *Notes on the Miracles*, popular works which are treasuries of erudite and acute illustration

In 1856 Trench was raised to the deanery of Westminster. Here he instituted evening nave services. In January 1864 he was advanced to the more dignified but less congenial post of archbishop of Dublin. He died in London on March 28, 1886.

See his *Letters and Memorials* (2 vols., 1886).

TRENCHARD, SIR HUGH MONTAGUE, 1ST BART, cr. 1919, K C B. 1918 (1873–), British air marshal, was born on Feb. 3, 1873. Commissioned in the Royal Scots Fusiliers in 1893, he served in the South African War with the Imperial Yeomanry and the Canadian Scouts From 1903 to 1910 he served in West Africa In 1912 he qualified as an air pilot and became an instructor at the central flying school at Upavon, where he was appointed assistant commandant the following year. On the outbreak of the World War Trenchard assumed charge at Farnborough, but before the end of 1914 was summoned to France, and became head of the military wing of the Royal Flying Corps. His strong personality, foresight and power of command made his name a household word in France, and with the expansion of the air service he rose from major to major-general in little over a year After the formation of the Royal Air Force he became, in March 1918, chief of the air staff This position he resigned a month later, owing to disagreement with the first air minister, Lord Rothermere But a few weeks later he received command of the newly formed independent air force, whose mission was to raid Germany, a post that gave scope to his gift for inspiring men and to his development of the strategical rôle of aircraft In 1922 he was promoted air chief marshal

TRENCK, FRANZ, FREIHERR VON DER (1711–1749), Austrian soldier, was born on Jan 1, 1711, of a military family Educated by the Jesuits at Sopron (Oldenburg), he entered the Imperial army in 1728 but resigned in disgrace three years later He then married and lived on his estates for some years. Upon the death of his wife in 1737 he offered to raise an irregular corps of "Pandours" against the Turks, but this offer was refused and he then entered the Russian army. But after serving against the Turks for a short time as captain and major of cavalry he was accused of bad conduct, brutality and disobedience, and condemned to death, the sentence being commuted by Field Marshal Münnich to degradation and imprisonment. He returned to Austria, where his father was governor of a small fortress, but there too came into conflict with every one and actually "took sanctuary" in a convent in Vienna But Prince Charles of Lorraine obtained for him an amnesty and a commission in a corps of irregulars, where he rose to be lieutenant-colonel (1743) and colonel (1744). But at the battle of Soor he and his irregulars plundered when they should have been fighting and Trenck was accused (probably falsely) of having allowed the king of Prussia himself to escape. He was court-martialled in Vienna, and condemned to death; but the sentence was commuted by the queen into one of cashiering and imprisonment. The rest of his life was spent in mild captivity in the fortress of Spielberg, where he died on Oct. 4, 1749.

His cousin, FRIEDRICH, FREIHERR VON DER TRENCK (1726–1794), the writer of the celebrated autobiography, was born on Feb 16, 1726, at Königsberg, his father being a Prussian general. He was educated at the University of Konigsberg, entered the Prussian army in 1742 and became an orderly officer on Frederick's own staff. But within a year he fell into disgrace because of a love affair—whether real or imaginary—with the king's sister Princess Amalie, and in 1743 Frederick had him arrested and confined in the fortress of Glatz, whence in 1746 he escaped Making his way home and thence to Vienna, in the vain hope of finding employment under his now disgraced cousin, he finally entered the Russian service On succeeding to the family estates on his cousin's death, he returned to Germany In 1754 he visited Prussia, but was there arrested and confined in Magdeburg for ten years, making frequent attempts, of incredible audacity, to escape. After the close of the Seven Years' War, Maria Theresa requested his release Trenck then spent some years in Aix-la-Chapelle, and eventually returned to his Hungarian estates Here he composed his celebrated autobiography and many other writings, and undertook various diplomatic or secret service missions. He went to Paris in 1791 to witness the Revolution He was denounced as an Austrian spy and guillotined on July 24, 1794

His autobiography first appeared in German at Berlin and Vienna (13 vols) in 1787 Shortly afterwards a French version, by his own hand, was published at Strasbourg His other published works, in eight volumes, appeared shortly after the autobiography at Leipzig. A reprint of the autobiography appeared in 1910 in "Reclam's Universal Series"

See Wahrmann, *Leben und Thaten des Franz, Freiherr von der Trenck* and *Friedrich, Freiherrn von der Trencks Leben, Kerker und Tod* (both published at Leipzig, 1837).

TRENDELENBURG, FRIEDRICH ADOLF (1802–1872), German philosopher and philologist, was born on Nov 30, 1802, at Eutin, near Lübeck He was educated at the universities of Kiel, Leipzig and Berlin He became more and more attracted to the study of Plato and Aristotle, and his doctor's dissertation (1826) was an attempt to reach through Aristotle's criticisms a more accurate knowledge of the Platonic philosophy (*Platonis de ideis et numeris doctrina ex Aristotele illustrata*) He spent seven years as tutor in a private family, occupying his leisure in preparing a critical edition of Aristotle's *De anima* (1833; 2nd ed by C Belger, 1877) In 1833 Altenstein, Prussian minister of education, appointed Trendelenburg extraordinary professor in Berlin, and four years later he was advanced to an ordinary professorship In 1865 he engaged in an acrimonious controversy on the interpretation of Kant's doctrine of Space with Kuno Fischer, whom he attacked in *Kuno Fischer und sein Kant* (1869), which drew forth the reply *Anti-Trendelenburg* (1870) He died on Jan. 24, 1872

Trendelenburg's *Naturrecht* may be taken as in a manner the completion of his system, his working out of the ideal as present in the real The ethical end is taken to be the idea of humanity, not in the abstract as formulated by Kant, but in the context of the State and of history Law is treated throughout as the vehicle of ethical requirements In Trendelenburg's treatment of the State, as the ethical organism in which the individual (the potential man) may be said first to emerge into actuality, we may trace his nurture on the best ideas of Hellenic antiquity

Trendelenburg was also the author of the following: *Elementa logices Aristotelicae* (1836; 9th ed, 1892; Eng trans., 1881), a selection of passages from the *Organon* with Latin translation and notes, containing the substance of Aristotle's logical doctrine, supplemented by *Erlauterungen zu den Elementen der Aristotelischen Logik* (1842; 3rd ed 1876); *Logische Untersuchungen* (1840; 3rd ed. 1870), and *Die logische Frage in Hegels System* (1843), important factors in the reaction against Hegel; *Historische Beiträge zur Philosophie* (1846–67), in three volumes, the first of which contains a history of the doctrine of the Categories; *Das Naturrecht auf dem Grunde der Ethik* (1860); *Lücken im*

Volkerrecht (1870), a treatise on the defects of international law, occasioned by the war of 1870

On Trendelenburg's life and work *see* H. Bonitz, *Zur Erinnerung an F.A.T* (1872), P. Kleinert, *Grabrede* (1872), E. Bratuschek, *Adolf Trendelenburg* (1873), C von Prantl, *Gedachtnissrede* (Munich, 1873), G. S Morris in the *New Englander* (1874), xxxiii

TRENT, the chief river in the midlands of England, the third in length in the country, exceeded only by the Thames and Severn. It rises in north Staffordshire, and discharges through the Humber into the North Sea, having a course of about 170 m The source is on Biddulph Moor The course is first southerly, and it skirts the Potteries, passing Stoke-on-Trent Passing Stone, the course becomes south-easterly, and the united waters of the Sow and the Penk are received on the right. Near Rugeley the direction becomes easterly, and near Alrewas the Trent receives the Tame (right), and turns to the north-east The river now passes Burton-on-Trent, in this part of its course forming the boundary between Staffordshire and Derbyshire The valley opens out as the stream, dividing into several channels at Burton and receiving on the left the Dove, enters Derbyshire. It then separates that county from Leicestershire and Nottinghamshire, receives in succession the Derwent (left), Soar (right) and Erewash (left), enters Nottinghamshire, and passes Nottingham, 81¼ m. from the mouth. The next important town is Newark, the Devon (right) joins here The valley becomes flat, though the river is rather deeply entrenched in some parts Forming the boundary between Nottingham and Lincolnshire, the Trent passes Gainsborough, receives the Idle (left) and, entering Lincolnshire and skirting the Isle of Axholme, joins the Yorkshire Ouse near Faxfleet The lower part of the valley resembles the Fens in character The highest tides are about 40 m up river, and the phenomenon of a bore is seen rising on spring tides to a height of 4 or 5 ft, 15 m above the mouth of the river

The Trent is navigable for 94¾ m from its junction with the Ouse, to a point a short distance above the junction of the Derwent It is also navigable for barges of 120 tons as far as Nottingham There are eight locks Below Gainsborough the navigation is open, and vessels drawing 9 ft can reach this point on spring tides. From the Derwent mouth the Trent and Mersey Canal follows the Trent valley upward, and gives connection with the inland navigation system of the midlands and west of England Short canals give access to Derby and the Erewash valley, the Leicester Navigation, following the Soar, connects with the Grand Junction canal; and the Grantham Canal carries a little traffic between that town and Nottingham The Fossdyke, connects the Trent with Lincoln and the Witham, and lower down the Sheffield and South Yorkshire canal joins the river from the west at Keadby There is also a canal, little used, to Chesterfield

TRENT (ITALY) *see* TRENTO

TRENT, COUNCIL OF. The Council of Trent (1545–1563) has a long antecedent history of great significance for the fortunes of the Catholic Church During the 15th and the earlier half of the 16th century, the conception of an "ecumenical council" remained an ideal of which the realization was expected to provide a solution for the serious ecclesiastical difficulties which were then prevalent The emperor Charles V urged on the papacy the necessity of convening a general assembly of the church The passive resistance of the Curia was so stubborn that the decisive step was postponed time and again But the goal was finally attained, and this result was the work of Charles, aided by three powerful cardinals

The bull *Laetare Hierusalem* (November 19. 1544) fixed the meeting of the council for March 15, 1545, in Trent, and assigned it three tasks: (1) the pacification of the religious dispute by doctrinal decisions. (2) the reform of ecclesiastical abuses, (3) the discussion of a crusade against the infidels

The opening of the council was deferred once again Towards the end of May 1545, twenty bishops were collected at Trent; but there was no sign of action, and the papal legates—Del Monte, Corvinus and Reginald Pole—delayed the inauguration, the emperor and the pope being at cross purposes as to procedure In the eyes of Paul III the council was simply the means by which he expected to secure a condemnation of the Protestant heresy, in hopes that he would then be in a position to impose the sentence of the Church upon them by force. For him the question of ecclesiastical reform possessed no interest whatever In contrast to this, Charles demanded that these very reforms should be given precedence, and the decisions on points of dogma postponed till he should have compelled the Protestants to send representatives to the council The pope, however, alarmed by the threat of a colloquy in Germany, at last ordered the synod to be opened (December 13, 1545).

The procedure adopted secured the predominance of the Roman chair from the first As the voting was not to be by nations, as at Constance, but by individuals, the last word remained with the Italians, who were in the majority.

The council began its work in the region of dogma by defining the doctrines of the Church with reference to the most important controversial points—a procedure which frustrated the emperor's hopes for a reconciliation with the Protestants. The doctrines dealt with, up to March 1547, were the Holy Scriptures and tradition (*sessio* iv), original sin (*sessio* v), justification (*sessio* vi.), and the sacraments in general, and baptism and confirmation in particular (*sessio* vii) In March the council was moved to Bologna on the pretext that an epidemic was raging in Trent (*sessio* viii.), though, at the imperial command, part of the bishops remained behind But on the 2nd of June the council of Bologna resolved (*sessio* x) to adjourn its labours At the Diet of Augsburg the emperor secured a *modus vivendi*, leavened by the Catholic spirit, between the adherents of either religion, and this provisory settlement—the so-called *Interim* of Augsburg—was promulgated as a law of the empire (June 3, 1548), and declared binding till the council should reassemble But the confusion of ecclesiastical affairs had grown worse confounded through the refusal of the pope to continue the council, when his death (November 10, 1549) changed the situation

Pope Julius III, the former legate Del Monte, caused the council to resume its labours on May 1, 1551 (*sessio* xi), under the presidency of Cardinal Crescentio The personnel was, for the most part, different, and the new members included the Jesuits, Laynez and Salmeron The French clergy had not a single delegate, while the Spanish bishops maintained an independent attitude under the aegis of the emperor, and Protestant deputies were on this occasion required to appear at Trent Their participation, however, was useless, for the discussion of doctrine on the basis of Holy Writ was from the Catholic standpoint impossible, and the revolt of the elector Maurice of Saxony (March 20, 1552) compelled the emperor to leave Innsbruck, and dissolved the conclave Its dogmatic labours were confined to doctrinal decrees on the Lord's Supper (*sessio* xiii), and on the sacraments of penance and extreme unction (*sessio* xiv) On April 28, 1552, the sittings were suspended

Ten years elapsed before the council reassembled for the third time in Trent During the intervening period, the religious problem in Germany had received such a solution as the times admitted by the peace of Augsburg (1555); and the equality there guaranteed between the Protestant estates and the Catholic estates had left the former nothing to hope from a council The incitement to continue the council came from another quarter. It was no longer anxiety with regard to Protestantism that exercised the pressure, but a growing conviction of the imperative need of more stringent reforms within the Catholic Church itself. In France and Spain—the very countries where the Protestant heresy had been most vigorously combated—a great mass of discontent had accumulated, and France already showed a strong inclination to attempt an independent settlement of her ecclesiastical difficulties in a national council. Pius IV. therefore announced (Nov 29, 1560) the convocation of the council; and on Jan. 18, 1562, it was actually reopened (*sessio* xvii.)

The Protestants indeed were also invited but the Evangelical princes, assembled in Naumburg, withheld their assent To secure freedom of action, France and the emperor Ferdinand required that it should rank as a new council; Pius IV, however, designated it a continuation of the earlier meetings. Ferdinand, in

addition to regulations for the amendment of the clergy and the monastic system, demanded above all the legalization of the marriage of the priesthood, while France and Spain laid stress on the recognition of the divine right of the episcopate, and its independence with regard to the pope. In consequence of these reformatory aspirations, the position of the pope and the council was for a while full of peril But the papal diplomacy, by concessions, threats, and by exploiting political and ecclesiastical dissensions, broke the force of the attack. In the third period of the council, which, as a result of these feuds, witnessed no session from September 1562 to July 1563, doctrinal resolutions were also passed concerning the Lord's Supper *sub utraque specie* (*sessio* xxi), the sacrifice of the Mass (*sessio* xxii.), the sacrament of ordination (*sessio* xxiii.), the sacrament of marriage (*sessio* xxiv.), and Purgatory, the worship of saints, relics and images. On Dec. 4, 1563, the synod closed.

The dogmatic decisions of the Council of Trent make no attempt at embracing the whole doctrinal system of the Roman Catholic Church, but present a selection of the most vital doctrines, partly chosen as a counterblast to Protestantism, and formulated throughout with a view to that creed and its objections

The reformatory enactments touch on numerous phases of ecclesiastical life—administration, discipline, appointment to spiritual offices, the marriage law (*decretum de reformatione matrimonii "Tametsi," sessio* xxiv), the duties of the clergy, and so forth. The resolutions include many that marked an advance, but the opportunity for a comprehensive and thorough reformation of the life of the Church—the necessity of which was recognized in the Catholic Church itself—was not embraced No alteration of the abuses which obtained in the Curia was effected, and no annulment of the customs, so lucrative to that body and deleterious to others, was attempted

The Council of Trent in fact enjoyed only a certain appearance of independence For the freedom of speech which had been accorded was exercised under the supervision of papal legates, who maintained a decisive influence over the proceedings and could count on a certain majority in consequence of the overwhelming number of Italians That the synod figured as the responsible author of its own decrees (*sancta oecumenica et generalis tridentina synodus in spiritu sancto legitime congregata*) proves very little, since the following clause reads *praesidentibus apostolicae sedis legatis;* while the legates and the pope expressly refused to sanction an application of the words of the Council of Constance—*universalem ecclesiam repraesentans.*

The whole course of the council was determined by the presupposition that it had no autonomous standing, and that its labours were simply transacted under the commission and guidance of the pope This was not merely a claim put forward by the Roman see at the time, it was acknowledged by the attitude of the synod throughout The legates confined the right of discussion to the subjects propounded by the pope, and their position was that he was in no way bound by the vote of the majority. In difficult cases the synod itself left the decision to him, as in the question of Clandestine Marriages and the Administration of the Lord's Supper *sub utraque specie.* Further, at the close of the sessions a resolution was adopted, by the terms of which all the enactments of the council *de morum reformatione atque ecclesiastica disciplina* were subject to the limitation that the papal authority should not be prejudiced thereby (*sessio* xxv *cap.* 21). Every doubt as to the papal supremacy is removed when we consider that the Tridentine Fathers sought for all their enactments and decisions the ratification (*confirmatio*) of the pope, which was conferred by Pius IV. in the bull *Benedictus Deus* (January 26, 1564); and in its last meeting (*sessio* xxv) the synod transferred to the pope a number of tasks for which their own time had proved inadequate. These comprised the compilation of a catalogue of forbidden books, a catechism, a short conspectus of the articles of faith and an edition of the missal and the breviary. Thus the council presented the Holy See with a further opportunity of extending its influence and diffusing its views. The ten rules *de libris prohibitis* were published in March 1564; the *Professio fidei tridentinae* in November 1564; and the *Catechismus a decreto concilii tridentini ad parochos*, early in 1568

The oecumenical character of the council was never seriously questioned. On the motion of the legates, the resolutions were submitted to the ambassadors of the secular powers for signature, the French and Spanish envoys alone withholding their assent The recognition of the council's enactments was, none the less, beset with difficulties So far as the doctrinal decisions were concerned no obstacles existed, but the reformatory edicts—adhesion to which was equally required by the synod—stood on a different footing In their character of resolutions claiming to rank as ecclesiastical law they came into conflict with outside interests, and their acceptance by no means implied that the rights of the sovereign, or the needs and circumstances of the respective countries were treated with sufficient consideration The consequence was that there arose an active and, in some cases, a tenacious opposition to an indiscriminate acquiescence in all the Tridentine decrees, especially in France, where only those regulations were recognized which came into collision neither with the rights of the king nor with the liberties of the Gallican Church. In Spain Philip II. allowed, indeed, the publication of the *Tridentinum*, but always with the reservation that the privileges of the king, his vassals and his subjects, should not thereby be infringed

In his official confirmation Pius IV had already strictly prohibited any commentary on the enactments of the council unless undertaken with his approval, and had claimed for himself the sole right of interpretation. In order to supervise the practical working of these enactments, Pius created (1564) a special department of the Curia, the *Congregatio cardinalium concilii tridentini interpretum;* and to this body Sixtus V entrusted the further task of determining the sense of the conciliar decisions in all dubious cases. The *resolutiones* of the congregation—on disputed points—and their *declarationes*—on legal questions—exercised a powerful influence on later development of ecclesiastical law

The Council of Trent attained a quite extraordinary significance for the Roman Catholic Church, and its pre-eminence was unassailed till the *Vaticanum* subordinated all the labours of the Church in the past—whether in the region of doctrine or in that of law—to an infallible pope On the theological side it fixed the results of mediaeval scholasticism and drew from it all that could be of service to the Church. Further, by pronouncing on a series of doctrinal points till then undecided it elaborated the Catholic creed; and, finally, the bold front which it offered to Protestantism in its presentation of the orthodox faith gave to its members the practical lead they so much needed in their resistance to the Evangelical assault. It showed that Church as a living institution, capable of work and achievement, it strengthened the confidence both of her members and herself, and it was a powerful factor in heightening her efficiency as a competitor with Protestantism and in restoring and reinforcing her imperilled unity Indeed, its sphere of influence was still more extensive, for its labours in the field of dogma and ecclesiastical law conditioned the future evolution of the Roman Catholic Church

Bibliography —Supreme among the sources for the history of the council stands the splendidly planned work *Concilium tridentinum; diariorum, actorum, epistularum, tractatuum nova collectio*, ed Societas Goerresiana (in successive volumes, 1901 ff) The following deserve special mention: P Sarpi, *Istoria del concilio tridentino* (London, 1619); Cardinal Sforza Pallavicini, *Istoria del concilio di Trento* (Rome, 1656–57, a counterblast to the preceding); Brischar, *Zur Beurteilung der Kontroversen zwischen Sarpi und Pallavicini* (1844); J. J v Dollinger, *Sammlung von Urkunden zur Geschichte des Konzils von Trient*, i. 1, 2 (1876); *Beitrage zur politischen kirchlichen, und Kulturgeschichte* (3 vols, 1862–82), G Paleottus, *Acta concilii tridentini a 1562 et 1563 usque in finem concilii*, ed. F. Mendham (1842), A. v Druffel, *Monumenta tridentina* (3 parts, 1884–87, parts 4 and 5, continued by K. Brandi, 1897–99); *Zur Geschichte des Konzils von Trient Aktenstucke aus den osterreichischen Archiven*, ed T v Sickel (3 parts, 1870–72), F Lainez, *Disputationes tridentinae*, ed Grisar (2 vols, 1886); *Die romische Kurie und das Konzil von Trient unter Pius IV. Aktenstucke zur Geschichte des Konzils von Trient*, ed F Susta (vols. i ii, 1904–09); *Canones et decreta concilii tridentini* (1564; critical edition by A L Richter, 1853); Wessenberg, *Die grossen Kirchenversammlungen des 15ten und 16ten Jahrhunderts*, vols. iii. and iv. (Constance, 1840); L. v. Ranke, *Die römischen Papste im 16 und 17 Jahrhundert*, vol. i; ibid. *Deutsche Geschichte im Zeitalter der Refor-*

mation, i. (Stuttgart, 1889); P. Tschackert, *s.v.* "Trienter Konzil," in Herzog-Hauck, *Realencyklopadie fur protestantische Theologie* (1908), vol. xx., ed. 3. (C. Mi.; X.)

TRENTE ET QUARANTE (called also *Rouge et Noir*), a game of French origin played with cards and a special table. It is one of the two games played in the gambling rooms at Monte Carlo, roulette being the other. The diagram illustrates one half of the table, the other half precisely corresponding to it. Two croupiers sit on each side, one of them being the dealer; behind the two on the side opposite to the dealer a supervisor of the game has his seat. Six packs of fifty-two cards each are used; these are well shuffled, and the croupier asks any of the players to cut, handing him a blank card with which to divide the mixed packs There are only four chances at trente et quarante. *rouge* or *noir*, known as the *grand tableau*, *couleur* or *inverse*, known as the *petit tableau*. At Monte Carlo the stakes are placed on the divisions indicated on the table, the maximum being 12,000 francs and the minimum 20 francs which must be staked in counters. The dealer, who has placed all the cards before him, separates a few with the blank card, takes them in his left hand and invites the players to stake with the formula, "Messieurs, faites votre jeu!" After a pause he exclaims "Le jeu est fait, rien ne va plus!" after which no stake can be made. He then deals the cards in a row until the aggregate number of pips is something more than 30, upon which he deals a second row, and that which comes nearest to 30 wins, the top row being always distinguished as *noir*, and the lower as *rouge* In announcing the result the word *trente* is always omitted, the dealer merely announcing *un*, *trois*, *quatre*, as the case may be, though when 40 is turned up it is described as *quarante*. The words *noir* and *inverse* are also never used, the announcement being *rouge gagne* or *rouge perd*, *couleur gagne* or *couleur perd* Gain or loss over *couleur* and *inverse* depends upon the colour of the first card dealt. If this should be also the colour of the winning row, the player wins. Assuming, for example, that the first card dealt is red, and that the lower row of the cards dealt is nearest to 30, the dealer will announce "Rouge gagne et le couleur." If the first card dealt is red, but the black or top row of cards is nearest to 30, the dealer announces "Rouge perd et le couleur." It frequently happens that both rows of cards when added together give the same number. Should they both, for instance, add up to 33, the dealer will announce "Trois après," and the deal goes for nothing except in the event of their adding up to 31. *Un après* (*i e.*, 31) is known as a *refait;* the stakes are put in prison to be left for the decision of the next deal, or if the player prefers it he can withdraw half his stake, leaving the other half for the bank. Assurance against a *refait* can be made by paying 1% on the value of the stake with a minimum of five francs. When thus insured against a *refait* the player is at liberty to withdraw his whole stake. It has been calculated that on an average a *refait* occurs once in 38 coups After each deal the cards are pushed into a metal bowl let into the table in front of the dealer. When he has not enough left to complete the two rows, he remarks "Les cartes passent"; they are taken from the bowl, reshuffled, and another deal begins.

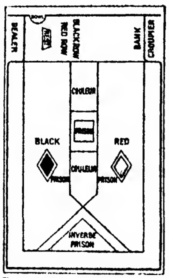


DIAGRAM SHOWING HALF OF TRENTE ET QUARANTE TABLE

TRENTINO, a mountainous area of North Italy, extending E. and W. of the middle course of the Adige. Before the World War it was part of the Austrian province of Tirol. The Trentino frontier, which had been delimited after the war of 1866, was strategically most unfavourable to Italy, as it left the mountain ranges wholly in Austrian hands and formed a wedge whence a dozen military roads branched outwards threatening the richest and most fertile parts of Italy It also left 400,000 Italians under Austrian rule. During the war the Trentino was the scene of heavy fighting, which extended from the Stelvio pass to the Ampezzo valley and spread over into the Asiago plateau within the borders of Italy. Early in the war the Italian troops occupied a number of positions beyond the frontier, especially east of the Adige, whence their line extended from north of Mori, along the Terragnolo valley, Costa d'Agra, across the Astico, Cima Mandriolo, across the river Brenta in the Val Sugana to the Cima d'Asta; farther east all the Ampezzo valley was occupied to the Tofana and Cristallo groups. There were many engagements in the autumn and winter of 1915, especially north of the Cadore and at the head of the Cordevole valley round the Col di Lana, the attacks on which caused serious losses to the Italians, until in April 1916 the summit was blown up by an Italian mine and the hill remained in Italian hands. The fighting on the Stelvio, the Adamello, the Ampezzo group and the peaks round San Martino di Castrozza was at a very high altitude, and the troops had to perform what even in ordinary times would be regarded as notable mountaineering exploits amid ice, snow and extremely difficult rocky terrain, exposed to intense cold, severe storms and heavy enemy fire, the Austrians usually holding the most favourable positions. Roads had to be built up the most precipitous mountains and heavy guns dragged up to a height of 2,000 to 3,000 feet The Italians managed to capture many of these positions, although at the cost of heavy losses; but in May 1916 the Austrians, after an intense artillery preparation with masses of heavy guns, launched a formidable attack on the Terragnolo–Val Sugana–Folgaria–Asiago area and drove the Italians back for a considerable distance. The object was to debouch into the Vicenza plain and cut the communications with the Isonzo army. There was desperate fighting along the whole line, but the key positions of Coni Zugna, Passo Buole and the Pasubio to the west and the peaks on the outer edge of the Asiago plateau on the east held firm. By June 16 the momentum of the Austrians had exhausted itself, and an Italian counter-attack recovered most of the lost ground After the Austrian break-through at Caporetto in Oct. 1917, an attempt was made to effect a breach also in the Asiago plateau. The Ampezzo and Cadore areas had to be evacuated by the Italians, and in the heavy fighting through Nov and Dec. some of the positions on the plateau were again lost, but the outer edge was held, and the Austrians failed to descend into the plain In the battle of June 1918, when the west sector of the Asiago area was held by British troops, another attack was delivered there, and although the Austrians at first broke through at several points they were driven back to their original line. When the final battle of the war began (Oct 23, 1918) the Italians, together with British and French forces, carried out a demonstrative action to prevent the enemy from shifting reserves to the Grappa and Piave areas where the main attacks were being delivered. It was from the Asiago plateau that the victorious troops on Nov. 1 poured into the Val Sugana, while the I. Army advanced up the Adige valley and the two forces converged on Trento, which was reached on Nov. 3.

TRENTO (Lat *Tridentum;* Ger. *Trent* or *Trient*), the capital of a province in the district of Venezia Tridentina, Italy. Pop. (1921), 31,881, town; 35,130, commune. It stands on the left bank of the Adige where this river is joined by the Fersina, and is a station on the Brenner railway, 35 m S of Bolzano and 56½ m. N of Verona, while a railway runs along the Fersina valley and the Val Sugana to Bassano (60 m.). There is also an electric railway to Malè (45 m. N.). It has a very picturesque appearance, especially when approached from the north, with its embattled walls and towers filling the whole breadth of the valley. A conspicuous feature in the view is the isolated rock Doss Trento (the site of the Roman *Verruca*), that rises on the right bank of the Adige to a height of 308 ft. above the city. The cathedral (dedicated to San Vigilio, the first bishop) was altered at various times between the 11th and 15th centuries, and was restored in 1882–89. Outside is the fine fountain of Neptune (1767–69). The Renaissance church of Santa Maria Maggiore, built in 1520–39, was the scene of the sessions of the famous Oecumenical Council (*see* p. 454) which lasted, with several breaks, from 1545 to 1563, during the episcopate of Cristoforo Madruzzo. To the east of the city rises the Castello del Buon Consiglio, for centuries the residence of the prince-bishops, which is decorated with interesting frescoes, and contains the museum of antiquities and fine arts

for the district. Opposite the railway station a statue of Dante by Zocchi was erected in 1896.

Tridentum, the capital of the Tridentini, was a station on the great road from Verona to Veldidena (Innsbruck) over the Brenner. It was later ruled by the Ostrogoths (5th century) and the Lombards (6th century) after the conquest of whom by the Franks (774) Trento became part of the kingdom of Italy. But in 1027 the emperor Conrad II bestowed all temporal rights in the region on the bishop (the see dates from the 4th century) and transferred it to Germany, an event which fixed all its later history. The Venetian attacks were finally repulsed in 1487, and the bishop retained his temporal powers till 1803 when they passed to Austria In 1814 the Trentino was formally annexed to the Austrian province of Tirol. Trento became an Italian city in 1919, when the Trentino passed from Austrian to Italian hands.

TRENTON, a city of Missouri, U S A., 100 m. N E of Kansas City, on the east fork of the Grand river, the county seat of Grundy county. It is on Federal highway 65, and is served by the Quincy, Omaha and Kansas City and the Rock Island railways Pop. (1920) 6,951 (96% native white); estimated locally at 8,000 in 1928. The Rock Island railway has repair shops here Trenton was platted as the county seat in 1841, incorporated as a town in 1857, and chartered as a city in 1893.

TRENTON, the capital city of New Jersey, U S A., and the county seat of Mercer county, on the Lincoln highway and the east bank of the Delaware river, 30 m N E of Philadelphia and 55 m S W of New York city It has a county airport, and is served by the Pennsylvania and the Reading railways, 4 interurban electric lines, numerous motor-bus and truck lines and small steamers and barges on the Delaware river and through the Delaware and Raritan canal to the Raritan river at New Brunswick Pop (1920) 119,289 (25% foreign-born white); 1928 estimate 139,000, with 35,000 more in contiguous suburbs.

Trenton is at the head of navigation on the Delaware, which falls 8 ft. at this point Three miles of the water front is occupied by Riverside park, and there are municipal docks, wharves and warehouses, with which a public roof-garden is combined. The city has an area of 8 5 sq m , of which 266 ac are in public parks; an assessed valuation for 1928 of $248,089,324; and commission form of government, adopted in 1911 It is the seat of a State normal school (1855), the State library, the State school for the deaf, the State home for girls, a State hospital for the insane (1848), the State prison (1836) and the State arsenal, occupying the old prison. The State House stands on high ground not far from the river In Mahlon Stacy park, adjoining the Capitol grounds, are the "Hessian" barracks, erected by the Colony in 1758 to mitigate the evils of billeting, and occupied by British troops during the Seven Years' War, and at different times during the Revolution by British, Hessian and American troops. Washington's crossing of the Delaware on Christmas night, 1776, took place 8 m above Trenton, and in the centre of the city stands a granite column 150 ft high, marking the spot where he planted his guns in the Battle of Trenton on the following day. Among the interesting old houses are "Woodland" (formerly called "Bloomsbury Court"), built early in the 18th century by William Trent, "The Hermitage," and "Bow Hill," a quaint colonial mansion in the suburbs, which for some time before 1822 was the home of Joseph Bonaparte Trenton is the see of Roman Catholic and Protestant Episcopal bishops There are 100 churches in the city, 33 public and 17 parochial schools, hospitals with about 900 beds and a number of homes and other charitable institutions under religious auspices. The Trenton Municipal Colony, on the outskirts of the city, is an assemblage of the city's institutions for the care of the sick and the aged, in connection with a farm of 25 acres. There are two daily papers: the *State Gazette*, established in 1792, and the *Times* (1882).

Trenton is an important industrial city, with 303 manufacturing establishments in 1925, producing goods valued at $126,516,024, of which $16,084,831 represented pottery (14% of the total produced in the United States) and $2,768,250 other clay products. Bank debits in 1927 aggregated $905,187,000.

In 1680 Mahlon Stacy, a Quaker of Burlington, erected a mill on the Delaware here, at the mouth of the Assanpink creek, and by 1685 a small settlement had grown up around it. In 1714 Stacy sold his plantation at "The Falls" to William Trent, later chief justice of New Jersey, after which the village came to be known as Trent-town, or Trenton. In 1745 Trenton was incorporated as a borough by a royal charter, but in 1750 the citizens voluntarily surrendered this privilege, deeming it "very prejudicial to the interest and trade" of the community. In 1783 Trenton was proposed by the New Jersey delegates in Congress for the seat of the Federal Government, and in Nov. 1784, while it was under consideration, Congress met here for a brief period. It became the capital of the State in 1790 and was chartered as a city in 1792 The modern pottery industry dates from 1852. In 1860 the population was 17,228; in 1880, 29,910; in 1900, 73,307; and in 1910, 96,815. There have been no annexations of territory since 1900.

TRENTON AND PRINCETON, BATTLES OF (1776-1777) These battles in the War of American Independence are noted as the first successes won by Washington in the open field. Following close upon a series of defeats, their effect upon his troops and the population at large was marked After the capture of Ft Washington on Manhattan island, on Nov. 16, 1776, the British general, Sir William Howe, forced the Americans to retreat through New Jersey and across the Delaware into Pennsylvania. Howe then went into winter quarters, leaving the Hessian general, Rahl, at Trenton on the river with a brigade of 1,200 men Although Washington's army was discouraged by the year's disasters, it could still be trusted for a promising exploit, and by reinforcements had been brought up to 6,000 effectives. Ascertaining that the Hessians at Trenton were practically unsupported, the American general determined to attempt their capture. He planned to recross the Delaware with three columns, but only his own got across The passage was made on the night of Dec 25, 1776, through floating ice, to a point 9m above the enemy, whom he expected to reach at dawn of the following day, the 26th. Dividing his force of 2,500 men into two divisions under Generals Sullivan and Greene, he approached the town by two roads, surprised the Hessian outposts, and then rushed upon the main body before it could form effectively. The charge of the American troops and the fire of their artillery and musketry completely disconcerted the enemy All avenues of retreat being closed and their general mortally wounded, the latter to the number of 950 quickly surrendered.

Elated by this success and eager to harass the enemy's advanced posts at other points, Washington again crossed the Delaware on Dec 30, and occupied Trenton Hearing of this move Lord Cornwallis at Princeton, 10m north of Trenton, marched down with about 7,000 troops upon the Americans on Jan. 2, 1777, and drove them across the Assanpink, a stream running east of the town The Americans, who encamped on its banks that night, were placed in a precarious position, as the Delaware, with no boats at their disposal at that point, prevented their recrossing into Pennsylvania, and all other roads led towards the British lines to the northward Washington accordingly undertook a bold manoeuvre Fearing an attack by Cornwallis on the next morning, he held a council of war, which confirmed his plan of quietly breaking camp that night and taking a by-road to Princeton, then cutting through any resistance that might be offered there and pushing on to the hills of northern New Jersey, thus placing his army on the flank of the British posts. His tactics succeeded At Princeton (*q v*) he came upon three British regiments, which for a time held him at bay. The 17th foot especially, under Colonel Mawhood, twice routed the American advanced troops, inflicting severe loss, but were eventually driven back toward Trenton. The other regiments retreated north toward New Brunswick, and Washington continued his march to Morristown, New Jersey Here he was on the flank of the British communications with New York, and hence Cornwallis retired to New Brunswick Washington, besides his success in breaking through Howe's lines, had placed himself in an advantageous position for recruiting his army and maintaining a strong defensive in the next campaign These two affairs of Trenton and

Princeton put new life into the American cause, and established Washington in the confidence of his troops and the country

See W. S. Stryker, *The Battles of Trenton and Princeton* (Boston, 1898); and Varnum L. Collins, ed., "A Contemporary Account of the Battles of Trenton and Princeton," *Princeton Hist. Assoc.*, Extra pub. No. 1 (Princeton, N.J., 1906).

TREPOV, DIMITRI FEODOROVICH (1855–1906), Russian general, chief of the imperial police, born at St. Petersburg (Leningrad), was city prefect of Moscow. In the disturbances of 1905 he was placed in command of St. Petersburg, when he immediately took steps to expel all those who had taken part in the procession led by Father Gapon to the Winter Palace The result was an epidemic of strikes throughout the empire. In the railway strike (Oct 20) Trepov gave the famous order to the troops "not to spare their cartridges" He was now made commandant of the imperial police, and used his great power to undermine the authority of Count Witte with the tsar. He then became assistant-minister of the interior An unsuccessful attempt to assassinate him was made on March 30, 1905 He died on Sept. 15, 1906.

TRESCOT, WILLIAM HENRY (1822–1898), American diplomatist, was born in Charleston, S C., on Nov 10, 1822 He graduated at Charleston college in 1840, studied law at Harvard, and was admitted to the bar in 1843 In June, 1860 he was appointed assistant secretary of State, and he was acting secretary of State in June-October, during Gen Lewis Cass's absence from Washington His position was important, because of his intimacy with President Buchanan and his close relations with the secession leaders in South Carolina He opposed the re-enforcement of Ft Sumter and used his influence to prevent any attack on the fort by South Carolina before the meeting of the State's convention called to consider the question of secession. He returned to Charleston in Feb. 1861; served as colonel on the staff of Gen. Roswell S Ripley during the Civil War, and later returned to Washington. He was counsel for the United States before the Halifax Fishery commission in 1877; was minister to Chile in 1881–82 and in 1882 with Gen. U S Grant negotiated a commercial treaty with Mexico. He died at Pendleton, S C, on May 4, 1898

His writings include *The Diplomacy of the Revolution* (1852), *An American View of the Eastern Question* (1854) and *The Diplomatic History of the Administrations of Washington and Adams* (1857).

TRESPASS, in law, any transgression of the law less than treason, felony or misprision of either. The term includes a great variety of wrongs committed to land, goods or person Up to 1694 the trespasser was regarded, nominally at any rate, as a criminal, and was liable to a fine for the breach of the peace, commuted for a small sum of money, for which 5 Will and Mar c. 12 (1693) substituted a fee of 6s 8d recoverable as costs against the defendant Trespass is not now criminal except by special statutory enactment, *e g*, the old statutes against forcible entry, the game acts, and the private acts of many railway companies. When, however, trespass is carried sufficiently far it may become criminal, and be prosecuted as assault if to the person, as nuisance if to the land At one time an important distinction was drawn between trespass general and trespass special or trespass on the case, for which *see* TORT.

In its more restricted sense trespass is generally used for entry on land without lawful authority by either a man, his servants or his cattle. To maintain an action for such trespass the plaintiff must have possession of the premises The most minute invasion of private right is trespass In addition to damages for trespass, an injunction may be granted by the court

Trespass may be justified by exercise of a legal right, as to serve the process of the law, or by invitation or licence of the owner, or may be excused by accident or inevitable necessity, as deviation from a highway out of repair.

In Scots law trespass is used only for torts to land. By the Trespass (Scotland) Act 1865 trespassers are liable on summary conviction to fine and imprisonment for encamping, lighting fires, etc., on land without the consent and permission of the owner.

In the United States, common law doctrines as to trespass hold in most of the States It means, more particularly, an injury to the person, property or rights of another, as the immediate result of a wrongful act committed with actual or implied force. The statutes have provided for criminal trespass in many States, but not to the extent as existed prior to 1694 in England. Trespass on the realty of another often is a criminal offence, through statutory enactment in the States.

TRES TABERNAE (Three Taverns), an ancient village of Latium, Italy, a post station on the Via Appia. It is probable that it stood at Cisterna, where a branch road running from Antium joins the Via Appia. Tres Tabernae is best known as the point to which St. Paul's friends came to meet him on his journey to Rome (Acts xxviii. 15). It became an episcopal see, but this was united with that of Velletri in 592

TRESVIRI or **TRIUMVIRI,** in Rome, a board of three, either ordinary officials or extraordinary commissioners.

1. *Tresviri capitales,* whose duty it was to assist the higher magistrates in their judicial functions, especially criminal, were first appointed about 289 B C. They possessed no criminal jurisdiction or *ius prensionis* (right of arrest) in their own right. They kept watch over prisoners and carried out the death sentence; took accused or suspected persons into custody, and exercised general control over the city police They went the rounds by night to maintain order, and had to be present at outbreaks of fire They assisted the aediles in burning forbidden books. They had to collect the *sacramenta* (deposit forfeited by the losing party in a suit) and examined the plea of exemption put forward by those who refused to act as jurymen In imperial times most of their functions passed into the hands of the *praefectus vigilum.*

2 *Tresviri epulones,* a priestly body, assisted at public banquets They were first created in 196 B C to superintend the *epulum Iovis* (banquet of Jupiter) on the Capitol, but their services were also requisitioned on the occasion of triumphs, imperial birthdays, the dedication of temples, games given by private individuals, and so forth, when entertainments were provided for the people.

3. *Tresviri monetales* were superintendents of the mint, up to the Social War occasional, afterwards permanent, officials. As they acted for the senate they only coined copper money under the empire, the gold and silver coinage being under the exclusive control of the emperor.

4 *Tresviri reipublicae constituendae* was the title bestowed upon Octavianus, Lepidus and Antony for five years by the lex Titia, 43 B C The coalition of Julius Caesar, Pompey and Crassus has also been called a "triumvirate," but they never had the title *tresviri,* and were not a formally appointed commission

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TREVELYAN, GEORGE MACAULAY (C B E 1920), English historian (1876–), third son of Sir George Otto Trevelyan (*q v*), was born on Feb 16, 1876, and educated at Harrow and at Trinity college, Cambridge During the World War he served as Commandant of the 1st British Ambulance unit for Italy (1915–18). In 1927 he became regius professor of modern history at Cambridge.

His numerous publications include: *England under the Stuarts* (1907); *Garibaldi and the Making of Italy* (1911), *The Life of John Bright* (1913), *Lord Grey of the Reform Bill* (1920); *British History of the Nineteenth Century, 1782–1901* (1922); *Manin and the Venetian Revolution of 1848* (1923) and *History of England* (1926).

TREVELYAN, SIR GEORGE OTTO, O.M. 1911 (1838–1928), English historian, was born on July 20, 1838, at Rothley Temple, Leicestershire, the son of Sir C E. Trevelyan and his wife Hannah More Macaulay. He had a brilliant career at Harrow, which he entered in 1851, and at Trinity College, Cambridge. In 1862 he went to India as his father's private secretary, and while there wrote two humorous books, *The Dawk Bungalow,* and *The Competition Wallah,* and in 1865 his first serious work, *Cawnpore.* In 1864 he was again in London, and the following year was returned as Liberal M P. for Tynemouth. From 1868 to 1887 he represented the Hawick Burghs, and from

1887 until his retirement in 1897, the Bridgeton division of Glasgow. In 1868 he had become a civil lord of the Admiralty, but resigned two years later. He then completed his *Life* of his uncle Lord Macaulay, which was immediately recognised as a masterpiece of biography. He was for two years (1880–82) secretary to the Admiralty, and then became for a year chief secretary for Ireland, after the murder of Lord Frederick Cavendish The strain of this position told severely on his health, and he returned in 1884, and was given the office of the duchy of Lancaster, with a seat in the cabinet He was credited with a large share in the authorship of the measure extending household suffrage to the counties (1885) He was secretary for Scotland in the first Home Rule parliament, but resigned with Chamberlain two months later. With Chamberlain he joined the Round Table Conference on the Irish question at Harcourt's house. Finding, however, that Liberal Unionism could not stand alone, he took office under Gladstone in 1892 as secretary for Scotland, a post which he held also in Lord Rosebery's government His many honours were crowned in 1911 with the Order of Merit

His *Life and Letters of Lord Macaulay* (1876) still holds its place as a biography of the first importance, and a new edition was issued in 1923. His next work was *The Early History of Charles James Fox* (1880). The second volume which he intended to write, was put aside in favour of his history of *The American Revolution* This history led to a long and interesting correspondence with Roosevelt, to whom he sent a copy in 1904, some of Roosevelt's letters being published later in *Scribner's Magazine*.

He married in September, 1869, Caroline, daughter of R. N. Philips He died on Aug 16, 1928, and was succeeded in the baronetcy by his eldest son, Charles Philips Trevelyan, M P (b 1870) who was minister for education in Ramsay MacDonald's two administrations, in 1924 and 1928 His second son, Robert Calverley Trevelyan, is the author of admirable translations from the Greek drama, and of original verse His third son was George Macaulay Trevelyan (*q v*)

TREVES, SIR FREDERICK (1853–1923), British surgeon, was born at Dorchester on Feb 15, 1853, and was educated at Merchant Taylor's school, London, and the London hospital, where he became surgical registrar In 1881 he was appointed as professor of pathology and in 1885 as professor of anatomy at the Royal College of Surgeons, subsequently going into private practice He served as consulting surgeon during the South African War in 1900, and was made surgeon extraordinary to Queen Victoria in that year and surgeon to King Edward VII in 1901 He operated on King Edward VII when he fell ill in June 1902 He was created K C V O in 1901 and a baronet in 1902, and later serjeant-surgeon to King George and surgeon in ordinary to Queen Alexandra During the World War he assisted in the founding of the British Red Cross

His publications include several surgical and medical books, of which *Surgical Applied Anatomy* (1883) is well known, as well as a number of more popular books such as *The Tales of a Field Hospital* (1900), *The Riviera of the Corniche Road* (1921), *The Lake of Geneva* (1922), and *The Elephant Man and Other Reminiscences* (1923).

TREVET (or TRIVET), **NICHOLAS** (*c* 1258–*c* 1328), English chronicler, was the son of Sir Thomas Trevet (d 1283), a judge, and became a Dominican friar. After studying at Oxford and in Paris, he spent most of his subsequent years in writing and teaching, and died about 1328 His chief work is his *Annales sex regum Angliae*, a chronicle of English history covering the period between 1135 and 1307, this is valuable for the later part of the reign of Henry III. and especially for that of Edward I.

The *Annales* were published in Paris in 1668, in Oxford in 1719, and were edited by Thomas Hog for the English Historical Society in 1845 Manuscripts are at Oxford and in the British Museum.

TREVI (anc. *Trebiae*), a town of the province of Perugia, Italy, 30 m S E. of Perugia and 5 m S of Foligno by rail. Pop. (1921), 4,566 (town); 6,009 (commune). The town stands on a steep hill 1,355 ft above sea-level. Several of its churches are architecturally interesting, especially the Madonna delle Lacrime (1487) outside the town, and most of them (and also the municipal picture gallery) contain paintings by artists of the Umbrian school—notably Lo Spagna, a pupil of Perugino. The cathedral (S. Emiliano) has a group of three altars decorated with fine sculptures by Rocco da Vicenza (1521).

TREVISO (anc TARVISIUM), a town and episcopal see of Venetia, Italy, capital of the province of Treviso, 49 ft. above sea-level. Pop. in 1921, 35,366 (town); 49,737 (commune) It is situated on the plain between the Gulf of Venice and the Alps, 18 m by rail north of Venice, at the confluence of the Sile with the Botteniga The former flows partly round its walls, the latter through the town, and it has canal communication with the lagoons It has narrow irregular colonnaded streets and old frescoed houses The cathedral of San Pietro, dating from 1141 and restored and enlarged in the 15th century by Pietro Lombardo, with a classical façade of 1836, has seven domes It contains a fine "Annunciation" by Titian (1519), an important "Adoration of the Shepherds" by Paris Bordone (born at Treviso in 1500), and frescoes by Pordenone. There are also sculptures by Lorenzo and Battista Bregno and others The baptistery is Romanesque. The Gothic church of San Nicolò (1310–52) contains important works of art, including a large altarpiece by Fra Marco Pensabene and others, in the church and adjoining chapter-house are frescoes by Tommaso da Modena (1352), some frescoes by whom (life of S Ursula) are also in the Museo Civico The churches of S Leonardo, S Andrea, S Maria Maggiore, and S Maria Maddalena also contain art treasures The Piazza dei Signori contains picturesque brick battlemented palaces—the Palazzo dei Trecento (*c* 1207) and the Palazzo Pretorio (1218–68) The loggia dei Cavalieri (1195) is also fine.

The ancient Tarvisium lay off the main roads, and is hardly mentioned by ancient writers In the 6th century it appears as an important place and was the seat of a Lombard duke. Charlemagne made it the capital of a marquisate. It joined the Lombard league, and was independent after the peace of Constance (1183) until, in 1339, it came under the Venetian sway From 1318 it was for a short time the seat of a university Its walls and ramparts were renewed under the direction of Fra Giocondo (1509), two of the gates, the Porta Mazzini and Porta Cavour, dating from 1517–18 Treviso was taken in 1797 by the French under Mortier (duke of Treviso) In March 1848 the Austrian garrison was driven from the town by the revolutionary party, but in the following June the town was bombarded and compelled to capitulate.

See A Marchesan, *Treviso medioevale* (Treviso, 1923).

TREVITHICK, RICHARD (1771–1833), English engineer and inventor, was born on April 13 in the parish of Illogan, Cornwall, and was the only son of Richard Trevithick (1735–97), manager of the Dolcoath and other important Cornish mines His earliest invention of importance was his improved plunger pole pump (1797) for deep mining, and in 1798 he applied the principle of the plunger pole pump to the construction of a water-pressure engine, which he subsequently improved in various ways Two years later he built a high-pressure non-condensing steam-engine, which became a rival of the low-pressure steam-vacuum engine of Watt He was a precursor of George Stephenson in the construction of locomotive engines On Christmas Eve 1801 his common road locomotive carried the first load of passengers ever conveyed by steam, and on March 24, 1802 he and Andrew Vivian applied for a patent for steam-engines in propelling carriages In 1803 another steam vehicle made by him was run in the streets of London, from Leather Lane along Oxford Street to Paddington, the return journey being made by Islington He next built a steam locomotive for tramways, and in Feb. 1804 at Pen-y-darran in Wales he worked a tramroad locomotive which was able to haul 20 tons of iron; a similar engine was supplied to the Wylam colliery (Newcastle) in the following year. In 1808 he constructed a circular railway in London near Euston Square, on which the public were carried at the rate of 12 or 15 miles an hour round curves of 50 or 100 ft. radius. Trevithick applied his high-pressure engine with great success to rock boring and breaking, as well as to dredging. In 1806 he contracted with the board of Trinity House, London, to lift ballast from the bottom of the Thames, at the rate of 500,000 tons a year, for a payment of 6d a ton. Trevithick

was the first to recognize the importance of iron in the construction of large ships, and in various ways his ideas also influenced the construction of steamboats He was a pioneer in the application of steam to agriculture A high-pressure steam threshing engine was erected by him in 1812 at Trewithen, while in the same year, in a letter to the Board of Agriculture, he stated his belief that every process in agriculture might be performed by steam, and that such a use of the steam-engine would "double the population of the kingdom and make our markets the cheapest in the world." In 1814 he entered on an agreement for the construction of engines for mines in Peru, and to superintend their working removed to Peru in 1816. Thence he went in 1822 to Costa Rica He returned to England in 1827, and in 1828 petitioned parliament for a reward for his inventions, but without success. He died, penniless, at Dartford on April 22, 1833.

A *Life of Richard Trevithick, with an account of his Inventions* was published in 1872 by his third son, Francis Trevithick (1812–77).

TRIAL: *see* PRACTICE AND PROCEDURE

TRIAL BY BATTLE: *see* DUEL and WAGER.

TRIAL OF ANIMALS, an ancient legal custom which persisted in Europe until recent times and which is continued by various savage or barbaric peoples There is evidence that it grew out of the popular belief that animals are intelligent and consequently morally responsible for their acts However, the old doctrine of deodand (*q v*), which penalized inanimate objects that had taken human life, may be germane to the concept of the responsibility of animals, in which case both must be traced to the idea underlying animism. that not only human beings, but all other entities, are endowed with volition and consciousness An early example of legal procedure against animals is furnished by Exodus xxi, 28: "And if an ox gore a man or a woman to death, the ox shall be surely stoned " Plato, in *The Laws,* prescribed that "If a beast of burden or any other animal shall kill anyone, except while the animal is competing in the public games, the relatives of the deceased shall prosecute it for murder."

In Western Europe procedure against animals was settled, both in the ecclesiastical and civil courts; in all cases they were provided with counsel, were duly summoned to appear, exceptions taken in their favour were considered, and their sentences sometimes commuted on the grounds of relative youth, exiguity of body, or a reputation for respectability. a she-ass condemned to death in France in 1750 was pardoned because of good character.

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TRIANGLE. A triangle, or more precisely a plane triangle, is the geometrical figure composed of three points called the *vertices* (not lying in one straight line), and the three straight lines joining these, called the sides Since no part of a plane can be inclosed by fewer than three straight lines, the triangle ranks as the simplest figure of its class, and plays a correspondingly important part in both practical and theoretical geometry

Congruence Theorems.—It is important to recognize the conditions under which two triangles may be known to be *congruent;* that is, alike in all respects except position in space, so that the one triangle is merely the other moved into a new position without change of form The most important theorems of this character have been known from very ancient times, and were handed down in the first book of Euclid's *Elements.*

Two triangles are congruent if two sides of the one are respectively equal in length to two sides of the other, and if these two sides are in each case inclined at the same angle.

Thus in figure 1, to be sure that the triangles ABC and abc are exactly alike, it is enough to know that $AB=ab$, $AC=ac$, and the angle at A=the angle at a It would *not* be enough to know that these same two pairs of sides were equal together with the angles at B and b, since in this case the triangle ABC might equally well have had the form of ABC' in the figure, and therefore not have agreed with abc in form.

Two triangles are congruent if the three sides of the one are equal respectively to the three sides of the other.

Two triangles are congruent if a side of one is equal to a side of the other, and if the angles at the ends of these equal sides are the same in both triangles.

Thus the triangles ABC and abc will be identical in form if

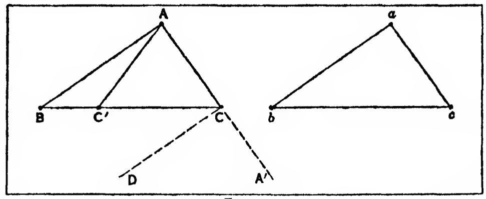

FIG. 1

$BC=bc$, the angle at B=the angle at b, and the angle at C=the angle at c

This theorem supplies the basis for the method of triangulation. If B and C are given stations whose position is known, the measurement of the angles ABC and ACB will determine, together with a knowledge of BC, the form of the triangle ABC, and so the position of A.

Two triangles are congruent if two angles of the one are equal to two angles of the other respectively, and if the sides opposite one of the equal pairs of angles are equal

This theorem is readily reduced to the one before by means of the property stated at the beginning of the next section The same consideration prepares us to accept the statement that two triangles may have the angles of one equal to the angles of the other without being congruent In such a case the triangles are similar in shape, but may be of different sizes.

Relations Between the Parts of a Triangle.—The foregoing remarks emphasize the fact that the three sides and the three angles are not six independent magnitudes to which any values whatsoever may be given For instance it is impossible to draw a triangle in which all the sides are equal and the angles unequal.

The simplest relation connecting the parts of a triangle in general is that *the sum of the three angles is two right angles.* This follows from the fact that, when one side is continued outside the triangle, the angle so formed on the outside is equal to the sum of the angles inside the triangle at the other two vertices. The latter relation is exhibited in figure 1 for the triangle ABC, the line CD, drawn parallel to BA, dividing the exterior angle into two parts, of which DCA' is equal to A, and DDC' to B. The relation between the three angles enables one to find the value of the third when two of the angles are known. Thus, if two of the angles are 60° and 70°, the third is 180°–60°–70° = 50°.

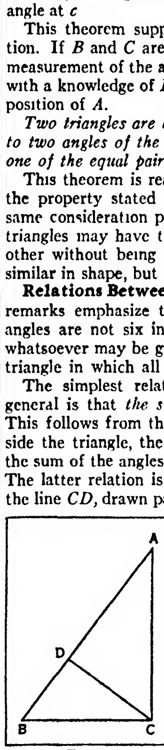

FIG. 2

It is convenient to consider here certain special forms of triangle. A triangle with two equal sides is called *isosceles.* Such a triangle has the angles opposite to these sides also equal. This is easily proved by joining the middle point of the unequal side to the opposite vertex and deducing the congruence of the two triangles so formed. The proof given by Euclid was much more elaborate, because Euclid did not permit the use of the middle point at a stage when the problem of finding it had not been taken up; and the theorem was nick-named the *pons asinorum,* and regarded at one time as a notable obstacle to the beginner in geometry.

A *right triangle* is one which has one of its angles a right angle. In figure 2 the triangle ABC has a right angle at C. Evidently $CB=AB\times s$, and $AC=AB\times k$, where s and k are proper fractions depending on the angle A, and not on the size of the triangle.

The ratios s and k are called the sine and cosine respectively of the angle A, and their theory constitutes the science of trigonometry (*q.v.*). If CD is perpendicular to AB, by the similarity of the three triangles, $BD = CB \times s = AB \times s^2$, *and* $AD = AC \times k = AB \times k^2$. Since $AD + BD = AB$, it follows that $s^2 + k^2 = 1$. On multiplying this equation by AB^2, it is seen that $BC^2 + AC^2 = AB^2$. Here the meaning of BC^2 may be understood to be the

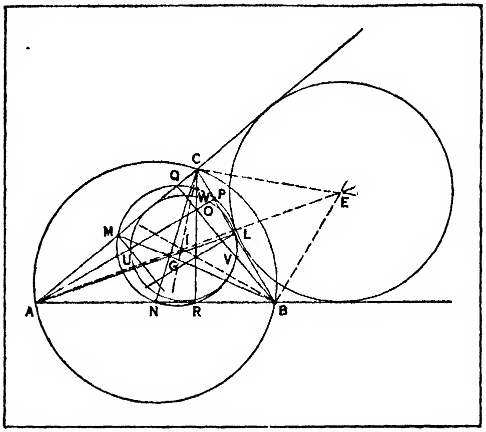

FIG 3

arithmetical square of the number of units in BC The side AB opposite the right angle is called the *hypotenuse* of the right triangle, and the result just obtained is that *the square of the hypotenuse is equal to the sum of the squares of the other two sides*, a theorem ascribed to Pythagoras (*q v*), and of the utmost importance in geometry.

Allusion may be made to two triangle inequalities. (1) *The sum of any two sides is greater than the third side;* (2) *the greater of two unequal sides has the greater angle opposite to it*

As supplementing the preceding statement (2) we have the *sine formula.* In fig. 3, if CR is perpendicular to AB, the sines of A and B are respectively $\frac{RC}{AC}$ and $\frac{RC}{BC}$. These are proportional to BC and AC, so that *the sines of angles are proportional to the lengths of the opposite sides* Also $BC^2 = RB^2 + RC^2 = (AB - AR)^2 + (AC^2 - AR^2) = AB^2 + AC^2 - 2AB\,AR = AB^2 + AC^2 - 2AB \cdot AC\,k$, where k is the cosine of A These two relations are of great importance in triangle computations.

Associated Lines and Circles.—It is only possible to quote summarily a few of the more interesting configurations that arise in connection with the triangle. The construction for the circumscribed circle (which passes through the vertices) reveals that the three straight lines drawn perpendicular to the sides through their middle points meet at a common point, the centre of the circle in question.

The centre of the inscribed circle (which touches the sides and lies between them) is the intersection of another set of concurrent lines, the three internal bisectors of the angles of the triangle.

The bisectors of two exterior angles, as BE and CE in fig. 3, meet at a point on the bisector of the interior angle at the other vertex, this point being the centre of another circle touching the three sides. Four circles in all are found to touch the sides.

The lines joining the vertices to the middle points L,M,N, of the opposite sides meet in a point G called the *centroid.* The perpendiculars AP, BQ and CR meet in a point O, called the *orthocentre.*

There is the remarkable theorem that the points L,M,N,P,Q,R and the middle points U,V,W of AO, BO, CO lie on a circle (the *nine-point circle*), and the still more striking result (Feuerbach's Theorem) that this circle touches the four circles touching the sides of the triangle.

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TRIANGLE, in music, an instrument of percussion of indefinite musical pitch, consisting of a rod of steel bent into the form of a triangle. Suspended by a loop, it is played by means of a short steel rod. The tone of the triangle is clear and ringing, but it should have no definite pitch.

TRIANON, TREATY OF. The treaty of peace between the Allied and Associated Powers and Hungary was signed at the Trianon on June 4, 1920. Owing to the outbreak of Béla Kun's revolution in Hungary, the delegates of that nation were not summoned to the Peace Conference till Nov. 1919. Previous to that date, however, on June 13, 1919 the Supreme Council had decided upon the new frontiers of Rumania and Czechoslovakia and had published them The Hungarian Government received the treaty in Jan. 1920 and on June 4 it was signed at Trianon.

Though the separation of Hungary from Austria and its complete independence were recognized, the details of the Hungarian Treaty were otherwise very closely akin to those of the Austrian, the most important difference being that, while the Treaty of St. Germain was signed with the republic of Austria, that of Trianon was signed with Hungary, or with "the national Government of Hungary," a phrase permitting her to be regarded as a Government where the monarchy is temporarily in suspense Though Charles never abdicated the kingship of Hungary and there is no provision in the treaty for his deposition or for that of any Habsburg, he was formally deposed by a law passed by the Hungarian Assembly (after his attempted *Putsch*, Oct 1921) at the insistence of the Allies. (*See* HABSBURG.) On her admission to the League of Nations in 1922 Hungary submitted to the League a document pledging herself not to restore the Habsburgs without the consent of the Allies, and confirming the undertaking to the Conference of Ambassadors of Nov. 10, 1921.

Territorial Clauses.—The territorial clauses of the Hungarian Treaty reduced her to a population of 7,500,000 (1910 census), of whom approximately 6,250,000 are Hungarians (Magyars); 500,000 are Germans, 500,000 are Jews, 230,000 are Slavs and Slovaks and 50,000 are Rumanians Fiume was ceded to the principal Allies by article 53 and, after being erected into a free city, was eventually annexed by Italy (1924). Hungary lost to other nations over 3,000,000 Magyars, of whom 1,500,000 go to Rumania, nearly 1,000,000 to Czechoslovakia and 500,000 to Yugoslavia. Much of the Magyar population lost (as *e g*, the Székler area) consists of Magyar islands isolated amid a sea of Slavs or Rumanians The Pécs area, with its valuable coal mines, was returned and a line drawn in this area so as to give Hungary a defensible frontier. For economic reasons the three Magyar towns of Satul-Mare (Szatmár) Oradea-Mare (Nagyvárad) and Arad and the surrounding Magyar zone were given to Rumania.

Part V.—The military, naval and air clauses were almost exactly similar to those of the Austrian Treaty except that Hungary was allowed an army of 35,000 instead of Austria's 30,000. Part VI, *Prisoners of War and Graves*, and Part VII, *Penalties*, were the same as in the Austrian Treaty. (*See* ST. GERMAIN, TREATY OF)

Part VIII.—Reparation.—This section is verbally almost identical with the Austrian section, and both are a close imitation of the German. For various reasons it was not possible to fix the exact amount of reparation. But Hungary was forced to surrender all rights to her merchant ships on "the ton for ton, class for class basis," and her reparations in kind were to be fixed in three months by the Reparation Commission, which was to deliver cattle to Italy, to Rumania, and to the Serb-Croat-Slovene kingdom (Annex iv. to Part viii.).

Financial and Economic Clauses.—Articles 180–199 are mainly concerned with liquidating the Austro-Hungarian National Bank, thus separating the last link with Austria Part X., the economic clauses, calls for no special remark, nor does Part XI, Aerial Navigation The economic clauses are the same as the Aus-

trian, the latter like that of both German and Austrian Treaties Part XII, ports, waterways and railways, is mainly concerned with the regulation of the Danube, for which a statute was eventually drawn up. As in the case of the Austrian Treaty (Article 311), the Hungarian in Article 294 provides for the free access of Hungary to the Adriatic, though practically nothing has been done to secure it. Part XIII., labour, is the same in all treaties and Part XIV, miscellaneous provisions, calls for no remark

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TRIASSIC SYSTEM or **TRIAS,** geological terms used to designate the lowest major division of the Mesozoic era—given by F. von Alberti (1834) owing to the division of the system into a threefold series in Germany, in contradistinction to the twofold division (Dyas) of the underlying Permian

Like the Permian (*q v*) the Trias is represented by two phases of sedimentation, the one continental as in Germany, the other marine—the latter being the normal aspect

Where the marine facies is developed the division between the Permian and Triassic systems, or in other words between the Palaeozoic and Mesozoic eras, can best be drawn by means of the faunas Where the continental facies occurs fossil evidence is scanty, and the general similarity of the deposits, together with their rapid changes in lithological type, makes it difficult to define the boundaries of the two systems. In Britain they are so closely knit that the term New Red Sandstone was formerly suggested by Goodchild for the combined Permo-Trias; and there is a tendency to revert to that grouping

Records of the continental phase reside in breccias, conglomerates, red and mottled sandstones, marls and clays, with beds of dolomite, limestone and coal, and layers of gypsum, anhydrite or rock-salt The coarser deposits consist of frost- or sun-riven scree material accumulated almost *in situ*, or as widespreading torrential fans Conglomerates afford evidence of transportation by water, whilst the oblique bedding of certain sandstones, coupled with the perfect rounding of many of the grains and the *dreikanter* form of some of the enclosed pebbles, point to the action of wind Some of the sands may represent dunes, but the majority were deposited with layers of mud in sheets of water which were shallow and subject to frequent desiccation Of this we have evidence in reptilian footprints, fossil rain-pits, ripple-marks, sun-cracks and precipitated salts. Fresh influxes of water are shown by pellets of sun-dried mud and salt-pseudomorphs included in the sandstones

GERMANY

The Trias occupies a larger area than any other formation in Germany and is classified as follows —

Keuper	Rhaetic	Sandstones and clays with *Avicula contorta* Bone bed
	Gypsekeuper	Steinmergel and Stubensandstein Gypsekeuper and Schlifsandstein
	Kohlenkeuper	Grenzdolomite Lettenkohlensandstein Dolomitic limestones and marls
Muschelkalk	Haupt-Muschelkalk	Trigonodus beds Nodusus beds Prochiten Kalk
	Anhydrite group, dolomite, and marls and limestones with rock-salt, gypsum and anhydrite	
	Wellenkalk, with Schaumkalk zones near top	
Bunter	Upper or Roth variegated clays or marls with plants	
	Middle or Hauptsandstein (and Vosgessandstein), with subordinate conglomerates	
	Lower: Sandstones (some clayey) and shales, with oolite (Rogenstein)	

In North and Central Germany the Zechstein clays are succeeded conformably by clayey Bunter beds. In other districts there is unconformity, with overlap of higher members of the Bunter.

The Röth contains rock-salt and bivalve-bearing beds of limestone and dolomite (Rhizocorallum Dolomite)

The Muschelkalk—mainly calcareous—is the only division with a considerable fauna, which is poor, however, in comparison with that of the marine deposits of the Alps. In extent it is inferior to the Bunter, its westward limits stopping short of central France, although it occurs near Toulon and Montpellier In Alsace-Lorraine the Lower Muschelkalk takes on a sandy facies (Muschelsandstein) as does the Middle division in part of Luxembourg The Upper Muschelkalk is the richest in fossils, being characterized by *Ceratites nodosus, C. semipartitus* and *C enodis.*

The Keuper (*Marnes irisées* of France) comprises red and variegated clays, pale sandstones, limestones, dolomites and impure coals Estuarine conditions in the Kohlenkeuper are shown by *Myophoria goldfussi* and *Estheria minuta* as well as relics of fishes (*Acrodus, Ceratodus*, etc.), and terrestrial conditions by Labyrinthodonts and Saurians (*Mastodonsaurus*, etc) The Gypsekeuper contains rock-salt in Lorraine Stubensandstein and Schlifsandstein occur in south Germany The former yields saurian remains (*Aetosaurus ferratus* and *Belodon kappfi*), the latter plants (*Equisetum arenaceum*, etc)

Rhaetic beds, typical of the Rhaetic Alps, mark the return into western Europe, by a wide-spread marine transgression, of the seas that characterized the subsequent Mesozoic era, and form a passage between Keuper and Lias (Infra-Lias of France), although the molluscan fauna and the flora suggest a Triassic age In Germany the Rhaetic consists mainly of pale sandstones and grey shales. The fauna—with *Avicula* (*Pteria*) *contorta, Protocardium rhaeticum,* and other forms—is not rich, but highly important, because of its great extent Remarkable features are the bone-beds, a few inches thick, which occur at several horizons, crowded with teeth, bones, scales and coprolites of fishes and reptiles. Here are found *Ichthyosaurus* and *Plesiosaurus*, anticipating their maximum development; while remains of *Belodon* and *Mystriosuchus* serve as a link with Triassic Stegocephalian reptiles Teeth of *Microlestes antiquus,* the oldest known mammal, occurred near Stuttgart

Trias of German type, including Muschelkalk, extends at intervals beyond the Pyrenees to the south of Spain. Triassic rocks occur in Heligoland and there is an outlier of Upper Triassic in the south of Sweden which includes coal-bearing Keuper and marine Rhaetic Trias with Muschelkalk extends from Silesia into Poland In north-west Russia the beds belong chiefly to the Tartaric stage—in part only Triassic.

BRITAIN AND IRELAND

As in Germany (excluding the Rhaetic) the Trias of Great Britain is of continental facies Its outcrop in England and Wales is narrow in the south-west, but expands in the Midlands and bifurcates at the southern end of the Pennines, one extension projecting into Durham, the other into Cumberland and Westmorland, whence it extends into parts of south Scotland. Other occurrences are found in the Western Isles and on the opposed shores of Moray firth Denudation has removed the Trias from all but north-eastern Ireland.

No representative of the Muschelkalk has been found.

The deposits usually follow the Permian (where developed) with conformity, although minor discordances occur here and there Tending to fill up the Permian basins, they spread, in many cases, further afield and rest upon still older rocks, their higher members often overlapping their lower divisions The typical sequence is as follows, and is compared with that occurring west of the Pennines:

The relationship of Trias to Permian is difficult to determine. As stated elsewhere (*see* PERMIAN) it has been claimed that part, if not all, of the Bunter of Nottinghamshire is equivalent to a great part of the Permian Zechstein of Durham. This awaits more general acceptance or denial: what may be conceded

	S. Lancashire and the Midlands	Maximum thickness	Furness (Lancs.), Westmorland, Cumberland and Isle of Man	Maximum thickness
	Rhaetic beds (marine)		? Rhaetic beds .	..
Keuper	Marls with gypsum	Over 2,000	Stanwix Shales (saliferous) .	About 1,000
Keuper	Waterstones	200		
Keuper	Lower Sandstones and, or, .	200	? Waterstones . .	
Keuper	Basement conglomerates and breccias	400		
Bunter	Upper Mottled Sandstone .	500		
Bunter	Pebble Beds . .	700	Kirklinton Sandstone St. Bees Sandstone	Over 3,000
Bunter	Lower Mottled Sandstone (? Permian)	650	St Bees Shales, with gypsum (Permian-Trias) .	Brockrams 200

is that probably the Lower Mottled Sandstone of South Notts may represent some of the highest Permian strata occurring farther north The Lower Mottled Sandstone of Wirral[1] (Cheshire) is possibly also of Permian age, whilst there are grounds for the belief that the St. Bees Shales (correlated with the Durham Permian Marls) are transition beds and may represent, in part at least, Lower Mottled Sandstone of other areas

The Mottled Sandstones consist typically of alternations of soft red and variegated sandstones, generally without pebbles In Nottinghamshire and south Yorkshire the Upper group is absent The Pebble Beds are harder red and brown sandstones, with, in places, strong false-bedding, aeolian sand grains, dreikanter, etc In some localities they contain abundant quartzose pebbles, probably derived from local sources now concealed In the Midlands they form undulating country typically expressed in Cannock Chase and Sherwood Forest and furnish a first-class water-bearing horizon In Devon is the "Budleigh Salterton Pebble-bed," with pebbles derived both from Normandy and from a northern local source These Pebble beds were accumulated chiefly in shallow water, but some of the coarser deposits may represent dune sands The absence of pebbles, and the finer grade of material, makes it difficult to distinguish the Bunter of north Yorkshire and Durham from the Keuper. The St. Bees and Kirklinton Sandstones also are almost devoid of pebbles. Breccias (Brockrams) were formed continuously to the west of the Cumberland hills both before and during the deposition of the Zechstein, St Bees Shales, and part of the St. Bees Sandstone —emphasizing the intimacy of these deposits

Keuper deposits extend into most of the above described regions, in places slightly unconformable to the Bunter, beyond the limits of which they frequently extend, and may have local breccias at the base Of these the best known is the "Dolomitic Conglomerate" (Bristol district), a shore-line breccia of the inland Keuper sea which gradually buried a well-dissected landscape of older rocks It is largely composed of Carboniferous Limestone set in a dolomitic matrix, but local patches contain Old Red Sandstone It has yielded reptiles (*Thecodontosaurus, Palaeosaurus*) The Keuper of Charnwood Forest, Leicestershire, conceals mountains of which the tops only are now visible

Typical Keuper Marl consists of rhythmic alternations of chocolate red marls, red shales and pale dolomitic sandstones (skerries). In the Midlands is the Arden Sandstone with *Estheria, Hybodus, Acrodus,* Labyrinthodonts and plants The Waterstones are variegated shales and marls with soft red sandstone; whilst the Lower Keuper Sandstones are false-bedded freestones—not always present. In Worcestershire the latter have yielded scorpions, and, near Birkenhead, Cheshire, footprints of reptiles.

At the top of the Keuper is a belt of "tea-green marls" which, in the south-western counties, pass up into fossiliferous grey shales (Sully Beds). These shales have been classed with the Rhaetic.

Gypsum and alabaster appear at several horizons, the most important occurring in the Midlands at 60–70 and 160 ft. respectively below the Rhaetic. They are extensively mined (Newark, Chellaston, etc) In Cheshire and Worcestershire great beds of salt set in at lower horizons, and this mineral appears also at Puriton in Somerset The Stanwix Shales of the Carlisle district carry gypsum, whilst those of the Isle of Man, Walney Island and Preesall, Lancashire, have deposits of rock-salt.

In Britain the Rhaetic (or Penarth) Beds usually consist of White Lias (well developed in the south-west) on dark *Avicula (Pteria) contorta* Shales Certain smooth-textured White Lias limestones yield a landscape marble (Cotham): at the top is the sun-bed or "jew-stone" At the base of the *Avicula* Shales is a bone-bed with fossils similar to those of Germany, including the mammal *Microlestes*, which is also found in the Sully Beds

In South Scotland the Annan Sandstone is correlated with the St. Bees Sandstone, whilst in Arran the Bennan Shales and Auchenshaw Sandstones and Shales are considered to be Bunter, and the overlying marls and shales (Levencorroch and Torr nan Uain) Keuper. At the top are grey-green marls succeeded by Rhaetic Beds Triassic rocks occur also in Skye, Raasay and Mull—breccias, conglomerates, marls and cornstones, with gypsum in the upper beds—and at Morven and Ardnamurchan (Argyllshire) and Gruinard bay (Ross-shire) There is a complete passage into the Lias here The Trias of Elginshire south of Moray Firth contains sandstones with a reptilian fauna. That of the lower beds is allied to the Karroo forms, whilst the upper beds (Lossiemouth) contain *Hyperodapedon gordoni, Ornithosuchus woodwardi*, etc, which are undeniably Triassic.

In Ireland existing Triassic deposits have been largely protected by Tertiary basalts Both Bunter and Keuper are represented (Lagan valley) very similar to that of the Cumberland coast at Carrickfergus and Kilroot, near Belfast, rock salt is found in the Marls Rhaetic beds with *Avicula contorta*, etc., link the Keuper with the Lias (Larne; Collenglen, near Belfast).

THE ALPS

The marine Trias is frequently referred to as "Alpine," "Mediterranean" or "Pelagic" In Europe and eastwards through Asia it forms part of the deposits of the great Mediterranean sea, or "Tethys," situated north of Gondwanaland (*See* article PERMIAN) The facies is distributed widely in southern Europe, particularly in the eastern Alps, Apennines, Sicily, Balearic Islands, Spain, Balkan Peninsula and part of the Carpathians

In the Alps, where the rocks form a broad zone on both sides, sandy rocks are subordinate to limestones, dolomites and marls, whilst the fauna makes that of the German Muschelkalk appear poor by comparison The following divisions are recognized, chiefly in the eastern Alps —

Keuper	Rhaetic	Dachsteinkalk and Kossener beds	with *Megalodon triqueter* and *Avicula contorta*
Keuper	Noric	Dachsteinkalk and Hauptdolomit (or)	„ *Megalodon triqueter, Worthenia solitaria*, etc
Keuper	Noric	Hallstatterkalk	„ *Pinacoceras metternichi, Cladiscites, Halorites*, etc
Keuper	Karnic	Raibl beds	„ *Tropites subbullatus* and *Trachyceras aonides.*
Keuper	Ladinic	St Cassian beds	„ *Trachyceras aon*
Keuper	Ladinic	Wengen beds	„ *Daonella lommeli*
Keuper	Ladinic	Buchenstein beds	„ *Protrachyceras reitzi, Ceratites, Arcestes*, etc
Muschelkalk	Anisic	Alpine Muschelkalk (with Mendola-dolomite, etc.)	„ *Ceratites trinodosus, Athyris trigonella, Spiriferina fragilis, Pinacoceras, Gervillia socialis*, etc.
Bunter	Scythic	Werfen beds	„ *Myophoria costata, Avicula clarai, Ceratites cassianus, Tirolites*, etc

The Werfen beds (Salzburg) are conformable to the underlying Permian and consist of red sandy shales and beds of gypsum and rock-salt, with impure limestone in the upper part The

Alpine Muschelkalk is highly fossiliferous and differs in many respects from that of Germany, being of truly marine character. Typically the Ladinic consists of limestones, dolomites, tuffs and lavas, though there is also a calcareous and a dolomitic facies. In the St Cassian beds the fossils are dwarfed

The Raibl beds indicate a regression of the sea, evidenced by plant-bearing sandstones (Lunz), and marls with gypsum The Rhaetic consists generally of marly limestones forming a thin but continuous sheet

The small masses of limestone of Bogdoberg (Kirghiz Steppes, south Russia) overlying red sandstones and marls are portions of Muschelkalk of Alpine type on the equivalents of the Bunter.

Marine Trias occurs also in Asia Minor, many parts of Asia as far east as China, the Indo-Pacific islands, Japan, Spitsbergen, New Zealand, New Guinea, Timor, Peru, Colombia, Mexico and western North America With the exception of the last these areas lie north of or on the margins of Gondwanaland. Certain of these occurrences are dealt with below.

ASIA

In India the finest development of marine Trias occurs in the Himalayas In Spiti (Lilang), Garhwal and Kumaon and on the north-west extension of the same geo-synclinal axis in Kashmir the rocks comprise three subdivisions corresponding to the Alpine Bunter, Muschelkalk and Keuper (with Rhaetic). The Bunter, which rests conformably on the Permian Productus Shales, consists of 50 ft. of shales and limestones with an ammonite fauna (*Otoceras, Ophiceras, Meekoceras*) The Muschelkalk is chiefly concretionary limestones, 400 ft thick, with *Ceratites, Siberites,* etc., and, at the top a Daonella (lamellibranch) limestone. The Keuper comprises 2,000 ft of shale and marl beneath thick limestones and dolomites with a cephalopodan fauna The lower division corresponds to the Karnic and Noric stages, whilst the limestones probably represent the Rhaetic

In the north-west Himalayas (Sirban Mountains, Hazara) Trias rests unconformably on Devonian shales and limestones (Infra-Trias). Felsitic lavas are succeeded by limestones from 500–1,200 ft thick, with characteristic fossils

Trias of reduced thickness and comprising only the Lower and part of the Middle division occurs in the western part of the Salt Range where it caps the Permian Productus Limestone The Lower division consists of thin limestones with an extraordinary abundance of *Ceratites.* The Middle, or Muschelkalk, contains many cephalopods

In north Baluchistan shales and slates with a few limestones represent the Rhaetic stage It contains *Monotis* and cephalopods (*Didymites, Halosites*) and rests unconformably on Carboniferous Fusulina limestone. A similar development occurs in the Arakan Yoma of Burma whilst in the Northern Shan States the Noping beds, with *Avicula contorta,* suggest a Rhaetic age

Peninsular India was at this time joined up to Australia and Antarctica, Madagascar, South Africa, and South America, and formed part of the continent named Gondwanaland (*See* article PERMIAN) The Trias is represented by the Middle Gondwana Series which is divided into three groups:—Panchet, Kamthi and Maleri (or Denwa) corresponding approximately to the divisions of the German Trias In the type area (Satpura Range) the rocks consist of massive sandstones, conglomerates, grits and shales devoid of coal seams and are unconformable to the Permian Damuda Series. Vegetation, hitherto profuse, became scanty or failed

The Panchet group (1,500 ft) is of restricted development and is overlapped by the Kamthi division (3,000–8,000 ft.), whilst the Maleri is of variable thickness and occurs but locally. In the Panchet group vertebrate remains include fishes, Labyrinthodonts (*Stegocephala*), Amphibia (*Glyptognathus,* etc.) and reptiles (*Dicynodon,* etc.), whilst the Kamthi group contains similar forms as well as a flora with *Glossopteris, Gangamopteris, Phyllotheca,* etc. The clayey Maleri group has remains of fishes (*Ceratodus*), Labyrinthodonts (*Gondwanosaurus*) and reptiles (*Hyperodapedon,* etc.). Biologically the fauna agrees closely with the English Trias.

AFRICA

In South Africa the Triassic deposits are continental and form the greater part of the Karroo Beds covering much of what is now the Union They occur also in south-west Africa, along the borders of the Kalahari, over parts of Rhodesia, Portuguese Africa and regions farther north.

In the Cape Province, the Permian Ecca Beds are followed by the Beaufort and Stormberg Series, the former divided into Lower, Middle and Upper Beds, the latter into Molteno Beds, Red Beds, Cave Sandstone and Drakenberg Volcanics In central Transvaal the Beaufort Series is absent and the Stormberg Series is represented by Bushveld Marls, Sandstone and Amygdaloids. The Lower Beaufort Beds, with their reptilian remains (*Pariasaurus, Dicynodonts,* etc), are considerd by du Toit to be Upper Permian and the Volcanics to cover the period from Rhaetic to Lias, the Middle Beaufort are Lower Triassic and the remainder (Upper Beaufort–Cave Sandstone) Upper Triassic.

The Beaufort beds of the Cape are divided by lithological characters agreeing with fossil vertebrate zones. The Middle group consists of mudstones and sandstones, whilst the Upper group has more of the bright coloured mudstones. They contain reptiles (*Erythrosuchus, Cynognathus,* etc) and Amphibians (*Trematosaurus,* etc) Plants include *Schizoneura,* and, at the top, *Thinnfeldia, Ginkgoites,* etc Rhodesian representatives are the Upper Wankie Sandstone (with fresh-water beds, *Glossopteris,* and reptiles) and the Madumabisa Shales

The Stormberg Series occurs in Basutoland and neighbouring parts of the Union The Molteno Beds, which disappear northwards, contain silicified trunks of Dadoxylon and plant remains (*Thinnfeldia, Ginkgoites, Schizoneura,* etc). The Red Beds thin northwards, becoming the Bushveld Marls, represented on Rhodesia by Escarpment Grits Next comes the massive Cave Sandstone, with false-bedding primarily of aeolian origin Its counterparts are Bushveld Sandstone (Central Transvaal) and the Forest Sandstone (Rhodesia).

The Drakenberg Volcanics are basaltic lavas with, in places, agglomerates and ashes or beds of sandstone near the base At Mont-aux-Sources, Natal, they are 4,500 ft. thick North of Pretoria (Springbok Flats) they become amygdaloidal basalts, whilst in the Wankie-Zambezi area (Rhodesia) the Batoka Basalts form the picturesque scenery about Victoria Falls. Intrusive into the Karroo system is a phenomenal number of sills and dikes of dolerite

Beaufort beds have been detected on the west coast of Madagascar overlying coal-bearing beds with *Glossopteris.*

AUSTRALIA

In New South Wales Triassic strata of the Sydney-Blue Mountain area follow the Permian nearly conformably. The district was above sea and extended farther east than at present, the deposits being formed in shallow fresh water lakes The Hawkesbury Series is divided into Narrabeen, Hawkesbury Sandstone and Wianamatta Stages in upward sequence The Narrowbeen beds thin westwards from the coast, becoming also coarser *Estheria coghlani* is common at one horizon; *Schizoneura* is abundant; *Glossopteris* is rare

Hawkesbury Sandstones are strikingly represented near Port Jackson and in the canyons and ravines of the Blue Mountains. They contain plants (*Thinnfeldia, Phyllotheca*), fish (*Ceratodus* and shark) and Labyrinthodonts (*Mastodonsaurus, Platyceps*). The Wianamatta beds are largely clay shales with ferns (*Thinnfeldia, Alethopteris australis*), Ginkgoales, Cycadaceae, Equisetaceae, fish (*Palaeoniscus,* etc), a few molluscs and crustacea.

Of slightly later date (Trias-Jura) are the Clarence Series of New South Wales and the Artesian Series of the New England Tableland. They seem to be equivalent to the Ipswich and Burrum Beds of Queensland and the Gippsland and Otway Beds of Victoria. In Tasmania the Knockfofty Series and the overlying Ida Bay Series, near Hobart, possibly represent the Hawkesbury Series.

NEW ZEALAND

Trias forms the lower division of the Hokonui System in New Zealand and consists of sandstones, shales and conglomerates of

estuarine and fluviatile origin (with plant-remains from a continental region to the north-west in the present Tasman sea) intercalated with marine beds containing characteristic species of the Alpine Trias of south Europe and India. The Noric, Karnic and part of the Ladinic stages are represented.

AMERICA

In South America the sea lay westward of Gondwanaland, marine Trias occurring west of the Andes In Uruguay, Paraguay and south Brazil continental deposits are remarkably like those of parts of South Africa. The Rio do Rasto Beds comprise variegated mudstones and sandstones and pass up through aeolian sandstones into the Botucatu Sandstone, which is covered by basaltic lavas that occupy an enormous region in Paraná, Santa Catherina, Paraguay, etc *Scaphonyx,* from the Rio do Rasto Beds is allied to *Erythrosuchus* of the Upper Beaufort Beds. The upper groups resemble the Cave Sandstone and Drakenberg Volcanics

A tillite in eastern Argentina passes up into unfossiliferous beds rather like those of the Falklands, where the thick Lafonian (Permo-Triassic) System covers over one half of the eastern island Towards the top the facies resembles that of the Beaufort Beds.

The Appalachian revolution in North America resulted in the uplift of the eastern and southern part of the continent with the concurrent formation of continental deposits. Open sea lay on the Pacific border and extended inland to the site of the Rocky Mountains, where the chief deposits were of fresh-water type.

In the Eastern States disconnected and faulted troughs filled mainly with Middle and Upper Triassic deposits extend from Nova Scotia through Connecticut and New Jersey (Newark System) to South Carolina Deposits are usually red and everywhere unconformable to underlying formations With them are associated sheets (*e g* "palisades" of the Hudson, New Jersey) and dikes of diabase, and basaltic lavas The Newark System, 20,000 ft. thick, is divided into the Stockton-Norriston, Lockatong and Brunswick Groups. The sediments and their scanty fossils (land-plants, fishes and tracks of reptiles) point to deposition under semi-arid conditions.

The finest development of marine Trias is in the Sierras, California, Nevada, Idaho and Oregon, where the deposits are usually calcareous and about 4,000 ft. thick. From Vancouver to Queen Charlotte Islands they increase to 13.000 ft., more than nine-tenths being volcanic.

The early Triassic sea stretched eastwards possibly to central Wyoming. In middle times it withdrew westward, whilst later it spread from Alaska to northern Mexico. This sea had connection with Asia by the northern Pacific, and with "Tethys" by way of the northern shores of Gondwanaland. The deposits can be divided in harmony with the Alpine Trias, California possessing the best known development of the Upper Trias. The Noric is represented by two zones, in the lower of which coral reefs (*Astraeidae*) extend from California into Alaska. Almost 25% of the fauna is identical with that of the Mediterranean area.

Throughout the Rocky Mountain region between Canada and western Texas, and in northern New Mexico and Arizona, continental Upper Triassic gypsiferous shales and sandstones overlie older eroded formations often of a similar character. They contain bone conglomerates with amphibia (*Stegocephalia*), crocodilian types (*Mystriosuchus*) and dinosaurs Silicified wood, as in the petrified forest of Arizona (Flagstaff), is common. Plants include cycads, ferns and conifers. Gingkos were represented by *Baiera* (also in Upper Karroo). The *Glossopteris* flora, so characteristic of Gondwanaland, is absent. (B. Sm.)

TRIBALLI, in ancient geography, a Thracian people whose earliest home was near the junction of the Angrus and Brongus (the east and west Morava), and included towards the south "the Triballian plain" (Herodotus iv. 49), which corresponds to the plain of Kossovo in Turkey. In 424 B.C they were attacked by Sitalces, king of the Odrysae, who was defeated and lost his life in the engagement. On the other hand they were overcome by the Autariatae, an Illyrian tribe; the date of this event is uncertain (Strabo vii 317). In 376 B.C. a large band of Triballi crossed Mt. Haemus, and were preparing to besiege Abdera when Chabrias appeared off the coast with the Athenian fleet and compelled them to retire In 339 B C. when Philip II of Macedon was returning from his expedition against the Scythians, the Triballi refused to allow him to pass the Haemus unless they received a share of the booty. Hostilities took place, in which Philip was defeated (Justin ix 3), but the Triballi appear to have been subsequently subdued by him After the death of Philip, Alexander the Great in 334 crossed the Haemus and drove the Triballi to the junction of the Lyginus with the Danube Their king Syrmus took refuge in Peuce, an island in the Danube, whither Alexander was unable to follow him The punishment, however, inflicted by him upon the Getae (*q v*) induced the Triballi to sue for peace. In spite, however, of misfortunes at the hands of the Gauls, they continued (135–84 B C) to cause trouble to the Roman governors of Macedonia Under Tiberius mention is made of Triballia in Moesia, and the Emperor Maximin (A D. 235–237) had been commander of a squadron of Triballi

TRIBE. A tribe is defined by Dr. Rivers as "a social group of a simple kind, the members of which speak a common dialect, have a single government, and act together for such common purposes as warfare" In this definition it is necessary to understand by single government a political unity of a very simple kind, which may not imply the existence of any obvious mechanism of government, such as an hereditary monarchy or an elected council, with which we are familiar amongst civilized peoples

Although it is usual to regard primitive peoples as always organized in definite tribes (Carveth Read, *The Origin of Man and his Superstitions,* 1925), the tribe as a definite group is often entirely lacking In the case of pastoral peoples, definite groups with a political function, transcending families and clans, are likely to occur, but a settled population needs no such unification, unless the special demands of industry or the need for united action in warfare necessitate central control or the delimitation of groups Thus it is often difficult in Melanesia to find any division of the people into distinct political units One district usually shades into another politically, unless there is established enmity between the groups, and the names of groups, which might be thought to be tribal names, are found to be of indefinite extension In these cases the social and political organization is comprised in the family, clan and local relations; the political solidarity of any given district depends on the sum-total of family, clan, local and personal relationships in that district (W E. Armstrong, *Rossel Island,* 1928) There is tribal organization but there are no distinct tribes. In other places, however, in which social organization is of the same general kind, but in which conditions, such as isolation on a small island, or historical circumstances, have unified a district, on account of economic or other conditions, we can speak of definite tribes In so far as the political unity of such a district becomes dependent on locality, rather than on kinship and other relationships between the members of the district, the tribe passes into a simple form of state

BIBLIOGRAPHY —The tribe is discussed in most general works on Sociology; for example, in Giddings, *Principles of Sociology* (New York, 1896); in R. H Lowie, *Primitive Society* (1921) under the heading "Government," and in W. H. R. Rivers, *Social Organization* (1924).

TRIBONIAN, the famous jurist and minister of Justinian, was born in Pamphylia in the latter part of the 5th century Adopting the profession of an advocate, he came to Constantinople and practised in the prefectural courts there, reaching such eminence as to attract the notice of the emperor Justinian, who appointed him in 528 one of the ten commissioners directed to prepare the first *Codex* of imperial constitutions. When the commission of sixteen eminent lawyers was created in 530 to compile a collection of extracts from the writings of the great jurists of the earlier empire, Tribonian was made president He had already been raised to the office of quaestor, which at that time was a sort of ministry of law and justice, something like that of the English lord chancellor of the later middle ages During the progress of the work of the commission there broke out in Constantinople (532) the Nika insurrection. Tribonian

was accused of having prostituted his office for the purposes of gain, and the mob searched for him to put him to death (Procop. *Pers.* i. 24–26) Justinian, yielding for the moment, removed him from office, and appointed a certain Basilides in his place. After the suppression of the insurrection the work of codification was resumed A little earlier than the publication of the *Digest*, or *Pandects*, there had been published another but much smaller law-book, the *Institutes*, prepared under Justinian's orders by Tribonian, with Theophilus and Dorotheus, professors of law (see Preface to *Institutes*) About the same time the emperor placed Tribonian at the head of a fourth commission, consisting of himself as chief and four others—Dorotheus, professor at Beyrut, and three practising advocates, who were directed to revise and re-edit the first *Codex* of imperial constitutions. The new *Codex* was published in November 534 With it Tribonian's work of codification was completed But he remained Justinian's chief legal minister. He was reinstated as quaestor some time after 534 (Procop *Pers* i 25, *Anecd* 20) and seems to have held the office as long as he lived He was evidently the prime mover in the various changes effected in the law by the novels of Justinian (*Novellae constitutiones*) The date of his death has been variously assigned to 545, 546 and 547 *See* JUSTINIAN.

The usual criticisms on Tribonian may be found in the *Anti-Tribonianus* (1567) of Francis Hotman, and an answer to them in J P von Ludewig, *Vita Justiniani M. atque Theodorae Augustorum, nec non Triboniani* (1731).

TRIBUNE [Lat *tribunus*, connected with *tribus*, tribe], a name assigned to officers of different descriptions in ancient Rome

Military Tribunes.—The original tribunes were the commanders of the contingents of cavalry and infantry supplied to the Roman army by the early tribes. the Tities, the Ramnes, and the Luceres In the historical period, the infantry in each legion was commanded by six tribunes, and the number six is to be traced to the doubling of the three tribes by the incorporation of the new elements which received the names of *Tities secundi, Ramnes secundi, Luceres secundi* The *tribuni celerum*, or commanders of the horsemen, no longer existed in the later times of the republic, having died out with the decay of the genuine Roman cavalry. So long as the monarchy lasted these tribunes were nominated by the king as commander-in-chief; and the nomination passed over to his successors, the consuls From 362 B C six tribunes were annually nominated by popular vote, in 311 B C the number was raised to 16, and in 207 B C to 24, at which figure it remained The tribunes thus elected sufficed for four legions and ranked as magistrates of the Roman people, designated *tribuni militum a populo*, while those who owed their office to the consuls bore the title of *tribuni rufuli* The rights of the assembly passed to the emperors, and "the military tribunes of Augustus" were still contrasted with those nominated in the camp by the actual commanders. (For *Tribuni aerarii*, *see* AERARII.) There was another important class of tribunes that owed its existence to the army. In the long struggle between the patrician and plebeian sections of the population, the first distinctions to which the plebeians forced their way were military, and the contest for admission to the consulate was, in part, a contest for admission to the supreme command of the national forces. In 445 B C, power was given to the senate of determining from year to year whether consuls or military tribunes with consular authority (*tribuni militares consulari potestate*) should be appointed But no election was valid without the express sanction of the senate

Tribunes of the Plebs.—The most important tribunes were the tribunes of the *plebs* (*tribuni plebis*). These were the outcome of the struggle between the patrician and the plebeian orders When in 494 B C. the plebeian legionaries met on the Sacred Mount, it was determined that the plebeians should by themselves annually appoint executive officers, two tribunes (the very name commemorated the military nature of the revolt) to confront the two consuls, and two helpers, called *aediles*, to balance the *quaestors*, and that the persons of the tribunes and aediles should be regarded as inviolable. The ancient traditions concerning the revolution are extremely confused and contradictory It must have ended in something which was deemed by both the contending bodies to be a binding compact, although the lapse of time has blotted out its terms. This is necessary to explain the "sacrosanct" character always attached to the tribunate. There must have been a formal acceptance by the patricians of the plebeian conditions; probably the oath which was first sworn by the insurgents was afterwards taken by the whole community, and the "sacrosanctity" of the plebeian officials became a part of the constitution. There must also have been some constitutional definition of the powers of the tribunes These rested at first on an extension of the power of veto which the republic had introduced. Just as one consul could invalidate an order of his colleague, so a tribune could invalidate an order of a consul, or of any officer inferior to him There was, no doubt, a vague understanding that only orders which sinned against the just and established practice of the constitution should be annulled, and then only in cases affecting definite individuals. This was technically called *auxilium* The cases which arose most commonly concerned the administration of justice and the levying of troops

Development of the Tribunate.—Although the revolution of 494 B C gave the tribunes a foothold in the constitution, it left them with no very definite resources against breaches of compact by the patricians. The traditional history of the tribunate from 494 to 451 B C. is obscure, but there is a thread running through it which may well be truth We hear of attacks by patricians on the newly won privileges, even of the assassination of a tribune, and of attempts on the part of the plebeians to bring patrician offenders to justice. The plebeians attempted to set up a criminal jurisdiction for their own assembly parallel to that practised by the older centuriate assembly Furthermore, the *plebs* attempted something like legislation; it passed resolutions which it hoped to force the patrician body to accept as valid As to details, only a few are worth notice In the first place, the number of tribunes was raised to ten; how we do not know, but apparently some constitutional recognition of the increase was obtained Then an alteration is made in the mode of election As to the original mode, the authorities are hopelessly at variance It was in accordance with the Roman spirit of order that the tribunes, in summoning their assemblies, should ask the plebeians to organize their supporters in bands. The *curia* was certainly a territorial district, and the tribunes may have originally used it as the basis of their organization If tribunes were elected by plebeians massed *curiatim*, such a meeting would easily be mistaken in later times for the *comitia curiata* A change was introduced in 471 B.C. by the Publilian Law of Volero, which directed that the tribunes should be chosen in an assembly organized on the basis of the Servian tribe, instead of the *curia* This assembly was the germ of the *comitia tributa*. The question by what authority the Law of Volero was sanctioned is difficult to answer Possibly the law was a mere resolution of the plebeians with which the patricians did not interfere, because they did not consider that the mode of election was any concern of theirs Whatever view may be taken of the movement which led to the decemvirate, an important element in it was the agitation carried on by the tribunes for the reduction of the law of Rome to a written code Until they obtained this, it was impossible for them to protect those who appealed against harsh treatment by the consuls in their capacity of judges.

During the decemvirate the tribunate was in abeyance It was called into life again by the revolution of 449 B C, which gave the tribunes a considerably stronger position. Their personal privileges and those of the aediles were renewed The road was opened up to legislation by the tribunes through an assembly summoned by them on the tribe-basis (*concilium plebis*), but subject to the control of the senate. The growth of the influence of this assembly over legislation belongs rather to the history of the *comitia* (q.v.) than to that of the tribunate. After the Hortensian Law of 287 B.C., down to the end of the republic, the legislation of Rome was mainly in the hands of the tribunes. The details of the history of the tribunate in its second period, from 449 to 367 B.C, are hardly less obscure than those which belong to the earlier time. There was, however, on the whole, undoubtedly an advance in dignity and importance Gradually a right was acquired of watching and

interfering with the proceedings of the senate, and even with legislation. Whether the absolute right of veto had been achieved before 367 B.C. may well be doubted. But the original *auxilium*, or right of protecting individuals, was, during this period, undergoing a very remarkable expansion. From forbidding a single act of a magistrate in relation to a single person, the tribunes advanced to forbidding by anticipation all acts of a certain class, whoever the persons affected by these restrictions might prove to be. It therefore became useless for the senate or the *comitia* to pass ordinances if a tribune was ready to forbid the magistrates to carry them out. Ultimately, the mere announcement of such intention by a tribune was sufficient to cause the obnoxious project to drop; that is, the tribunes acquired a right to stop all business alike in the deliberative assembly, the senate, and in the legislative assemblies, or *comitia* The technical name for this right of veto is *intercessio* The two main objects of the tribunes were the opening of the consulate to plebeians, and the regulation of the state domain in the interests of the whole community. Both were attained by the Licinio-Sextian laws of 367 B C.

Then a considerable change came over the tribunate. From being an opposition weapon it became an important wheel in the regular machine of state. As the senate became more and more plebeian, the old friction between senate and tribunes disappeared. It was found that the tribunate served to fill some gaps in the constitution, and its power was placed by common consent on a solid constitutional basis From 367 to 134 B C (when Tiberius Gracchus became tribune) the tribunate was for the most part a mere organ of senatorial government.

Qualifications and Powers.—Even after the difference between patrician and plebeian birth had ceased to be of much consequence, the plebeian character was a necessity for the tribune When the patricians P Sulpicius Rufus and, later, P Clodius (the antagonist of Cicero) desired to enter on a demagogic course, they were compelled to divest themselves of their patrician quality by a peculiar legal process The other necessary qualifications were such as attached to the other Roman magistracies. complete citizenship, absence of certain conditions regarded as disgraceful, and fulfilment of military duties The election took place in a purely plebeian assembly, ranged by tribes, under the presidency of a tribune selected by lot The tribune was bound by law to see a complete set of ten tribunes appointed Technically, the tribunes were reckoned, not as magistrates of the Roman people, but as magistrates of the Roman *plebs;* they therefore had no special robe of office, no lictors, but only messengers (*viatores*), no official chair, like the curule seat, but only benches (*subsellia*) Their right to summon the *plebs* together, whether for the purpose of listening to a speech or for passing ordinances, was rendered absolute by the "laws under sacred sanction" (*leges sacratae*), which had been incorporated with the constitution on the abolition of the decemvirate. The right to summon the senate and to lay business before it was acquired soon after 367 B C, but was seldom exercised, as the tribunes had abundant means of securing what they wanted by pressure applied to the ordinary presidents, the consuls or the praetor. When an *interregnum* came about and there were no "magistrates of the Roman people," the plebeian tribunes became the presidents of the senate and conductors of state business At the end of the republic there were *interregna* of several months' duration, when the tribunes held a position of more than usual importance

The Right of Veto.—The real kernel of the tribune's power consisted in his *intercessio*, or right of invalidating ordinances, whether framed by the senate or proposed by a magistrate to the *comitia*, or issued by a magistrate in pursuance of his office. From 367 B C. down to the time of the Gracchi the power of veto in public matters was, on the whole, used in the interests of the governing families to check opposition arising in their own ranks. A recalcitrant consul was most readily brought to obedience by an exercise of tribunician power. The tribunes found a field for constant activity in watching the administration of justice, and in rendering assistance to those who had received harsh treatment from the magistrates. The tribunes were, in fact, primarily legal functionaries, and constituted in a way a court of appeal. It was to this end that they were forbidden to pass a whole night away from the city, except during the Latin festival on the Alban Mount, and that they were expected to keep their doors open to suppliants by night as well as by day. They held court by day in the Forum and frequently made elaborate legal inquiries into cases where their help was sought. We hear of this not infrequently in Cicero's speeches, and in other writings which deal with legal matters. According to the general principle of the constitution, magistrates could forbid the acts of magistrates equal to or inferior to themselves. For this purpose, the tribunes were deemed superior to all other officers If a tribune exercised his veto no other tribune could annul it, for the veto could not be itself vetoed, but it was possible for another tribune to protect a definite individual from the consequences of disobedience The number of the tribunes made it always possible that one might baulk the action of another, except at times when popular feeling was strongly roused The veto was not, however, absolute in all directions. In some it was limited by statute; thus, the law passed by Gaius Gracchus about the consular provinces did not permit a tribune to veto the annual decree of the senate concerning them. When there was a dictator at the head of the state, the veto was of no avail against him One of the important political functions of the tribunes was to conduct prosecutions of state offenders, particularly ex-magistrates These prosecutions began with a sentence pronounced by the tribune upon the culprit; whereupon, exercising the right given him by the XII Tables, the culprit appealed If the tribune sought to inflict punishment on the culprit's person, the appeal was to the assembly of the centuries; if he wished for a fine, the appeal was to the assembly of the tribes.

The Late Republic and Empire.—It is commonly stated that a great change passed over the tribunate at the time of the Gracchi, and that from their day to the end of the republic it was used as an instrument for setting on foot political agitation and for inducing revolutionary changes This view is an inversion of the facts The tribunate did not create the agitation and the revolutions, but these found vent through the tribunate, which gave to the democratic leaders the hope that acknowledged evils might be cured by constitutional means, and in the desperate struggle to realize it the best democratic tribunes strained the powers of their office to their ruin For the bad tribunes did not hesitate to use for bad ends the powers which had been strained in the attempt to secure what was good But the tribunate only fared like all other parts of the republican constitution in its last period The consuls and the senate were at least as guilty as the tribunes. After a severe restriction of its powers by Sulla and a restoration by Pompeius, which gave a twenty years' respite, the essential force of the tribunate was merged in the imperial constitution, of which indeed it became the principal constituent on the civil side The ten tribunes remained, with very restricted functions The emperors did not become tribunes, but took up into their privileges the essence of the office, the "tribunician authority" (*tribunicia potestas*). This distinction between the principle of the office and the actual tenure of the office was a creation of the late republic Pompeius, for example, when he went to the east, was not made proconsul of all the eastern provinces, but he exercised in them a "proconsular authority," which was the germ of the imperial authority on its military side Similarly the emperor, as civil governor, without being tribune, exercised powers of like quality with the powers of the tribune, though of superior force By virtue of his tribunitian authority he acquired a veto on legislation, became the supreme court of appeal for the empire, and to his person was attached the ancient sacrosanctity. Augustus showed the highest statesmanship in founding his power upon a metamorphosed tribunate rather than upon a metamorphosed dictatorship, upon democratic rather than aristocratic traditions

Rienzi.—The name "tribune" was once again illuminated by a passing glory when assumed by Cola di Rienzi (q v.). The movement which he headed was in many respects extremely like the early movements of the plebeians against the patricians, and his scheme for uniting Italy in one free republic was strangely parallel with the greatest dream of the Gracchi

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TRICAMERON, BATTLE OF (A.D. 535). This battle is one of the landmarks in the Emperor Justinian's (*q v*) series of campaigns by which Italy, Africa and Southern Spain were temporarily recovered In itself it was the decisive victory by which the army of the Eastern Roman empire overthrew the Vandal power in Africa, and in military history it has special significance as an outstanding illustration of the predominant power of cavalry during the 1,000 years which succeeded the overthrow of the Roman (infantry) legions at Adrianople (*q v.*) Belisarius's infantry was a day's march in rear of his cavalry when he encountered the Vandal army, under King Gelimer, assembled in order of battle So great was Belisarius's faith in the combined firepower and mobility of his horse-archers that he accepted the risk of battle without waiting for his infantry He took up a position behind a small stream, hoping that he might have the opportunity to launch his own stroke while the Vandals were entangled in the crossing, and to this end sent out small detachments to tease them into an advance. Finding that the enemy were too wary, or too doubtful of success, to be drawn across the river, Belisarius took a more audacious risk—advancing his own centre through the stream as a bait. Thereupon the Vandals, still holding their centre back, moved their wings forward to envelop and assail the Roman centre during the passage. While the leading lines were locked in this close-quarter struggle, and the rear lines waiting to engage, Belisarius launched his own wings at them The charge, having the advantage of impetus, shattered the Vandal wings. The Roman centre, if hard pressed for a brief time, had admirably fulfilled its rôle of fixing the enemy. The rout of the Vandal wings uncovered their centre, which was then surrounded and almost annihilated by the Romans

TRICERATOPS, an extinct quadripedal herbivorous reptile about 12ft. long, with an immense head bearing three horns and a frill over the neck. Its remains are found in the upper Cretaceous rocks of Wyoming. It is a member of the Ornithopodous group of Dinosaurs (*q.v*).

TRICHINOPOLY, a city and district of British India, in the Madras presidency The city is on the right bank of the river Cauvery, 250 m by rail S.W. from Madras. Pop. (1921), 120,-422. The fort which forms the nucleus of the city measures about 1 m by $\frac{1}{2}$ m; its defences have been removed Within it rises the isolated Rock of Trichinopoly, 273 ft. above the city, which is ascended by a covered stone staircase, entered by a carved gateway, and profusely ornamented Trichinopoly is an important trading centre and railway junction Its industries are goldsmiths' work and modelling in pith; silk-weaving, cigar and soap-making. Trichinopoly and its neighbourhood were the scene of much hard fighting between the English and the French during the Carnatic wars between 1749 and 1761.

The DISTRICT OF TRICHINOPOLY has an area of 4,319 sq m. The surface is generally flat, though broken by masses of crystalline rock, of which the Trichinopoly Rock in the fort is a well-known example. The only mountains are the Pachamalais, which rise to 2,500 ft and extend into Salem district The Cauvery and its branch, the Coleroon, are the only rivers of any importance The climate is very hot and not liable to great variations; the annual average rainfall is about 34 in. The principal crops are rice, millets, other food-grains and oil-seeds. The main line of the South Indian railway traverses the district, with a branch to Erode. In 1921 the population was 1,902,838. The district came into British hands along with the rest of the Carnatic in 1801.

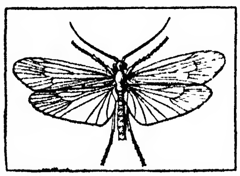
TRICHINOSIS or **TRICHINIASIS,** a disease, in man and other animals, caused by infection by the parasite *Trichina* or *Trichinella spiralis.* The presence of encysted trichinae in the muscles was discovered by Sir James Paget (*q.v.*) in 1835, and they were named by Sir R. Owen, but it was not until 1860 that the clinical characters of the acute disease caused by the invasion of the parasite were discovered by Friedrich von Zenker (1825–1898). Epidemics of this disease have occurred from time to time, especially in north Germany, from the eating of uncooked swine's flesh, in which trichinae are not uncommon.

The symptoms in man are occasioned by the presence of the free parasites in the intestine, by the development of young trichinae from the eggs, and most of all by the migration of the parasites from the intestinal canal to the muscles, where they become quiescent. This cycle occupies from four to six weeks. Lime-salts become deposited in the capsule, the calcification rendering the cyst visible, and this change usually takes five or six months. When consumed in small quantity, the parasites may give rise to no symptoms. In more serious cases, sometimes ending fatally, the early symptoms are nausea, failure of appetite, diarrhoea and fever; later, when the migration to the muscles begins, there is more fever, stiffness, pain and swelling in the limbs, swelling of the eyelids, continued exhausting diarrhoea, perspiration and sometimes delirium. The existence of a marked leucocytosis with an extraordinary increase of eosinophiles helps diagnosis in cases where the symptoms are obscure. If the diagnosis be made early in the case, brisk purgatives, particularly calomel, are the best treatment; if the parasites are already on their way to the muscles, the only thing left to do is to support the patient's strength.

TRICHOPTERA, the term used in zoological classification for that order of insects whose members are commonly known as caddis-flies. They are sombrely coloured insects, being generally some shade of brown often with darker markings, and are of small or moderate size Caddis-flies are weakly flying insects of moth-like appearance and are closely related to Lepidoptera: they are not often seen on the wing unless disturbed, while many are nocturnal and are attracted to a light. They are found in the vicinity of ponds and streams in which the early stages are passed.

Caddis-flies have four membranous hair-covered wings with a predominantly longitudinal venation. the hind wings are usually the broader and have a plicated posterior lobe. The mouth-parts are of the biting type but are weakly formed and mandibles are either wanting or reduced to vestiges. Metamorphosis is complete, the larvae being more or less eruciform or campodeiform and mostly live in cases formed of various foreign materials. the pupae have the appendages free and strong mandibles are present. More than 1,000 species are known and they are classified into thirteen families: about 400 species inhabit North America and over 170 are found in the British Isles.

The eggs are laid in masses covered with a mucilage and they are deposited in or near water. The larvae are aquatic and are the familiar objects known as caddis worms. They have a well-developed head, biting mouth-parts and rather long legs. respiration takes place either by means of lateral filamentous tracheal gills or through the skin only. The last segment of the body carries a pair of appendages terminated by strong hooks. Most of the larvae construct cases or shelters in which they live: these structures are commonly tubular, and are formed of a warp of silk binding together fragments of leaves, straw, sticks, gravel, sand or even of the shells of small molluscs—the material utilized often being constant for particular species or genera. Since these cases are open at either end a current of water, induced by the undulatory movements of the larva, flows through the case and out at the hind extremity. Some larvae (*Hydropsyche, Philopotamus,* etc.) construct silken snares, instead of cases, which serve to collect food particles wafted through them by the water Pupation takes place either in the larval case or, in species without the latter, in specially constructed shelters of minute stones, sand, etc. The pupa bites its way out by means of its jaws and either swims or wriggles to the surface of the water to allow of the emergence of the perfect insect



FROM MACLACHLAN, "TRANSACTIONS"

TYPICAL CADDIS-FLY (HALESUS GUTTAPENNIS), MAGNIFIED ABOUT TWICE

Caddis-flies are found on all continents but relatively little is known concerning the tropical species. They are to be regarded as beneficial insects, since their larvae are eagerly devoured by

trout and other fishes. In the fossil state they first appear in the Lias of Europe and later in Oligocene Baltic amber.

BIBLIOGRAPHY.—Further information on caddis-flies will be found in works on aquatic insects (*see* INSECTS): *see* also R. MacLachlan, *Trichoptera of the European Fauna* (1874–80), and for the British species *see* the same author in *Trans Entomological Soc. London* (1865, 1882). Life-histories of North American species are given in J. T. Lloyd, *Bull. 21 Lloyd Library* (Cincinnati, 1921). (A. D. I.)

TRICONODONTA, a group of small, extinct, carnivorous mammals of the Jurassic age, characterized by the condition of their molar teeth, which typically bore three cusps arranged in a line, the long axis fore-and-aft. They left no descendants. *See* MAMMALIA, PALAEONTOLOGY.

TRICOUPIS (or TRICOUPI), **CHARILAOS** (1832–1896), Greek statesman, born at Nauplia, was sent to London in 1852 as an attaché of the Greek legation In 1865, after he had concluded the negotiations for the cession by Great Britain to Greece of the Ionian Islands, he entered the Greek chamber of deputies, and in 1866 became foreign minister, at the early age of thirty-four He was prime minister for a few months in 1875 and again in 1880, 1882, and in 1885. In his fourth premiership he took seriously in hand a financial reconstruction. But, in spite of all his efforts, Greece could not meet her obligations. Tricoupis tried to make terms with the creditors of his nation, but he failed in this also. The first taxation which he proposed aroused great hostility, and in January 1895 he resigned At the general election, four months later, he and his party were defeated He retired from public life and died at Cannes on April 11, 1896

TRICYCLE. A light road vehicle similar to a bicycle (*q v*) but designed with three road wheels instead of two In use it therefore differs from a bicycle in that it is inherently stable and requires no "balancing," and so is specially suitable for elderly or nervous persons desiring to cycle for health or pleasure.

Tricycles for tradesmen's carriers have two wheels side by side at the front, and a single wheel behind The box intended for goods is usually built between the two front wheels, while the rider sits on a saddle mounted on a frame extending from the axle of the front wheels to the rear wheel, and steers the two wheels with box by a bar fastened to the box. He drives the latter wheel by a similar arrangement of cranks, chain and sprocket as that on a bicycle

For pleasure purposes the tricycle has the single or steering wheel at the front, and the two driving wheels behind From the front of the wheel to the rider's saddle, and down to the bracket holding the cranks and pedals, etc the construction is identical with that of a bicycle, but rearward there are bracing tubes connecting the seat lug (*see* BICYCLE) to each end of the axle on which the rear wheels are mounted, while two or more strong tubes are taken from the bracket to the centre of the axle to withstand the driving thrust The driving chain runs over a small sprocket wheel mounted at or about the centre of the axle, but to permit one wheel to over-run the other, as in rounding corners, etc, the axle is in two halves connected by a differential (*see* MOTOR-CAR) on which the driven sprocket is mounted.

TRIDYMITE, a rare mineral consisting of silicon oxide or silica, SiO_2, but differing from quartz in crystalline form. The crystals are small, thin hexagonal plates or scales, which are usually twinned together in groups of three; hence the name, from Greek, τρίδυμος, triplet The apparent hexagonal plates are themselves pseudo-symmetric twins of optically biaxial material, but at a temperature of 117° C these optical anomalies disappear and the plates are then truly hexagonal (β-tridymite) The specific gravity is 2·28 (that of quartz being 2·65). Unlike quartz, tridymite is soluble in a boiling solution of sodium carbonate; it occurs in the cavities of acid volcanic rocks (rhyolite, trachyte and andesite), but in most instances the crystals are replaced by a fine granular aggregate of quartz At a temperature of 870° quartz passes over into β-tridymite with a considerable increase in volume; and this change has an important bearing on siliceous refractory materials used for furnace linings and silica-bricks. At a still higher temperature (1,470°) tridymite itself passes over into another modification of silica known as cristobalite.

TRIER (French *Trèves*), an ancient city of Germany, formerly capital of an archbishopric and electorate of the empire, and now seat of a Roman Catholic bishop and chief town of a governmental department in the Prussian province of the Rhine. Pop. (1925) 57,344. It stands on the Moselle, about 6 m. from the Luxembourg frontier and 69 m. S.W. of Coblenz by rail on the Coblenz-Metz and Cologne-Saarbrücken lines.

Some of the piers and buttresses of the bridge over the Moselle may date from about 28 B C. The well-preserved amphitheatre just outside the modern town to the south-east was probably built in the reign of Trajan or Hadrian It accommodated about 8,000 spectators. The most remarkable Roman building is the *Porta Nigra,* the fortified north gate of the city, 115 ft. long, 75 to 93 ft. high and 29 ft deep, built of sandstone blocks and held together with iron clamps. This building may date from the 1st to the 4th century A D It is also called the *Simeonstor,* after a Greek hermit who inhabited it. In 1035 Archbishop Poppo converted the gate into two churches, one above the other, but all the additions except the apse have now been removed. In the south-east of the city are ruins of the Roman imperial palace, and near the bridge substructures of the 4th-century Roman baths, 660 ft long On the Constantinsplatz stands the brick basilica, probably of the age of Constantine. Converted into a palace for the Frankish kings and their deputies, it passed in 1197 to the archbishops, and was restored (1846–56) and turned into a Protestant church.

Another Roman basilica forms the nucleus of the cathedral. Built under the emperors Valentinian I. and Gratian as a quadrilateral hall, it was converted into a church about the close of the 4th century, and restored by Bishop Nicetius about 550. It is the most important pre-Carolingian church in Germany. Archbishop Poppo and his successors in the 11th and 12th centuries extended the cathedral and added an apse at each end. The vaulting of the nave and aisles and the cloisters were added in the 13th century. In the vaults are buried 26 archbishops and electors The most famous relic preserved is the "Holy Coat of Trier," believed by the devout to be the seamless robe of the Saviour, and said to have been discovered and presented to the city by the empress Helena The cloisters connect the cathedral with the church of Our Lady, a building in the form of a circle intersected by a cross, with a vault, built 1127–1143, and said to be the oldest Gothic church in Germany. St. Matthias in the south, now represented by a 12th-century building, has a Christian cemetery of the Roman age. A market cross dates from 958, and a beautiful Renaissance fountain, the *Petersbrunnen* was erected in 1595. Close by are the *Steipe* or *Rotes Haus,* formerly the town hall, of the 15th century, and the *Frankenturm* or *propugnaculum,* of the 10th century.

The Provincial Museum (1885–89) contains many Roman and mediaeval antiquities, and the town library has valuable examples of early printing Among its most treasured mss are the *codex aureus,* a copy of the gospels presented to the abbey of St. Maximin by Ada, a reputed sister of Charlemagne, and the *codex Egberti* of the 10th century At Igel is a remarkable Roman column, 83 ft high. It dates from the 2nd century, and was the family monument of the Secundini At Nennig is a fine Roman mosaic pavement.

HISTORY

The Treveri or Treviri, from whom the city derived its name, were one of the most powerful tribes among the Belgae, and according to Julius Caesar, who conquered them in 56 B.C., possessed the best cavalry in Gaul. Attempts have been made to show that they were of German origin (*see* BELGAE), but although they were doubtless subject to Germanic influences they spoke a Celtic language The Roman city, Augusta Treverorum, was probably fortified by Augustus about 14 B.C., and organized as a colony about A D. 50, in the reign of Claudius, but is not mentioned before the war of Civilis in 69 (Tacitus, *Hist.* iv.). At first the Treveri resisted the appeal of Civilis and his Batavi to join the revolt, and built a defensive wall from Trier to Andernach, but soon after the two Treverans, Tutor and Classicus, led their fellow tribesmen, aided by the Lingones (Langres), in the attempt to set up a "Gallic empire" After a brief struggle the

rebels were overthrown at Trier by Cerealis, and 113 senators emigrated to Germany (70). Mainly on account of its strategic position, Diocletian, on his reorganization of the empire, made Trier the capital not only of *Belgica Prima*, but of the whole "diocese" of Gaul. Constantine the Great, who generally resided here from 306 to 331, and his successors, beautified the city with public works, and villas arose upon the hillsides.

The Franks, who had thrice previously sacked the city, gained permanent possession of it about 455 The city passed to Lorraine in 843, and to the East Frankish kingdom in 870 Hetti, who occupied the see from 814 to 847, is said to have been the first Archbishop of Trier, and Radbod acquired the temporal rights of the counts of Trier in 898. In the 10th century Archbishop Dietrich I obtained the primacy over Gaul and Germany.

The temporal power of the archbishops was not gained without opposition The German kings Otto IV and Conrad IV. granted charters to the city, which, however, admitted the jurisdiction of its archbishop, Baldwin of Luxembourg, in 1308 This prince, a brother of the emperor Henry VII, ruled from 1307 to 1354 and was the real founder of the power of Trier He raised it to great prosperity by his foresight, and chiefly as a result of the active support he rendered to the emperors Henry VII, Louis the Bavarian, and Charles IV, enlarged his dominions almost to their ultimate extent. He assumed the title of arch-chancellor of Gaul and Arles (or Burgundy), and thenceforward the elector of Trier held the third place in the electoral college After Baldwin's death the prosperity of Trier was checked by wars and disputes between rival claimants to the see, and in 1456 the estates united for the purpose of restoring order and secured the right of electing their archbishops.

Throughout the middle ages the *sancta civitas Trevirorum* was a great seat of monastic learning The university, founded in 1473, existed until 1797 The elector Richard von Greiffenklau (1467–1531) successfully opposed the Reformation and inaugurated the exhibitions of the holy coat, which called forth the denunciations of Luther but long after his time continued to bring wealth and celebrity to the city In the latter half of the 16th century education fell into the hands of the Jesuits.

The last elector and archbishop, Clement Wenceslaus (1768–1802), granted toleration to the Protestants in 1782, established his residence at Coblenz in 1786, and fled from the French in 1794 In 1814 nearly the whole of the former electoral dominions were given to Prussia. A bishopric was again founded in 1821, but it was placed under Cologne The area of the former electoral principality covered a broad strip of territory along the lower Saar and the Moselle from its confluence with that river to the Rhine, with a district on the right bank of the Rhine behind Ehrenbreitstein The chief towns in addition to Trier were Coblenz, Cochem, Beilstein, Oberwesel, Lahnstein, and Sayn The territory under the spiritual authority of the archbishop included the bishoprics of Metz, Toul, and Verdun, and after 1777 also those of Nancy and St Dié.

At the close of 1918, after the Armistice, the town of Trier was occupied by units of the Third American Army, the last of which returned to the United States in 1923

See J. N. von Wilmowsky, *Der Dom zu Trier in seinen drei Hauptperioden* (Trier, 1874); S Beissel, *Geschichte der trierer Kirchen* (Trier, 1888), G Kentenich, *Geschichte der Stadt Trier* (Trier, 1915).

TRIESTE, formerly Austrian, but ceded to Italy under the Treaty of S Germain in 1918, a seaport in the district of Venezia Giulia, Italy, capital of the province of Trieste and an episcopal see, situated at the north-east angle of the Adriatic sea, on the Gulf of Trieste, is picturesquely built on terraces at the foot of the Carso. Pop (1921) 228,523 (town), 238.655 (commune) It is divided into the old and the new town, which are connected by the broad and handsome Via del Corso, the busiest street in the town. The old town, nestling round the hill on which the castle stands, consists of narrow, steep and irregular streets. The new town, which lies on the flat expanse adjoining the crescent-shaped bay, partly on ground that has been reclaimed from the sea, has large and regularly-built streets

The Austrian-Lloyd Steam Navigation company, which for many years has had its headquarters at Trieste, is now the Lloyd-Triestino company, and controls several shipbuilding establishments; it has recently united with the Cosulich company. There is also a large yard at Muggia (3 m. to the S) with about 1,000 workmen; the other industries include petroleum refineries, iron-foundries, chemicals, soap-boiling, silk and cotton spinning, jute works, the production of canned fish, soap, beer and preserves, distilleries, etc.; there are steel works at Servola (three smelters). Several marble quarries are worked in the neighbourhood, and there are some large cement factories Good wine, fruit and olive oil are the most important natural products of the country round Trieste Under Austria, Trieste owed its development to its geographical situation in the north-east angle of the Adriatic sea at the end of the deeply indented gulf, and to its harbour, which was more accessible to large vessels than that of Venice. Besides, it was declared a free imperial port in 1719, and was therefore released from the obstruction to trade contained in the hampering legislation of the period. It was deprived of this privilege in 1891, when only the harbour was declared to be outside the customs limit With the 20th century an active policy was inaugurated New and direct services were started to East Africa, Central America and Mexico; the service to India and the Far East, as well as that to the Mediterranean ports, was much improved, and Trieste was made the centre of the large emigration from Austria to America by the inauguration of a direct emigrant service to New York Railway communications were also improved, and Trieste, besides being the principal port of Austria, was the centre port for much of Germany's trade with the Mediterranean and the East In 1924 Trieste recovered 95% of her pre-war trade, but this abnormal "boom" was not maintained, and the competition of Hamburg is being felt

In 1926, 27,438 ships entered and cleared the port (total tonnage 8,817,124), dealing with 1,700,099 passengers, and in 1927, 1,656,935 tons of goods were imported, and 813,500 were exported. In 1925, 201 ships with a tonnage of 621,015 were registered in the district (compartimento) of Trieste

Trieste is connected by rail with Monfalcone (branch for Gorizia and Udine, Treviso and Venice (another line to Gorizia runs across the Carso), with Postumia Grotte, the frontier station on the line to Lubiana, with Parenzo and with Pola, and by electric railway with Villa Opicina

About 4 m N.W of Trieste on the very edge of the sea is the famous castle of Miramare, built in 1854–56 for the archduke Maximilian, the ill-fated emperor of Mexico

History.—After the break-up of the Roman dominion Trieste shared the general fortunes of Istria From the emperor Lothair II (in 948) it received an independent existence under its count-bishops, and it maintained this position down to its capture by Venice in 1202 For the next 180 years its history consists chiefly of a series of conflicts with this city, which were finally put an end to by Trieste placing itself in 1382 under the protection of Leopold III of Austria The overlordship thus established insensibly developed into actual possession, and except in the Napoleonic period (1797–1805 and 1809–13) Trieste remained an integral part of the Austrian dominions until 1918, though always a centre of Italian irredentist feeling It was an imperial free port from 1719 until 1891.

See Giulio Caprin, *Trieste* (Bergamo, 1906); A. Tamaro, *Storia di Trieste* (Trieste, 1924)

TRIFOLIUM, the generic name of the plants commonly called clover (*q v*), from the Latin *tres*, three and *folium*, a leaf.

TRIFORIUM, in architecture, a longitudinal passage or gallery of a church or other high ceiled interior, the triforium floor being usually above a side aisle vault or ceiling. The usage of the term is loose; by some it is applied to any second floor gallery opening on to a higher nave by means of arcades or colonnades, like the galleries occurring in some pagan Roman basilicas, or similar galleries in Byzantine churches. In other cases its usage is limited to an arcaded gallery above the side aisle of a mediaeval church and below the clerestory windows, thus occupying the height of the side aisle lean-to roof. The triforium became an integral part of interior church design during the Romanesque

period, sometimes merely as a series of openings to light and ventilate the roof space, and sometimes as a complete open gallery, often vaulted with a quarter circle vault, which transmitted the thrust of the main nave vault to the outside walls, as in the church of S. Cernin at Toulouse (begun 1096) With the development of articulated Gothic vaulting in France the usage became confused. At times there was a complete vaulted gallery over the side aisle, which created a lower triforium, in the height of the lean-to roof over this a second, minor triforium was developed, as in Laon cathedral (1160–1205), and in Noyon (1150–1200)

In Notre Dame at Paris (1163–96) the upper triforium was originally represented by a series of simple, round openings with rudimentary tracery opening to the roof space The change in Notre Dame, in the rebuilding (between 1240–58), by which the aisle roofs were flattened, the clerestorey windows heightened and the circular openings eliminated, shows the 13th century dissatisfaction with the old four stage composition, and the upper vaulted gallery is found in few churches of the developed Rayonnant period. Chartres cathedral (1194–1212), Reims cathedral (begun 1220) and Amiens (1220–47) all show triforia of little relative height, but of rich arcading and, in the last, the central mullion of the clerestorey tracery is carried down through the triforium arcading, so as to bind clerestorey and triforium into one composition In the apse of Amiens, moreover, the flatness of the side aisle roofs allows windows to be placed behind the triforium arcading, which thus becomes, as it were, merely a decorated base to the slim clerestorey above This development reaches its climax in the church of S Urbain at Troyes (1262–80), in which the triforium gallery completely disappears as a separate motif, although it is faintly recalled by the tracery of the clerestorey windows

In the Flamboyant period the entire omission of the triforium becomes the rule The English love of horizontal lines shows in a great development of the triforium gallery as an important decorative element in church interiors In both Norman and Gothic work it is relatively much higher than in similar work in France, often almost equalling the pier arcades It frequently receives the richest possible treatment, by the use of both tracery and sculpture The richest and most characteristic example is the angel choir at Lincoln (completed 1282) In the 15th century the tendency toward height of pier arcade and clerestorey window, so clearly shown in Perpendicular work generally, leads to the marked reduction in importance and the final disappearance of the triforium (*See* Byzantine and Romanesque Architecture, Gothic Architecture) (T F H)

TRIGONOMETRY. To compute numerical results for which geometry would require diagrams plotted to scale is the first function of trigonometry Such problems as relate to a figure lying wholly in one plane constitute *plane trigonometry;* principally the calculations of certain unknown distances and angles from other known or measured distances and angles Problems whose diagrams lie in two or more different planes of three-dimensional space are comprised in *spherical trigonometry.* Their relation to a sphere will be shown below Algebraical discussion of such computations or calculations forms what is called *theoretical trigonometry,* while the numerical work is called concrete or *practical trigonometry.*

PLANE TRIGONOMETRY

All solutions of problems of distance and direction in a plane depend upon finding unknown parts of a triangle when three parts are known (or "given"). Most simply, these may be sides and angles, at least one being the length of one side For calculations involving the size of an angle, the ratios of sides in a right triangle are employed, a right triangle having one angle equal to the given angle, or differing from it by some even number of right angles; or the *supplement* of such an angle For convenience of measurement and uniformity of language a technical system is adopted, as follows:

The angle to be measured is depicted in a vertical plane, facing the observer. The angle is defined by one straight segment OA, called its *initial side,* and a second segment OB, its *terminal side.* It is often said to be *generated* by the continuous rotation of a straight segment about the point O, from the position OA to the position OB. Since this rotation has two conceivable directions or senses, one is called the negative sense, namely, that performed by the hands of a clock as seen by an observer standing before its face; the opposite sense of rotation is called positive If one could stand at the position of the north pole-star and face toward the sun, the planets of our solar system would appear in their orbits to revolve in the positive sense about the sun

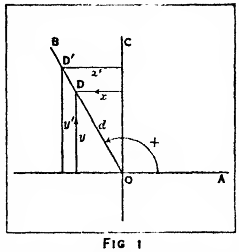


FIG 1

Fix arbitrarily a point D on the terminal segment (fig 1), and let d denote the distance OD Draw a line OC perpendicular to OA and measure the Cartesian coordinates x and y of D, taking as x the distance of D from the line OC (right or left), and y its distance above or below the initial line or that line produced in the direction AO. The indefinitely extended lines OA and OC are termed the axes of coordinates (*see* Coordinates) in this diagram, OA being the x axis and OC the y axis; so that x coordinates are parallel to the x axis, y coordinates parallel to the y axis. Coordinates are measured from an axis, to the point D, and are positive for an acute angle Hence on the diagram which is used here, a positive x extends from the y axis toward the observer's right, a negative x toward his left, a positive y upward from the x axis, a negative y downward These conventional definitions enable us to characterize the picture of any real angle by three real numbers, d, x and y But any new selection of the point D on the terminal line, as D', would give a second set of numbers, d', x', y', which are proportional to d, x and y Accordingly not these numbers, but their ratios, are chosen to describe or measure the angle

Trigonometric Functions or Ratios, of an Angle.—Six names are assigned to the six ratios of the numbers, x, y, d Some symbol, as K, is used for the angle Then

y/d is called the sine of K, or $\sin K = y/d$
x/d „ „ „ cosine of K, or $\cos K = x/d$
y/x „ „ „ tangent of K, or $\tan K = y/x$
x/y „ „ „ cotangent of K, or $\cot K = x/y$
d/x „ „ „ secant of K, or $\sec K = d/x$
d/y „ „ „ cosecant of K, or $\operatorname{cosec} K = d/y$

By definition three of these six are reciprocals of three others;

$$\cot K = 1/\tan K, \quad \sec K = 1/\cos K, \quad \operatorname{cosec} K = 1/\sin K$$

The sine is also the product of two others, $\sin K = \cos K \tan K$ Since also the Pythagorean relation connects x, y and d,—viz, $x^2+y^2=d^2$,—there are quadratic relations or identities among the six ratios One of these is $\sin^2 K + \cos^2 K = 1$. By the use of these five relations or any equivalent set, when the numerical value of any one ratio or function is known the five others can be found numerically, but not always their plus or minus sign If however the *sign* of a second ratio is given, a ratio not the reciprocal of the first, then the rest can be found completely

Limits of Values of the Six Functions —From the fact that d is numerically greater than either x or y, and that either one of the latter may become equal to zero for some angle which is a whole number of right angles, it is seen that two functions of real angles have outer boundaries, two have inner boundaries, and two are unbounded.

$$-1 \leqq \sin K \leqq (+1), \qquad \sec K \geqq (+1) \text{ or } \sec K \leqq (-1),$$
$$-1 \leqq \cos K \leqq (+1), \qquad \operatorname{cosec} K \geqq (+1) \text{ or } \operatorname{cosec} K \leqq (-1),$$

$\tan K$ and $\cot K$ are unlimited in value.

Unit of Real and Imaginary Angles.—In geometry the unit of angle, a *degree,* was defined as one ninetieth part of a right angle, a *degree* is divided into sixty equal parts called *minutes,* and each minute into sixty equal parts called *seconds.* In terms of these units an angle can be described by three whole numbers if it

does not demand more precise measurement, or it may be described by the aid of a decimal fraction of a unit. Astronomers use degrees, minutes, seconds, and often tenths and hundredths of a second. Land surveyors use degrees and minutes, and sometimes tenths of a minute. For purely theoretical discussions a larger unit is usually employed. This is the *radian* and is best described by saying that π radians are the same as 180 degrees. Using the symbols °, ′, ″ for degrees, minutes, seconds, we may say that

$$1 \text{ radian} = 57^\circ{\cdot}2957796 = 57^\circ 17' 44''{\cdot}81$$
$$1 \text{ degree} = 0{\cdot}01745329 \text{ radians.}$$

Glaisher has calculated the value of the radian to 41 places of decimals

In calculations regarding angles it may happen that data are used which do not admit the construction of a *real* triangle (or other figure that is sought); then the impossibility will come to light when either: (a) the value of some function is given by an equation whose roots are imaginary, or (b) the numerical value of some function is excluded by the above statement of boundary values. In either case, (a) or (b), the angle is said to be ***imaginary***.

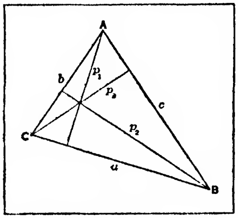


FIG 2

Dissection of an Oblique Triangle into Right Triangles.—From any vertex of an oblique triangle a perpendicular may be drawn to the opposite side In three ways, therefore, the oblique triangle may be looked at as the sum, or the difference, of two right triangles. Then, in fig 2, we have

$$p_1 = b \sin C = c \sin B$$
$$p_2 = a \sin C = c \sin A$$
$$p_3 = a \sin B = b \sin A$$

These equalities give first the

Law of Sines: $\qquad \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$;

and secondly the three equivalent expressions for the area T of this triangle.

$$T = \tfrac{1}{2}ap_1 = \tfrac{1}{2}bp_2 = \tfrac{1}{2}cp_3$$
$$= \tfrac{1}{2}ab \sin C = \tfrac{1}{2}bc \sin A = \tfrac{1}{2}ca \sin B.$$

In this diagram each side is the algebraic sum of two bases of right triangles, and each base is the product of one side of the triangle multiplied by the cosine of an angle. The three equations from this source are

$$a = b \cos C + c \cos B,$$
$$b = c \cos A + a \cos C,$$
$$c = a \cos B + b \cos A$$

Two cosines can be eliminated from these equations, leaving a relation among three sides and one angle.

$$b^2 + c^2 - a^2 = 2bc \cos A,$$

or

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}.$$

By this formula the angles can be computed when the three sides are known, if a table of cosines is available. Or, in terms purely geometric, this formula, and the two similar ones for cos B and cos C, reduce the problem from that of constructing the angles of an oblique triangle whose sides are given to that of constructing the angles of a right triangle when the ratio of two sides is given.

Addition of Angles.—The addition theorem, the most comprehensive formula in theoretical trigonometry, results easily from these cosine-equations and the rule of proportionality of sides and sines in a triangle. Since $A+B+C=180^\circ$, $\sin C = \sin(A+B)$. Also if in a given triangle the ratio $a/\sin A = m$, then $a = m \sin A$, $b = m \sin B$, and $c = m \sin(A+B)$. By these substitutions the third cosine-equation above becomes:

$$m \sin(A+B) = m \sin A \cos B + m \sin B \cos A.$$

This gives the following relation, identically true when A and B are positive real angles with a sum less than 180°:

$$\sin(A+B) = \sin A \cos B + \sin B \cos A.$$

Similar substitutions are made in the formula for cos C,

$$-\cos C = \frac{c^2 - a^2 - b^2}{2ab} = \frac{m^2(\sin^2 C - \sin^2 A - \sin^2 B)}{2m^2 \sin A \sin B}$$
$$= \frac{\sin^2(A+B) - \sin^2 A - \sin^2 B}{2\sin A \sin B}$$
$$= \frac{\sin^2 A(\cos^2 B - 1) + \sin^2 B(\cos^2 A - 1) + 2\sin A \sin B \cos A \cos B}{2\sin A \sin B}$$
$$\therefore -\cos C = \cos(A+B) = \cos A \cos B - \sin A \sin B.$$

The two formulae for sin $(A+B)$ and cos $(A+B)$ are termed the *addition theorem* for the sine and cosine Either may be derived from the other, together with the statements that supplementary angles have equal sines and that their cosines are numerically equal but unlike in sign They are valid not only within the limits already stated for A and B, but for real angles of any magnitude, positive or negative. Demonstration of this universal validity is conveniently made by adding 90° to one angle (as A) at a time and observing that $\sin(A+90^\circ) = \cos A$, $\cos(A+90^\circ) = -\sin A$, and the same for $(A+B+90^\circ)$ and $(A+B)$. Such increase of $A+B$ and A is found to exchange the formulae for sin $(A+B)$ and cos $(A+B)$, whence it is inferred that they are true for angles differing by entire multiples of 90° from acute angles. Further, for imaginary angles the definitions of sine and cosine are taken subject to the postulate that these addition theorems shall remain true

Functions of Multiples of 90°—When an angle becomes an exact multiple of 90°, the prescribed rules for constructing x, y, and d will give either $d=x$, $y=0$ or $d=y$, $x=0$. This gives for sine and cosine the values in this table.

	0°	90°	180°	270°
sine	0	1	0	−1
cosine	1	0	−1	0

Tangent and cotangent become, for such angles, either zero or infinitely great (0 or ∞)

Functions of Double Angles and Half Angles—Equal angles, $A=B$, give for sin $(A+B)$ and cos $(A+B)$ the two formulae.

$$\sin 2A = \sin(A+A) = 2\sin A \cos A,$$
$$\cos 2A = \cos(A+A) = \cos^2 A - \sin^2 A$$
$$= 2\cos^2 A - 1$$
$$= 1 - 2\sin^2 A$$

The latter gives both the following relations

$$\sin A = \sqrt{\left(\frac{1 - \cos 2A}{2}\right)}, \quad \cos A = \sqrt{\left(\frac{1 + \cos 2A}{2}\right)},$$

which relations are commonly quoted in the form:

$$\sin \tfrac{1}{2}A = \sqrt{\left(\frac{1 - \cos A}{2}\right)}, \quad \cos \tfrac{1}{2}A = \sqrt{\left(\frac{1 + \cos A}{2}\right)},$$
$$\tan \tfrac{1}{2}A = \sqrt{\left(\frac{1 - \cos A}{1 + \cos A}\right)}.$$

This permits a more convenient solution for the angles of a triangle when the three sides are given The substitution of $\dfrac{b^2+c^2-a^2}{2bc}$ for cos$A$, with easy factoring, gives

$$\tan \tfrac{1}{2}A = \sqrt{\left[\frac{(b+a-c)(c+a-b)}{(b+c-a)(a+b+c)}\right]},$$

and this allows the use of logarithms in multiplication and the extraction of a square root

Factorizing Formulae.—For a more expeditious calculation when logarithms are used, the sum or difference of two sines or of two cosines can be factored. To factor the sum, $\sin P+\sin Q$, one angle is taken as the sum of two auxiliary angles, and the other as their difference, thus:

$$P=A+B,\ Q=A-B;\ A=\tfrac{1}{2}(P+Q),\ B=\tfrac{1}{2}(P-Q).$$

The addition theorem is then applied for $A+B$ and $A-B$, as follows:

$$\begin{aligned}\sin P+\sin Q&=\sin(A+B)+\sin(A-B)\\&=2\sin A\cos B\\&=2\sin\tfrac{1}{2}(P+Q)\cos\tfrac{1}{2}(P-Q).\end{aligned}$$

Similarly,
$$\begin{aligned}\sin P-\sin Q&=2\cos\tfrac{1}{2}(P+Q)\sin\tfrac{1}{2}(P-Q),\\ \cos P+\cos Q&=2\cos\tfrac{1}{2}(P+Q)\cos\tfrac{1}{2}(P-Q),\\ \cos P-\cos Q&=-2\sin\tfrac{1}{2}(P+Q)\sin\tfrac{1}{2}(P-Q),\\ \sin P+\cos P&=2\sin(45^\circ+P)\cos 45^\circ,\\ \cos P-\sin P&=2\cos(45^\circ+P)\sin 45^\circ.\end{aligned}$$

The first two of these give a useful rule when two sides of a triangle and the included angle are known Since $\sin A/\sin B=a/b$,

$$\frac{a-b}{a+b}=\frac{\sin A-\sin B}{\sin A+\sin B}=\frac{2\cos\frac{1}{2}(A+B)\sin\frac{1}{2}(A-B)}{2\sin\frac{1}{2}(A+B)\cos\frac{1}{2}(A-B)}$$
$$=\frac{\tan\frac{1}{2}(A-B)}{\tan\frac{1}{2}(A+B)}=\tan\tfrac{1}{2}(A-B)\tan\tfrac{1}{2}C.$$

Other formulae for transformation purposes are derived from the addition theorem and the primitive reciprocities and Pythagorean relations, together with the premise that, in a plane triangle, $A+B+C=180^\circ$ Of frequent use are the formulae for radii of the circles inscribed and circumscribed respectively to a triangle:

$$r=\sqrt{\left[\frac{(a+b-c)(a-b+c)(-a+b+c)}{4(a+b+c)}\right]},$$

$$R=\frac{abc}{\sqrt{[(a+b+c)(a+b-c)(a-b+c)(-a+b+c)]}}.$$

Calculation of Tables.—When the radian is used as unit, small angles like 1° or 5° are represented by decimal fractions less than 0 1. The sine and cosine of x radians are represented by convergent series in ascending powers of x:

$$\sin x=x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}+\cdots,$$

$$\cos x=1-\frac{x^2}{2!}+\frac{x^4}{4!}-\frac{x^6}{6!}+\cdots.$$

For $x\leqq\frac{5}{180}\pi$, these functions can be computed with no error in the 10th decimal place by using five terms of the series. For larger angles, more terms can be used, or the addition theorem can be employed. From 15° up to 45° it saves labour to apply the relations

$$\sin(30^\circ\pm x)=\tfrac{1}{2}\cos x\pm\frac{\sqrt{3}}{2}\sin x,$$

$$\cos(30^\circ\pm x)=\frac{\sqrt{3}}{2}\cos x\mp\tfrac{1}{2}\sin x.$$

Beyond 45° of course no further calculation is necessary, since

$$\sin(45^\circ+x)=\cos(45^\circ-x),$$

and
$$\cos(45^\circ+x)=\sin(45^\circ-x).$$

Most sets of trigonometric tables therefore give values of the various functions for angles from 0° to 45°, and apply a system of double titles for completing the first quadrant.

Multiples of an Angle. De Moivre's Formula.—The inscription of regular polygons in a circle is parallel to the solution of an algebraic equation for $\sin x$ or $\cos x$ when $\sin(nx)$ or $\cos(nx)$ is a known quantity, n denoting any integer. To express $\sin(nx)$ in terms of $\sin x$ is a problem for the addition theorem of sines. It is shortened by De Moivre's (or Euler's) formula, itself a direct consequence of that addition theorem. Denote by i the imaginary unit $\sqrt{-1}$. The formula is this:

$$\cos(nx)+i\sin(nx)=(\cos x+i\sin x)^n.$$

The binomial theorem gives the expansion of the second member, terms in odd powers of $\sin x$ being imaginary, while the first and alternate terms are real The sum of real terms is then the desired expression for $\cos(nx)$; the others, divided by i, give $\sin(nx)$ Compare the treatment of hyperbolic functions, below.

Trigonometric or Fourier Series.—Many functions, especially periodic functions, can be calculated most easily by convergent series proceeding by sines, or cosines (or both), of integral multiples of a variable angle This topic is best treated in differential calculus (*see* CALCULUS) An interesting example, of little value, however, is this.

$$\frac{x}{2}=\sin x-\frac{\sin 2x}{2}+\frac{\sin 3x}{3}-\frac{\sin 4x}{4}+\cdots.$$

SPHERICAL TRIGONOMETRY

Figures composed of lines and points in a plane are accessible to computation through triangles, and these in turn through right triangles. In the totality of lines and planes radiating from a point in ordinary space of three dimensions the useful instrument for computation is that consisting of three lines or rays—half lines starting from a common point—and the three plane angles which are bounded each by two of these three lines. It is usually agreed to restrict these angles to be not over 180° each, and to fix the same limit for the dihedral angles whose edges are the three lines first mentioned The plane angles are called *face-angles*, angles formed by two planes at any edge are *dihedral angles*, and the complete figure of six parts is a *trihedral* or *solid angle* If the point (or vertex) lies at the centre of a sphere, the edges and faces cut the spherical surface in points and arcs of great circles that constitute a spherical triangle The sides and angles of this spherical triangle have the same measures (in degrees or radians) as the plane and dihedral angles of the trihedral angle The capitals A, B, C may be used for the positions and for the measures of the angles at the vertices, and a, b, c for the measures of the three plane angles (face angles) of the arcs of the triangle.

Right Trihedral Angles or Spherical Triangles.—If two planes of the trihedral angle are perpendicular, *e g*, if the angle C of the intercepted spherical triangle is 90°, the latter is a *right spherical triangle* and subtends a right trihedral angle. If a side (a face angle) is 90°, the triangle and its trihedral angle are called a *quadrantal triangle* In contrast to the plane triangle, two or even three angles of the triangle may be right angles; in the one case two and in the other case three of the sides will then be quadrants or quarter-circles of the sphere, and the triangles will be biquadrantal, or else equilateral (trirectangular or triquandrantal)

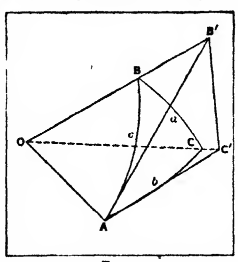


FIG 3

Let a trihedral angle at O, the centre, intercept on a sphere of radius R a right spherical triangle ABC, right angled at C. Then the planes AOC and BOC will be perpendicular along the edge OC. (Fig. 3) To measure the angle whose edge is OA, let a plane perpendicular to OA cut OB in B', and OC in C' There is then formed a figure in which all four triangles are right triangles, viz, OAB', OAC', $OB'C'$ and $AB'C'$. In three of these, the ratios of edges are trigonometric functions of c, b, a; in the other, they are functions of the angle A or of the dihedral angle OA. We may write from inspection these three relations:

$$\sin A=\frac{\sin a}{\sin c},\ \cos A=\frac{\tan b}{\tan c},\ \tan A=\frac{\tan a}{\sin b}.$$

Similar construction beginning from the edge OB gives the three

formulae

$$\sin B=\frac{\sin b}{\sin c},\ \cos B=\frac{\tan a}{\tan c},\ \tan B=\frac{\tan b}{\sin a}.$$

By proper elimination, four more relations, each among three parts of the spherical right triangle, can be derived algebraically from these six, as follows

$$\cos c=\cos a\cos b,\qquad \cos c=\cot A\cot B,$$

$$\cos A=\cos a\sin B,\quad \cos B=\cos b\sin A.$$

The ten formulae suffice for computing any desired part when two parts beside the right angle are given The last three of these ten determine the sides when two angles are given, a case having no parallel in plane triangles

Napier's Rules.—Two "Napier's Rules" form a mnemonic for these ten relations They relate not to the actual parts (viz, a, B, c, A, b, C), but to a set of so-called "Napier's Parts," amongst which the right angle C does not appear These are thought of as follows.

$$a,\ 90°-B,\ 90°-c,\ 90°-A,\ b,\ a,\ 90°-B,\ \text{etc.},$$

in cycle. Each Napier's part is *adjacent* to two in the cycle, the one next preceding and the one immediately following it in the cycle. The rules read.

1) The *sine* of any middle part is the product of the *tangents* of the *adjacent* parts,

2) The *sine* of any middle part is the product of the *cosines* of the *opposite* parts.

Here *opposite* means *non-adjacent*. When any three Napier's parts are specified, of the five excluding the right angle C, either they are consecutive in the cycle, and then the first and third are called *adjacent* to the second; or only two are consecutive, in which case they are both called opposite to the third These formulae solve most of the problems arising in geodetic navigation, and the problems of celestial astronomy concerning an altitude and an azimuth

Polar Triangles: Quadrantal Triangles.—There is a unique relation between two trihedral angles, each *polar* to the other The interior and exterior spaces of a trihedral angle must be defined Given three half-lines OA, OB, OC, and the plane angles, each less than 180°, which they bound, produce indefinitely AO, BO, and CO, to A_1, B_1, and C_1. Through O draw any other line DOD_1, not in any face plane (fig 4) If from D_1, but not from D, a point can move continuously to A_1 without crossing the interior of any face angle or any edge, then D is an interior point and D_1 is an exterior point If both D_1 and D can be so moved, then both are exterior to the trihedral angle O—ABC Take D an interior point, and from it draw three half-lines intersecting perpendicularly the three faces of the first trihedral angle On the half-line perpendicular to AOB mark any point C_2, and similarly mark two other points A_2, B_2. The edges DA_2, DB_2, DC_2, define a second trihedral angle called *polar* to the first The relations of perpendicularity among lines and planes show that also the first is polar to the second trihedral angle. In solid geometry it is shown, as is visible if one will construct a model, that each dihedral angle in either is the supplement of a face-angle in the other If the first is a right-trihedral angle (spherical triangle), the second is quadrantal, and vice versa. There is no need of new formulae for a quadrantal triangle, since the ten given already for a right triangle can be altered by merely exchanging small letters for capitals and reciprocally, and changing the sign prefixed to every *cosine*

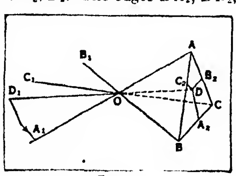


FIG. 4

Oblique Spherical Triangles.—When no angle is right, then from any point in an edge OC two planes can be passed, each perpendicular to one other edge, both therefore containing a line CX, of length p, perpendicular to the plane AOB (fig 5) From such a figure it is seen that

$$\frac{\sin A}{\sin B}=\frac{\sin a}{\sin b}\ \text{since}\ \frac{p/l_1}{p/l_2}=\frac{l_2/r}{l_1/r}.$$

From this, since A and B were any two angles of the triangle, there follows the *sine theorem* for every trihedral angle or spherical triangle,

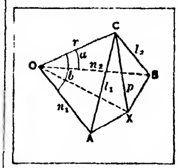


FIG 5

$$\frac{\sin A}{\sin a}=\frac{\sin B}{\sin b}=\frac{\sin C}{\sin c}.$$

From a slightly different diagram (fig 6), come formulae connecting three faces and a dihedral angle, or three angles and a face

At a point C on one edge, perpendiculars to OC are erected, terminating in A and B on the two other edges; also a perpendicular k to the segment AB at P. This point P is now connected to O by h, and other parts of the six right triangles are lettered as in the accompanying sketch We then have the face angle $C=\alpha+\beta$; now call the corresponding parts of angle C,

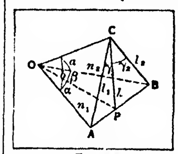


FIG 6

γ_1 and γ_2, and we have $C=\gamma_1+\gamma_2$.

Applying the addition theorem for cosines and referring the segments involved to r by ratios in right triangles, we have

$$\cos c=\cos(\alpha+\beta)=\cos\alpha\cos\beta-\sin\alpha\sin\beta=\frac{h^2-m_1m_2}{n_1n_2},$$

$$\cos C=\cos(\gamma_1+\gamma_2)=\cos\gamma_1\cos\gamma_2-\sin\gamma_1\sin\gamma_2=\frac{k^2-m_1m_2}{l_1l_2}.$$

Hence $\qquad r^2=h^2-k^2=n_1n_2\cos c-l_1l_2\cos C,$

$$1=\frac{n_1}{r}\cdot\frac{n_2}{r}\cos c-\frac{l_1}{r}\cdot\frac{l_2}{r}\cos C=\frac{\cos c}{\cos a\cos b}-\tan a\tan b\cos C,$$

or $\qquad \cos c=\cos a\cos b+\sin a\sin b\cos C,$

whence also $\qquad \cos a=\cos b\cos c+\sin b\sin c\cos A, \qquad (1)$

and $\qquad \cos b=\cos c\cos a+\sin c\sin a\cos B.$

But this trihedral angle is the polar of another, for which those same three cosine formulae are true. In them we may substitute for face-angles and dihedrals the *supplements* of the dihedrals and of the face-angles respectively, cosines and tangents reversing sign The results are, for this first trihedral angle,

$$\cos A=-\cos B\cos C+\sin B\sin C\cos a,$$

$$\cos B=-\cos C\cos A+\sin C\sin A\cos b, \qquad (2)$$

and $\qquad \cos C=-\cos A\cos B+\sin A\sin B\cos C.$

From set (1), dihedral angles may be calculated in terms of the face-angles, but derived formulae for halves of the dihedrals are more convenient for logarithmic computation, as when in plane triangles the angles are to be found from the sides. Since

$$\cos A=\frac{\cos a-\cos b\cos c}{\sin b\sin c},$$

it follows that

$$\sin^2\tfrac{1}{2}A=\frac{1-\cos A}{2}=\frac{\cos(b-c)-\cos a}{2\sin b\sin c}$$

$$=\frac{2\sin\frac{1}{2}(b-c+a)\sin\frac{1}{2}(a-b+c)}{2\sin b\sin c},$$

or, if $a+b+c=2s$,

$$\sin^2\tfrac{1}{2}A=\frac{\sin(s-b)\sin(s-c)}{\sin b\sin c}; \qquad (3)$$

and similarly $\qquad \cos^2\tfrac{1}{2}A=\dfrac{\sin s\cdot\sin(s-a)}{\sin b\cdot\sin c}; \qquad (4)$

and $\qquad \tan\tfrac{1}{2}A=\sqrt{\left[\dfrac{\sin(s-b)\cdot\sin(s-c)}{\sin s\cdot\sin(s-a)}\right]}. \qquad (5)$

The polar triangle converts these formulae into expressions for half-sides in terms of the three dihedral angles, or they may be derived in the same way from set (2) above They are, when S denotes $\frac{1}{2}(A+B+C)$,

$$\sin^2\frac{a}{2}=\frac{-\cos S\cos(S-A)}{\cos B\cos C},\tag{6}$$

$$\cos^2\frac{a}{2}=\frac{\cos(S-B)\cos(S-C)}{\cos B\cos C},\tag{7}$$

$$\tan\frac{a}{2}=\sqrt{\left[-\frac{\cos S\cos(S-A)}{\cos(S-B)\cos(S-C)}\right]}.\tag{8}$$

Gauss's Equations.—The *Gauss equations* are four relations deducible from (3), (4), (6), and (7) Restrict the trihedrals to having positive face-angles less than 180°, and dihedral angles with the same limitations; then the right-hand members of equations (3), (4), (6) and (7) are all positive, and their positive square roots must be taken. From the set represented by (3) and (4), substitute in the addition formula

$$\sin\tfrac{1}{2}(A+B)=\sin\frac{A}{2}\cos\frac{B}{2}+\cos\frac{A}{2}\sin\frac{B}{2},$$

and thus find

$$\cos\frac{c}{2}\sin\tfrac{1}{2}(A+B)=\cos\frac{c}{2}\sqrt{\left[\frac{\sin s\sin(s-c)}{\sin a\sin b\sin^2 c}\right]}\left[\sin(s-b)+\sin(s-a)\right]$$
$$=\cos\frac{C}{2}\cos\frac{a-b}{2}.$$

Not very different are three other proofs The set of four is this

$$\begin{aligned}\cos\frac{a}{2}\sin\tfrac{1}{2}(B+C)&=\cos\frac{A}{2}\cos\tfrac{1}{2}(b-c),\\ \cos\frac{a}{2}\cos\tfrac{1}{2}(B+C)&=\sin\frac{A}{2}\cos\tfrac{1}{2}(b+c),\\ \sin\frac{a}{2}\sin\tfrac{1}{2}(B-C)&=\cos\frac{A}{2}\sin\tfrac{1}{2}(b-c),\\ \sin\frac{a}{2}\cos\tfrac{1}{2}(B-C)&=\sin\frac{A}{2}\sin\tfrac{1}{2}(b+c).\end{aligned}\tag{9}$$

Professor Simon Newcomb is authority for the statement that these equations were first published anonymously by Delambre, although Gauss was the first to use them in spherical astronomy It is evident that they solve directly any triangle in which three consecutive parts are known, either two sides and the included angle, or two angles and the side adjacent to both Where all parts are less than 180°, so that the tangent is a sufficient index of the quadrant in which a part lies, Napier's analogies are the better statement of the solution.

Napier's Analogies—These analogies are found by division from pairs in set (9), as follows

$$\frac{\sin\frac{1}{2}(B+C)}{\sin\frac{1}{2}(B-C)}=\frac{\tan\frac{a}{2}}{\tan\frac{1}{2}(b-c)},\quad\frac{\sin\frac{1}{2}(b+c)}{\sin\frac{1}{2}(b-c)}=\frac{\cot\text{an}\frac{A}{2}}{\tan\frac{1}{2}(B-C)},$$

$$\frac{\cos\frac{1}{2}(B+C)}{\cos\frac{1}{2}(B-C)}=\frac{\tan\frac{a}{2}}{\tan\frac{1}{2}(b+c)},\quad\frac{\cos\frac{1}{2}(b+c)}{\cos\frac{1}{2}(b-c)}=\frac{\cot\text{an}\frac{A}{2}}{\tan\frac{1}{2}(B+C)}.$$

By the use of the polar triangle (or trihedral angle), the analogies are exchanged reciprocally two and two; while of the Gauss equations, two are exchanged, the others being self-reciprocal.

Equations of set (1) or (2), have been used here as fundamental, and that asserting proportionality of four sines, as derivative. A different selection is of course possible. While those given above suffice for the logarithmic solution of spherical triangles from any three given parts, and for checks, there is a great variety of other relations adapted to special sets of data, either saving labour or admitting of greater accuracy from the same set of tables.

Hyperbolic Functions.—Trigonometric functions are algebraically related to the sine or cosine. Sine and cosine of a real variable quantity, represented as rectangular coordinates in a plane, define a point whose locus is a circle of unit radius about the origin as centre. They may be defined either by this geometric property, or better, by two absolutely convergent series

$$\sin\theta=\theta-\frac{\theta^3}{3!}+\frac{\theta^5}{5!}-\frac{\theta^7}{7!}+\cdots,$$
$$\cos\theta=1-\frac{\theta^2}{2!}+\frac{\theta^4}{4!}-\frac{\theta^6}{6!}+\cdots.$$

Both converge for all values of θ, and are periodic with the common modulus 2π. Their relation to the circle is expressed by the identity. $\sin^2\theta+\cos^2\theta\equiv1$. Further, it is shown in the theory of limits (*see* LIMITS) usually given in treatises on differential calculus, that the relation of these two functions and their derivatives is nearly reciprocal, viz, in radian units,

$$\frac{d(\sin\theta)}{d\theta}=\cos\theta,\quad\frac{d(\cos\theta)}{d\theta}=-\sin\theta;$$

in other words, each is an integral of the differential equation

$$\frac{d^2u}{d\theta^2}=-u.$$

Two functions resembling these in the features mentioned are the *hyperbolic sine* and *hyperbolic cosine*, abbreviated to $\sinh\theta$ and $\cosh\theta$. They are defined by absolutely convergent series.

$$\sinh\theta=\theta+\frac{\theta^3}{3!}+\frac{\theta^5}{5!}+\frac{\theta^7}{7!}+\cdots,$$
$$\cosh\theta=1+\frac{\theta^2}{2!}+\frac{\theta^4}{4!}+\frac{\theta^6}{6!}+\cdots.$$

So far however as a real variable θ is concerned, these functions are not periodic Their modulus of periodicity is imaginary The identity connecting them is geometrically the equation of an equilateral (or rectangular) hyperbola,

$$\cosh^2\theta-\sinh^2\theta\equiv1.$$

Their interest for the physicist or engineer arises from their completely symmetrical or reciprocal differential relations.

$$\frac{d(\sinh\theta)}{d\theta}=\cosh\theta,\quad\frac{d(\cosh\theta)}{d\theta}=\sinh\theta$$

Both are solutions of the differential equation of the second order

$$\frac{d^2u}{d\theta^2}=+u.$$

Analogous to the trigonometric functions the hyperbolic tangent, cotangent, secant, and cosecant are defined as follows:

$$\tanh\theta=\frac{\sinh\theta}{\cosh\theta},\ \coth\theta=\frac{\cosh\theta}{\sinh\theta},\ \operatorname{sech}\theta=\frac{1}{\cosh\theta},\ \operatorname{cosech}\theta=\frac{1}{\sinh\theta}.$$

The first two are mutually reciprocals: $\tanh\theta\cdot\coth\theta=1$, and are related to the latter two by the equations. $\operatorname{sech}^2\theta=1-\tanh^2\theta$. $\operatorname{cosech}^2\theta=\coth^2\theta-1$.

Like the inverse trigonometric, or circular functions, the inverse hyperbolic functions are usefully represented as integrals Some writers indeed prefer to define them by integration, as follows:

$$\sinh^{-1}y=\int_0^y\frac{dy}{\sqrt{(y^2+1)}},\quad\cosh^{-1}x=\int_1^x\frac{dx}{\sqrt{(x^2-1)}}.$$

It follows then that

$$\sinh u=\frac{e^u-e^{-u}}{2},\ \cosh u=\frac{e^u+e^{-u}}{2},$$

as at first defined, while

$$\sinh^{-1}y=\log[y+\sqrt{(y^2+1)}],\quad \cosh^{-1}x=+\log[x\pm\sqrt{(x^2-1)}].$$

The addition theorem is evidently

$$\sinh(u+v)=\sinh u\cosh v+\cosh u\sinh v,$$

$$\cosh(u+v)=\cosh u\cdot\cosh v+\sinh u\sinh v.$$

Misled by apparent implication in the names, some suppose that the Jacobian elliptic functions sin *am u*, cos *am u*, etc., resemble the trigonometric and hyperbolic functions as closely as these sets resemble one another That this is far from correct may be seen at once by consulting the article on ELLIPTIC FUNCTIONS

HISTORY

The beginnings of trigonometry in explicit form may perhaps be traced to the lost work of a Greek, Hipparchus of Nicaea (*c.* 140 B C), which is said to have comprised twelve books with tables *On Chords of Circles*. Apparently Egyptian builders of the pyramids knew of fixed ratios in similar triangles, and they had a name *seqt* for the cosine of an angle, but there is no known record of tables or of further theory Three books of Menelaus of Alexandria show that interest in astronomy had induced more progress in spherical than in plane trigonometry. To advance toward its modern form, the science needed more named ratios or functions tabulated, being like a language scantily supplied with nouns In India, six centuries later, chords were halved, and became what we now call *sines*, appearing in the writings of Āryabhata (*c.* A D. 500) and Brahmagupta (*c* A D 620) The knowledge of India passed into the keeping of the Arabs, and Al Battani (*c.* A D 900) gave names to functions now called cotangent and secant Still later (*c.* A D 1250), there came a systematizer, the Persian Nasîr ed-dîn al-Tûsî, who collected and supplemented older knowledge into a coherent whole The sine theorem was employed wherever possible, but, lacking the cosine theorem, he resorted when necessary to auxiliary right triangles to solve problems in oblique triangles.

Among modern writers, the first to exhibit trigonometry as a science was the German Johann Muller, better known as Regiomontanus (*c.* 1460) He seems to have invented the tangent, traces of which have been suspected, however, in the ancient Egyptian Ahmes ms (*c* 1650 B C.) while the secant was reintroduced *c.* 1500 by Copernicus. Vieta, in Paris in the latter part of the sixteenth century, brought algebra and particularly algebraic transformations into the service of trigonometry. Euler, in the mid-eighteenth century, recast, simplified, and gave elegance to the body of rules and technique, by this time so necessary for navigation and the physical sciences The name, trigonometry, probably originated with Pitiscus (Heidelberg, 1593).

The first discoverers of leading theorems and formulae must of course be named with an implied proviso For plane triangles the sine theorem narrowly missed by Al Battânî and the Spanish Moor Jabir Ibn Aflah (*c.* 1140), was enunciated by Nasîr ed-dîn al-Tûsî (*c.* 1250). The cosine theorem in complete form is first found in Vieta's work of 1593, *Variorum de rebus mathematicis responsorum liber octavus.* The same author restated the tangent theorem in the accepted form of today, in 1593. It stands however unmistakable in the work of a Dane, Thomas Fincke, ten years earlier, save that the angle $\frac{1}{2}(A+B)$ is expressed as $\frac{1}{2}(180-C)$, a form immediately applicable to the usual data. Formulae for finding angles directly from the sides, without auxiliary right triangles, appear first with Rhaeticus of Wittenberg in a work written in 1568, published in 1596. He gives the rule for $\tan\frac{1}{2}A$. Rules for the sine and cosine of the half-angle are certainly as old as Oughtred's *Trigonometrie* of 1657 Proportions for sines and cosines, of $\frac{1}{2}(A+B)$ and of $\frac{1}{2}(A-B)$ are found, the sines in Newton's writings, 1707, and both functions appear in F. W. Oppel's *Analysis Triangulorum,* 1746

The six triadic relations in spherical right triangles evolved during long centuries, first of course in words stating proportions, later in the short-hand of equations. Menelaus of Alexandria (*c.* A.D. 100) and Ptolemaeus (*c.* A D. 140) give most of them, and all were known to Nasîr ed-dîn al-Tûsî (*c* 1250). For oblique spherical triangles, the sine theorem was found by the early Arabians. It was known to Abû'l-Wefâ (*c.* 980), and possibly to his contemporaries Abû Nàṣr or al-Khojendî (al-Chodschendî), in the tenth century of our era. The cosine theorem was implied in rules known to the early Indians, but was exhibited more fully by Regiomontanus (*c.* 1460), and ultimately by Tycho Brahe (before 1590) Gauss's formulae of 1809 were found earlier by Delambre (1807) and Mollweide (1808). Napier's analogies, curiously enough, arrived much earlier, 1619, in Napier's work, and were practically exhibited by Briggs in 1620

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TRIKKALA (anc *Trika*), a town of Thessaly, capital of the department of Trikkala, and the see of an archbishop, 38 m. W of Larissa In winter, when great numbers of Vlach herdsmen settle in the town, its population exceeds that of Larissa It has the appearance of a Mussulman town on account of its mosques (only two of which are in use) and is a centre of trade in wheat, maize, tobacco and cocoons In ancient times it was a seat of the worship of Aesculapius Pop (1923) 24,005, of the department, 198,319

TRILLIUM, a genus of beautiful plants of the lily family (Liliaceae, *q v*), comprising about 30 species, natives of North America and eastern Asia They are smooth low perennials, with a simple stem bearing at the top a whorl of three leaves and a single conspicuous flower There are three green sepals, three showy petals, six stamens and a three-celled ovary; the fruit is a many-seeded berry Some 18 species occur in the United States and Canada; these include many handsome spring wild flowers, known as wake-robin and birthroot Well-known eastern species are the large flowered wake-robin (*T grandiflorum*), the ill-scented wake-robin (*T erectum*), the painted wake-robin (*T. undulatum*) and the mountain wake-robin (*T. stylosum*)

BY COURTESY OF THE WILD FLOWER PRESERVATION SOCIETY

TRILLIUM OR WAKE ROBIN (TRILLIUM SESSILE), ONE OF THE LILY FAMILY HAVING BROWNISH PURPLE FLOWERS

TRILOBITA, a group of extinct Arthropoda of which the fossil remains are found in the rocks of the Palaeozoic era. Many species are found in the Lower Cambrian, among the earliest known fossils They are abundant in the Ordovician and Silurian when they begin to decline and only a single genus survives in the Permian.

A typical trilobite has a segmented body roughly resembling that of a wood-louse, with the dorsal surface marked by two longitudinal furrows which divide it into the three lobes alluded to in the name of the group. In the head-region the middle lobe is the glabella and usually shows transverse grooves marking the five segments of which the head is composed. On either side of the head are plates, the "free cheeks," divided from the central part of the head by the "facial sutures" and bearing the compound eyes. In some trilobites, however, the eyes are reduced or absent. Behind the head a number of the body-segments, from two to 29, are freely movable, and they are followed by a tail-shield or "pygidium" which often shows, by transverse furrows, that it is composed of a number, sometimes a large number, of segments. Some

trilobites, such as *Calymmene*, could roll up into a ball like many wood-lice and are often found in this condition.

For long no definite traces of the limbs of trilobites could be discovered and their nature was the subject of much speculation. They have now been described in several genera by C. D. Walcott, C. E. Beecher and P D. Raymond The structure is most fully known in *Triarthrus*, investigated by Beecher and by Raymond The appendages of the first pair, placed at the sides of the fore-lip (hypostoma) which underhangs the mouth, are long, slender, many-jointed antennae. The remaining appendages are all similar in structure and are attached, four pairs to the head and one pair each to the somites of the body whether free or coalesced into the pygidium. They are two-branched, the inner branch (endopodite) being a jointed leg, while the outer (exopodite) bears a fringe of what seem to be stiff flattened bristles. The two branches spring from a single basal segment drawn out on the inner side as a jaw-lobe (gnathobase) which served, no doubt, to seize food and pass it forward to the mouth. Towards the hinder end of the body the appendages become smaller and the inner edge of the endopodite is lobed in a way recalling the appendages of the Branchiopod Crustacea. In *Neolenus* another point of resemblance to certain Branchiopoda is provided by a pair of long thread-like tail-filaments. Walcott believed the structure of the limbs to be more complex, certain genera possessing, in addition to the parts mentioned, two or three "epipodites," but the presence of these awaits confirmation Still less probable is Walcott's conclusion that *Calymmene* and *Ceraurus* possessed corkscrew-like gills.

The development of various species has been traced. Starting with a minute larva with only indications of head and pygidium, segments appear between these regions in order from behind forwards, the new segments being set free in succession from the front edge of the pygidium The relationships of trilobites to the various groups of Arthropoda now living have been the subject of much discussion but the elucidation of their appendages leaves no doubt that their main affinities are with the Crustacea (*q v*). The five pairs of appendages on the head-region are directly comparable with those of Crustacea, since the second pair or antennae of Crustacea are still postoral and biramous and carry a masticatory process or gnathobase in the nauplius larva as in the trilobites. The biramous form of all the postoral limbs is also a weighty argument in favour of crustacean affinity On the other hand, there is no trace of the characteristic crustacean shell-fold or carapace In the uniformity of the postoral appendages, however, the trilobites are more primitive than any living crustacean The view that trilobites are phylogenetically connected with Arachnida (*q.v*) has less to support it, but it is possible that connecting links may yet be proved to exist in the imperfectly known Cambrian *Limulava* of Walcott

The trilobites were all marine and lived, some on sandy or muddy bottoms, some on coral reefs, and some, perhaps, in the deep sea. They were distributed all over the world and in some localities were in such abundance that rock strata are crowded with their remains A very large number of genera and species are known Their range of size is from a quarter of an inch to 20in. in length, but most species are between one and three inches long. (W. T. C.)

TRIM, a market town and the county town of Co. Meath, Ireland, on the upper waters of the Boyne, 30 m. N.W. by W. from Dublin on a branch of the Great Southern railway. Pop. (1921) 2,786. Monthly fairs are held, and there is considerable trade in corn and flour The town was the seat of a very early bishopric. A Norman tower, called the Yellow Steeple, is supposed to mark the site of St. Patrick's Abbey of St. Mary. Two gates remain from the old town walls. King John's castle was originally founded by Hugh de Lacy in 1173, but a later date is assignable to the greater part of the building Other castles are Talbot's and Scurlogstown castles; the former erected by Sir John Talbot, lord lieutenant of Ireland in 1415, the latter dating from 1180. About a mile east of the town, the ruins of the abbey of St. Peter and St. Paul occupy both banks of the river. These include the Transitional-Norman cathedral on the north bank, and a castle, guarding the crossing of the river, on the south, together with a chapel and other remains. North of the town ruins may be seen of a 13th century Dominican friary. The tower of the old parish church dates from 1449. Several Irish parliaments met at the castle until the middle of the 15th century, and a mint was established in 1469. The town was incorporated by Edward III.

TRIMONTIUM, according to Ptolemy (ii. 3, 6) a "city" in the territory of the Selgovae, was probably the name of the Roman fort at Newstead, near Melrose, Scotland, close under the three Eildon Hills (whence the name *trium montium*). It was an advanced post of the Romans towards Scotland from about A D. 80 onwards, and again (after an interval of evacuation) from about A D. 140–180. Excavations carried out between 1907 and 1911 yielded finds of almost unique importance. These included the foundations of several successive forts, one above the other, which throw much light on the character of the Roman military post, an unparalleled collection of Roman armour, notably ornate helmets, and a good series of coins and datable pottery. The whole illustrate the history of the Roman army and that of Roman Scotland very remarkably and to an extent equalled by no other Scottish site as yet explored.

See James Curle, *A Roman Frontier Post and its People* (Glasgow, 1911).

TRINCOMALEE, a town and former naval station on the north-east coast of Ceylon, 100 m. N E. by N. of Kandy. Pop. (1921) 34,112 It is built on the north side of the bay of Trincomalee, on the neck of a bold peninsula separating the inner from the outer harbour The annual average rainfall is 62.75 inches and the average temperature 81.2° F.

The town was one of the first Tamil settlements in Ceylon. Their temple, dedicated to Konatha, or Konasir, on a height at the extremity of the peninsula, was known as the "temple of a thousand columns." The building was destroyed in 1622 by the Portuguese. The town was successively held by the Dutch (1639), the French (1673), the Dutch (1674), the French (1782), and the Dutch (1783). It surrendered to the British fleet in 1795, and with other Dutch possessions in Ceylon was ceded to Great Britain by the Treaty of Amiens in 1802.

With its magnificent harbour—one of the five or six greatest natural harbours in the world—it used to be the headquarters of the admiral commanding on the East Indian station and had a military garrison Pearl oysters are found in the lagoon of Tambalagam to the west of the bay. Some tobacco, rice, and palm are grown in the district

Rice and general merchandise are imported while paddy, timber, dried fish, tobacco, deer horns and skins are exported. The merchant anchorage in the harbour is in 4 to 8 fathoms about 4 cable lengths from the wharf. The harbour can accommodate the largest vessels

TRING, a town in Hertfordshire, England, 31½ m N W of London on the L M S railway Pop. (1921) 4,345 It lies on the western slope of the Chiltern hills, close to the entrance to a narrow valley which pierces them, and forms one of the highways through them to London It has small straw-plaiting and other industries The Rothschild museum contains an extensive natural history collection The road which passes through Tring follows the ancient Icknield Way, and there may have been a Romano-British village on the site of the present town.

TRINIDAD, a town near the southern coast of Cuba, in Santa Clara province, about 45 m south-east of Cienfuegos, and 3 m from its seaport, Casilda, which lies due south. Pop. (1925) 45,930. There is a local railway, connected with the central trunk line of the island. The city lies on the slope of La Vigia hill (900 ft.) amid higher mountains, and on the banks of the Jayoba (San Juan) river. Casilda has a land-locked, shallow harbour; but Masio bay, a trifle farther distant, accommodates larger craft, and there are excellent deep-water anchorages among the quays off the coast. The Manatí river is navigable for about 7 m. inland and is used as an outlet for sugar and molasses crops These and honey are the chief exports; tobacco and various vegetables and fruits are of minor importance Trinidad is one of the seven original cities of Cuba established by Diego Velásquez. It was founded in 1514 on the coast, but after being attacked by pirates

was removed inland It was thrice sacked by English buccaneers—in 1642, 1654 and 1702, and in the following years, up to and for a time after the peace of Utrecht (1713), it maintained ships and soldiers. Indeed, throughout the first half of the 18th century it was on a continuous war footing against English corsairs, making reprisals on British ships and thriving at the same time on a large contraband trade with Jamaica and other foreign colonies

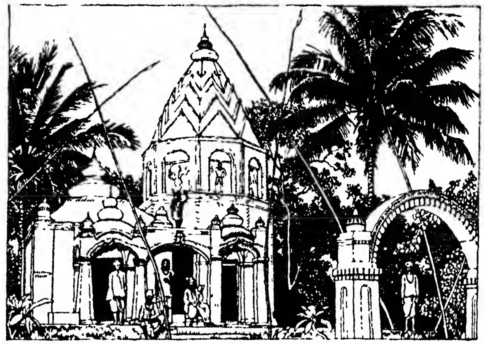
TRINIDAD, a city of southern Colorado, U S A , on Purgatory river, at an altitude of 5,963 ft , 10 m from the New Mexico line; the county seat of Las Animas county It is on Federal highways 85 and 350, and is served by the Colorado Southern, the Colorado and Wyoming, the Denver and Rio Grande Western and the Santa Fé railways The population was 10,906 in 1920 (87% native white) It is in the midst of beautiful mountain scenery and picturesque canyons, with Fisher's peak (9,586 ft), the highest in the Raton range, 5 m to the south The city is a shipping point for cattle and wool, and for the large quantities of coal (3,500,000 tons annually) mined in the vicinity. It has coking ovens and various other manufacturing industries Trinidad was incorporated as a town in 1876 and as a city in 1879 In the early days it was a frequent resort of the scout "Kit" Carson

TRINIDAD, the most southerly and, next to Jamaica, the largest of the British West Indian islands Pop (1925) including Tobago, 385,091. It is situated 6m E of the coast of Venezuela, between 10° 3′ and 10° 50′ N and 60° 39′ and 62° W Average length, 48m ; breadth, 35m ; area 1,754 sq miles In shape it is almost square, with promontories westward from its north and south corners, enclosing the Gulf of Paria To the west of the northern spur lie several islands, of which Chacachacare, Huevos Monos and Monos Gaspar Grande are the most important. The surface is undulating or level, except in the north and south, where there are ranges of hills running east and west, prolongations of the Venezuelan coast ranges Of these the northern is the more elevated, its highest point being Tucuche Peak (3,100ft) The southern hills attain 600ft A small ridge runs east to west by south, through the centre of the island, from Manzanilla Point to San Fernando, with the isolated Mt Tamana (1,028) The hills of the northern and southern ranges, furrowed by innumerable ravines, are densely wooded

In its geology, as well as in its flora and fauna, Trinidad differs little from the mainland, with which it was doubtless at one time connected There are four mineral springs and several mud volcanoes, but the two most striking natural features are the Maracas falls, and the Pitch lake The Maracas falls, 312ft high, are situated at the head of a valley of the same name, to the north-east of Port of Spain The Pitch lake lies some 38m S E of the capital, by water, in the ward of La Brea It is circular in form, about 3m in circumference, and 104ac in extent The asphalt wells up in low bulging masses, separated from one another by narrow channels, in which the rain forms pools Near the centre of the lake the pitch is always liquid and can be observed bubbling up When the sun is hot the lightest footfall leaves an impression, and the pitch emits a strong odour The soil of the surrounding district is charged with asphalt, but is very fertile, while the road to the neighbouring port of La Brea, running over a bed of asphalt, moves slowly towards the sea like a glacier. The lake is worked by a company which exports the asphalt to the United States, paying royalty to the local Government.

The mountain range which runs along the north coast is formed of clay-slates, micaceous and talcose schists, and crystalline and compact limestones, constituting the group of unknown age called the Caribbean series. The rest of the island is composed of Cretaceous, Tertiary and Quaternary strata. The Cretaceous beds rise to the surface in the centre and are flanked to north and south by later deposits The relations of the various divisions of the Tertiary formation are still somewhat obscure, but they are grouped by J B Harrison into (1) Nariva and San Fernando beds = Eocene and Oligocene; (2) Naparima marls = Miocene and (3) Moruga series = Pliocene and Pleistocene. The Naparima marls consist of a lower division containing *Globigerina* and an upper division with Radiolaria and diatoms and are clearly of deep-sea origin. The bitumen of the Pliocene and Pleistocene deposits appears to have been formed by the decomposition of vegetable matter Salses or mud volcanoes occur upon the island.

The presence of oil under Trinidad had been suspected for many years, and early in the 20th century the Government undertook a geological survey This survey revealed the presence of a series of anticlines at payable depths in the southern division of the island, and experimental borings by three companies, at La Brea and Point Fortin in the south-west, and Guayaguayare in the south-east, proved the presence of oil in large quantities. A considerable oil field has been located which has only in parts as yet been tapped, but a flourishing industry has already been established, the exports in 1928 being 5,200,000 barrels of oil and benzol, much of it refined locally



BY COURTESY OF THOMAS F LEE

A HINDU TEMPLE IN TRINIDAD, SHOWING SEVERAL PRIESTS ON THE STEPS

The soil of the island is very rich, and well adapted to the growth of tropical products, especially of sugar and cocoa, which are its staples Planting of new lands is rapidly progressing, the greater part of the unsold Crown lands (various blocks of which have been formed into forest or water reserves) containing a valuable supply of timber Owing to the variety of its resources, Trinidad has suffered less from economic depression than the other islands in the British West Indies It exports cocoa, sugar, rum, molasses, coffee, coco-nuts, Angostura bitters, timber, india-rubber and asphalt Large quantities of tonga-beans, the produce of the mainland, are cured in bond at Port of Spain The manufacture of bitters (Angostura and others) is an important industry, as is also the raising of stock In addition Trinidad has a large carrying trade with the neighbouring republics, and rivals St. Thomas (*q v*) as a centre of distribution for British and American merchandise through the West Indies and Venezuela Trinidad is immune from hurricanes and its seasons are regular, wet from May to January, with a short dry season in October known as the Indian summer and lasting usually about four weeks, and dry from end of January to middle of May The average annual rainfall is 63 22in and the mean temperature is 80°F. Of the inhabitants of the island, one-third are East Indians Of the rest, the upper classes are creoles of British, French and Spanish blood, while the lower classes are of negro or mixed negro origin, with a few Chinese. English is spoken in the towns and in some of the country districts, but in the north and generally in the cocoa-growing areas, a French *patois* prevails, and in several districts Spanish is still in use Elementary education is given chiefly in the State-aided schools of the different denominations, but there are a number of entirely secular schools managed by the Government Presbyterian schools are conducted by a Canadian mission. Agriculture is a compulsory subject in all the primary schools. Higher education is provided by the Queen's Royal college, a secular institution, to which the Presbyterian Naparima college and the Roman Catholic St Mary's college are affiliated. Attached to these colleges are four scholarships of the annual value of £150 for four years, tenable at any British university. The Roman Catholics (with an archbishop at Port of Spain) and the Anglicans, with the bishop of Trinidad at their head, are the most numerous

religious communities English money is legal tender, also the United States gold currency Accounts are kept in dollars by the general public, but in sterling by the Government. The public revenue of the colony in 1926 was £1,737,288, expenditure £1,580,-213, public debt £3,342,000, total imports £4,827,923 (£1,321,109 from the British empire, £1,181,378 from the United States), exports about £6,000,000; to the British empire, £2,644,367, to United States £1,800,500 There is a large transit trade, Trinidad being a convenient entrepôt. A complete system of main and local roads is constructed or under construction; there are about 90m of railways, and most of the larger towns can be reached from Port of Spain by rail. Steamers ply daily between Port of Spain and the islands at the northern entrance to the Gulf of Paria, and between San Fernando (the southern terminus of the railway) and the south-western ports of the island There is a weekly coastal service which calls at Tobago A number of British and European steamship lines visit Port of Spain

The colony (Trinidad and Tobago) is administered by a governor, assisted by an executive council and a legislative council of 20 members, of whom ten are officials sitting by virtue of office and ten are unofficials nominated by the Crown Port of Spain, the capital, is situated on the west coast on the shores of the Gulf of Paria It is considered one of the finest towns in the West Indies, with shaded streets, abundant water supply, and an excellent service of tramways It has two cathedrals, a fine block of public buildings containing the principal Government departments, the courts of justice and the legislative council chamber, other large Government buildings, a public library, and many good shops In its botanical garden the residence of the governor is situated The harbour is an open roadstead, safe and sheltered, but so shallow that large ships have to lie at anchor half a mile from the jetties It is, nevertheless, the place of shipment for the produce of the entire island, and also for that of the Orinoco region The population is about 61,530 It has a mayor and corporation Other towns are San Fernando, also on the Gulf of Paria, about 30m S of the capital; and Arima, an inland town 16m by rail E of Port of Spain

Trinidad was discovered by Columbus in 1496. It remained in Spanish possession (although its then capital, San José de Oruna, was burned by Sir Walter Raleigh in 1595) until taken by the British in 1797 It was finally ceded to Great Britain by the Treaty of Amiens in 1802

In 1921 the Imperial College of Tropical Agriculture was established in Trinidad, at St Augustine, about 7m from Port of Spain Its purposes are to provide training in the science and practice of tropical agriculture for students intending to become tropical planters, agricultural administrators or specialists in agricultural science and technology It is equipped with free laboratories and experimental fields The site was provided by the colony, and £50,000 was subscribed locally towards the cost of the building. Maintenance is provided for by imperial grants and contributions from West Indian and West African Governments. British sugar machinery firms contributed £20,000 towards the cost of the instructional sugar factory

See Stark's *Guide-Book and History of Trinidad* (London), and for geology G P. Wall and J G. Sawkins, *Report on the Geology of Trinidad* (London, 1860); J B Harrison and A. J. Jukes-Browne, "The Oceanic Deposits of Trinidad" (British West Indies), *Quart Journ Geol Soc*, lv 177–189 (London, 1899), R J L. Guppy, "The Growth of Trinidad," *Trans Canadian Inst*, viii 137–149 (1905).

TRINIDAD, an uninhabited island in the South Atlantic, 680 m. E. of the coast of Espirito Santo, Brazil, in 20° 30′ S. 29° 20′ W., 4 m. long by 2 broad.

TRINITARIANS, a religious order founded in 1198 by St. John of Matha and St. Felix of Valois, for the liberation of Christian prisoners and slaves from captivity under the Moors and Saracens. The two founders went to Rome and there obtained the approbation of Innocent III., 1198. The rule was the Augustinian, supplemented by regulations of an austere character. The habit was white, with a red and blue cross on the breast The Trinitarians are canons regular, but in England they were often spoken of as friars. The first to go on the special mission of the order were two Englishmen, who in 1200 went to Morocco and returned thence to France with 186 liberated Christian captives Vast sums of money were collected by the Trinitarians; but they were called upon, if other means failed, to offer themselves in exchange for Christian captives Many thousands were liberated by their efforts. In the 17th century a reform called the Barefooted Trinitarians was initiated, which became a distinct order and is the only one that survives There are now less than 500 members Their headquarters are at San Crisogono in Rome They devote themselves to the ransoming of negro slaves, especially children, and a great district in Somaliland has been since 1904 entrusted to them as a field for missionary work

BIBLIOGRAPHY.—The chief modern book on the Trinitarians is Deslandres, *L'Ordre français des Trinitaires* (2 vols, 1903) Sufficient information will be found in Max Heimbucher, *Orden u Kongregationen* (1907), ii. §57, and in the *Catholic Encyclopaedia*, article "Trinitarians."

TRINITY. The Christian doctrine of the Trinity can be best expressed in the words "The Father is God, the Son is God. and the Holy Ghost is God, and yet they are not three Gods but one God . for like as we are compelled by the Christian verity to acknowledge every Person by himself (*singillatim*) to be God and Lord, so we are forbidden by the Catholic religion to say that there be three Gods or three Lords" (*Quicunque vult*) Though this doctrine was one of the first to be dealt with by modern methods of "comparative religion" (as long ago as when Gibbon wrote, "300 B C, The Logos taught in Alexandria, A D 97. Revealed by St John")—and though it is natural to ask its relation to certain triple arrangements of Pagan deities, to Jewish doctrines of "Wisdom" and the "Word," to the Hegelian triad "The Idea: Nature Spirit"—it is probably less well adapted to this treatment than other Christian doctrines At any rate the first step is to discover what, in using this *prima facie* paradoxical language, the Christian Church believed itself to be asserting

Here a common misunderstanding must be cleared away "The Creed"—it has been suggested (see *Hibbert Journal*, xxiv No 1) —"means that there is only one being that can, with strict theological correctness, be called 'God,' viz, the Trinity as a whole; but each of the three persons can be called 'God' in a looser sense " This suggestion is offered as a short method of "rendering consistent" the statements of the Creed But the paradox is not thus lightly to be got rid of Plainly the Church did not regard itself as lowering the conception of the Father, so that He should become merely one Component of a Divine Whole "The Father," says St Thomas Aquinas, "is as great as the whole Trinity," and explains that in such matters "greatness signifies perfection of nature and pertains to essence" (*Summa Theol* i, xxx 1, xlii 4)

Fundamental Conceptions.—This conception of the Trinity is systematically developed by theologians, Greek, Latin and Protestant "The whole perfection of the Divine nature is in each of the persons The essence and dignity of the Father and the Son is the same, but is in the Father according to the relation of Giver, in the Son according to the relation of Receiver" (*S T.* i, xlii. 4). Writers in the 4th and 5th centuries had compared the relation of the Father to the Son with the relation of the "flame to its light," of the "spring to the stream," of the "seal" to its "impress" "Think," says St. Augustine (*Sermo ad Catechumenos*, sec 8) "of fire as a father, light as a son. See, we have found coevals: and it is easy to see which begets which." The meaning of these comparisons is plain They teach that the whole Divine nature or essence is in each of the Three Persons The impress, for example, is a *full* reproduction of the character of the seal. They teach also that the Divine persons are inseparable We are dealing both with a "generical" and a "numerical" unity (*cf* Aug, *F and S*, sec 4, *Modern Churchman*, vol xv. 12, 675–7; Webb, *God and Personality*, 69n).

Thus, side by side with language declaring that Father and Son are each in the full sense God, there is other language—not *intended* to be inconsistent with the former—which implies that the Son is "necessary to the completeness of the Godhead" The Son, we are told, is not "external" to the Father (Athan, *Discourse I.*, ch. v.), does not "accrue" to the Father from without, but is "of the Substance of the Father." If the Son, it is argued,

were not eternal, the Father would not always be Father, and this absence of fatherhood, it is implied, would be a defect (*cf.* the words *consortium, solitarius, S.T.* i, xxxi., 2 and 3). What is the value of these speculations? They cannot be understood apart from a knowledge of the context in which they grew up. This context may be summed up in a sentence. Christians, who were willing to die for Monotheism, deliberately held Jesus to be worthy of full Divine worship, and offered the phrase *Consubstantialem patri* as the intellectual justification of this attitude. In contact with the "Spirit" (who was held to speak in the heart of the individual Christian) they believed themselves to be in contact with God. In contact with Jesus as Master, they likewise found themselves in contact with God; but with no divided allegiance, since they conceived the Universe—in spite of its manifest evils—as the work of the Father of Jesus Christ, and so the embodiment of the same Holy Will which expressed itself most clearly in Jesus and in the Holy Spirit.

The doctrine, then, is primarily religious; and if we define God—as in practice religion does—as "That which has an absolute claim upon our obedience" or as "the Supreme Object of our reverence," the paradoxical element in the doctrine is at least diminished The ultimate Object of the Christian's reverence is—as reflection will show—the Christian ideal of holiness A being who fell short of this standard, however omnipotent or self-existent he might be, would not receive the Christian's worship Conversely, this standard would have an equal claim upon our reverence—since its claim to our obedience is conceived as being absolute—whether or not it were embodied in a person Jesus is worshipped because the Christian "identifies" Him with His Call—His Law. Reverence and subjection to Him are reverence and subjection to it (John xiv 21, etc). Is there, then, any insuperable difficulty in the notion of a threefold personal embodiment of the one Divine Will and Character, an embodiment so complete in each case that contact with the Divine Person is contact with God?

Claims of Unity.—The answer to the foregoing question turns upon the claims of unity. The unity of the world is sometimes represented as based upon its presence to, and its existence in, a single Divine Mind Religion, however, is interested primarily in the unity of the moral ideal, of the ideal of perfection generally "The Monotheism of Israel," it has been well said, "was primarily moral seriousness" Religion is concerned also with a faith—which is the basis of its trust and hope—in the necessity of the complete realization of the good in the universe as seen in God, with a faith in that "perfection of the Universe" which St Thomas regarded as God's chief purpose in creation (i. 50, 3). A Universe which has unity as the complete realization of this single ideal, has the unity which chiefly concerns religion This ultimate unity of subordination to a single principle is not necessarily identical with the unity which comes from being included within the mind of a single Divine Being Nor is it obviously identical with the theologian's "numerical unity of substance" (*see e g*, Tanqueray, *Syn Theol. Dog.*, ii. 575–576). The Unity, then, of the Object of our supreme reverence and trust is not plainly inconsistent with the existence of personal distinctions (in the modern sense of the word) within the Godhead. It was probably an afterthought to regard the doctrine of the Trinity as providing a more satisfactory conception of "personality in God" than could grow up under a "unipersonal" theology. Yet Trinitarianism has some points of superiority over a theory which may compel us to conceive God as waking up at the Creation from "an eternity of idleness" (Shelley, *Queen Mab*, vii. *cf. Journal of Theol Studies*, iv 376). Love—it may be argued—can only be at its highest perfection in the "love of God for God"—in a love in which He that loves and He that is loved are wholly adequate to one another. A faith in God's perfection would thus tend to a belief in the "plurality of persons in the Godhead"

Amplifying Conceptions.—It has been similarly argued that in conceiving the "not-self with which God contrasts Himself" as "wholly internal to His essence" while the unity (the Holy Spirit) "within which the relation of the two falls is not, as in us, a dark mystery at the back of our life but something which 'proceeds from both'" we have "the best notion that we can frame of Being at its highest" (Webb, *J.T.S.*, Oct. 1900). Such an argument leads not merely to a plurality but to a trinity of Divine persons, and supports the Western doctrine of the procession of the Spirit from the Father and the Son, *tanquam ab uno principio et unica spiratione* (Council of 1274). It agrees also with the conception of the mutual indwelling of the Three Persons (Tanqueray, *S.T.D.*, ii, 664–665). Again, the argument—if joined with the belief that "whatever we conceive the Divine life to be, our life cannot be outside it"—is in accordance with the Scriptural conception that mankind is within the Eternal Son, that the Church is His "body" or His "fulness." Such a conception would lead us beyond any mere "trinity of manifestation"; since it implies that, though in knowing each Person of the Trinity we are knowing God, yet to know God as Trinity is a real addition to our knowledge, and further, that the personal relations within the Trinity are necessary to His full glory, since they make possible to God something better than mere self-contemplation.

The doctrine, then, we may conclude, arose primarily from the conviction that worship of Jesus is consistent with Monotheism. But if, secondarily, the doctrine when formed is defended as offering the best attainable conception of the Divine perfection, it follows that our sense of what is good and fitting, our aesthetic and religious instinct for perfection, and likewise those qualities in the doctrine which moved Dante (*Parad.*, x. 1–6) to give it poetic expression, are all relevant to its discussion (*See* PANTHEISM, ATHEISM) (C. J. SH)

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TRINITY HOUSE, CORPORATION OF. An association of English mariners which originally had its headquarters at Deptford in Kent. In its first charter, received from Henry VIII in 1514, it was described as the "guild or fraternity of the most glorious and undividable Trinity of St Clement" The first master appointed was the founder of the corporation, Sir Thomas Spert, comptroller of the navy to the king, and commander of the "Harry Grace de Dieu." Deptford having been made a royal dockyard by Henry VIII., and being the station where outgoing ships were supplied with pilots, the corporation rapidly developed its influence and usefulness By Henry VIII. it was entrusted with the direction of the new naval dockyard. From Elizabeth, who conferred on it a grant of arms in 1573, it received authority to erect beacons and other marks for the guidance of navigators along the coasts of England. In 1604 a select class, was constituted called Elder Brethren, the other members being called Younger Brethren. By the charter of 1609 the sole management of affairs was conferred on the Elder Brethren; the Younger Brethren, however, having a vote in the election of master and wardens The practical duties of the fraternity are discharged by the acting Elder Brethren, 13 in number, of whom two are elected from the royal navy and 11 from the merchant service; but as a mark of honour persons of rank and eminence are admitted as honorary Elder Brethren. In 1647 the corporation was dissolved by parliament, but it was reconstructed in 1660, and the charter was renewed by James II. in 1685. In 1687 a by-law of the Trinity House for the first time required an agreement in writing between the master and crew of a ship. A new hall and almshouses were erected at Deptford in 1765; but for some time the offices of the corporation had been transferred to London, where for a while they had a house in Water lane, Lower Thames street, and in 1795 their headquarters were removed to Trinity House, Tower hill, built from the designs of Samuel Wyatt. By an Act of 1836 they received powers to purchase from the

Crown, as well as from private proprietors, all interests in coast lights. For the maintenance of lights, buoys, etc., they had power to raise money by tolls, the surplus being devoted to the relief of old and indigent mariners or their near relatives. In 1853 the control of the funds collected by the corporation was transferred to the Board of Trade, and the money over which the brethren were allowed independent control was ultimately reduced to the private income derived from funded and trust property. Their practical duties in erection and maintenance of lighthouses, buoys and beacons remain as important as ever. Similar functions are carried out by the Northern Lighthouse board and the Irish Lighthouse board, for Scotland and Ireland respectively. They have also the care and supervision of pilots. Other Trinity Houses established under charter or act of parliament for the appointment and control of pilots are at Hull and Newcastle. The Elder Brethren of Trinity Masters also act as nautical assessors in the high court of Admiralty. The corporation has a large wharf and repair shop at the mouth of the river Lea, where most of the work of buoying the Thames is carried out.

See W H Mayo, *Trinity House, London, Past and Present* (1905); C. R. B Barrett, *The Trinity House of Deptford Strond* (1893).

TRINITY SUNDAY, the Sunday next after Whitsunday. A festival in honour of the Trinity had been celebrated locally at various dates for many centuries before Pope John XXII. (1316–1334) ordered its general observance on the octave of Whitsunday From Trinity Sunday onwards all Sundays until the close of the ecclesiastical year are reckoned in the Church of England as "after Trinity," in the Roman Church as "after Pentecost"

TRINOVANTES, commonly *Trinobantes,* a powerful British tribe about 50 B C–A D 50 dwelling north and north-east of London, rivals and neighbours of the Catuvellauni. When Caesar invaded Britain 54 B C. they joined him against their domestic rivals They were conquered by Rome in A D 43 and joined in Boadicea's revolt in 61 In the tribal division of Roman Britain given by Ptolemy their land included Camulodunum (Colchester), but nothing more is known of them But their name plays a part in mediaeval legends and romances There it was interpreted as Troy Novant, the "new Troy," and connected with the names of the Trojans Brutus and Corineus who were reputed to have given their names to Britain and Cornwall (F. J H.)

TRIOLET, one of the fixed forms of verse invented in mediaeval France, and preserved in the practice of many modern literatures It consists of eight short lines on two rhymes, arranged a b a a a b a b, and in French usually begins on the masculine rhyme The first line reappears as the fourth line, and the seventh and eighth lines repeat the opening couplet; the first line, therefore, is repeated three times, and hence the name No more typical specimen of the triolet could be found than the following, by Jacques Ranchin (*c* 1690) —

"Le premier jour du mois de mai
Fut le plus heureux de ma vie
Le beau dessein que je formais,
Le premier jour du mois de mai!
Je vous vis et je vous aimais.
Si ce dessein vous plut, Sylvie,
Le premier jour du mois de mai
Fut le plus heureux de ma vie"

This poem was styled by Ménage "the king of triolets." The great art of the triolet consists in using the refrain-line with such naturalness and ease that it should seem inevitable, and yet in each repetition slightly altering its meaning, or at least its relation to the rest of the poem The triolet seems to have been invented in the 13th century. The earliest example known occurs in the *Cléomadès* of Adenès-le-Roi (1258–97). The mediaeval triolet was usually written in lines of ten syllables, and the lightness of touch in the modern specimens was unknown to these perfectly serious examples. One of the best-known is that of Froissart, "Mon coeur s'ebât en odorant la rose" According to Sarrasin, who introduces the triolet as a mourner in his *Pompe funèbre de Voiture,* it was that writer who "remit en vogue" the ancient precise forms of verse, "par ses balades, ses triolets et ses rondeaux, qui par sa mort (1648) retournaient dans leur ancien décri" Boileau threw scorn upon the delicate art of these pieces, but they continued to be written in France, though not by poets of much pretension, until the middle of the 19th century, when there was a great revival of their use. There are delightful examples by Theodore de Banville.

The earliest triolets in English are those of a devotional nature composed in 1651 by Patrick Carey, a Benedictine monk at Douai, where he probably had become acquainted with what Voiture had made a fashionable French pastime In modern times, the triolet was re-introduced into English by Robert Bridges, in 1873, with his—

"When first we met, we did not guess
That Love would prove so hard a master;
Of more than common friendliness
When first we met we did not guess.
Who could foretell this sore distress,
This irretrievable disaster,
When first we met?—we did not guess
That Love would prove so hard to master"

Since then the triolet has been cultivated very widely in English, most successfully by Austin Dobson, whose "Rose kissed me today," "I intended an Ode" and "In the School of Coquettes" are masterpieces of ingenuity and easy grace.

TRIPHENYLMETHANE, a hydrocarbon, $(C_6H_5)_3CH$, which gives its name to an important group of synthetic colouring matters which includes magenta, paramagenta (rosanilines), malachite green, brilliant green, patent blue, aurin and rosolic acid (*See* DYES, SYNTHETIC) It is a white crystalline solid melting at 92° C and boiling at 358° C/760 mm Its preparation is best effected by adding anhydrous aluminium chloride to a mixture of dry benzene and dry carbontetrachloride; after 24 hours anhydrous ether is slowly added and the mixture then treated with acidified ice water The hydrocarbon is extracted with benzene and obtained from this extract by a distillation under reduced pressure, being purified by crystallisation from ethyl alcohol (O Kamm and J F. Norris, *Organic Syntheses,* Vol iv, J Riley and Sons, 1925) Other modes of formation are as follows: (1) Condensation of benzal (benzylidene) chloride, $C_6H_5CHCl_2$, with mercury diphenyl, (2) condensation of benzene with chloroform in presence of aluminium chloride; (3) from paramagenta (pararosaniline chloride) by successive reduction, diazotisation and replacement of diazo-groups by hydrogen The third process is of historical interest as it served to establish the connection between the hydrocarbon and the rosaniline colouring matters (O. and E Fischer, 1881) Conversely, triphenylmethane can be nitrated and its trinitro-compound can be reduced to paraleucaniline, $CH(C_6H_4NH_2)_3$, which on oxidation in acid solution yields pararosaniline chloride or paramagenta, $(NH_2C_6H_4)_2C\,C_6H_4{\cdot}NH_2Cl$ Triphenylmethane on oxidation is found to give triphenylcarbinol, $(C_6H_5)_3C{\cdot}OH$, a feebly basic hydroxide which on treatment with hydrogen chloride is converted into colourless triphenylmethyl chloride, $(C_6H_5)_3C\,Cl$, melting at 111° C. This chloride is the primary product of the foregoing condensation of benzene and carbon tetrachloride (*v supra*).

By the action of various metals (zinc, silver, copper or mercury) on triphenylmethyl chloride, M Gomberg in the year 1900 isolated a very remarkable unsaturated hydrocarbon, triphenylmethyl, $(C_6H_5)_3C$, and he showed that the reaction was general by removing chlorine from other triarylmethyl chlorides

Triphenylmethyl is colourless in the solid state but yields yellow solutions. Cryoscopic determinations show that the dissolved hydrocarbon is chiefly in the bimolecular state,

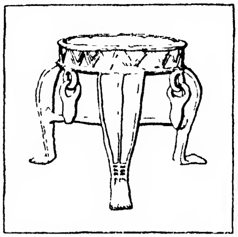
$$(C_6H_5)_3C\,C(C_6H_5)_3,$$

which is in equilibrium with the coloured unimolecular form. With increasing complexity of the aryl groups there is a greater tendency for the triarylmethyls to exist in the unimolecular condition, so that the successive replacement of phenyl by diphenyl is accompanied by an increase in depth of colour until trisdiphenylmethyl, $(C_6H_5C_6H_4)_3C$, which occurs only in the coloured unimolecular condition, is obtained as a green crystalline powder melting at 186° C (W Schlenk, T. Weickel and A. Herzenstein, 1910) On the other hand diphenyldiphenylenemethyl,

$$(C_6H_5 \cdot C_6H_4 \cdot C . C_{12}H_8)_2,$$

exists only in the colourless bimolecular condition. (*See* J Schmidlin, *Das Triphenylmethyl*, F Enke, 1914) (G T. M)

TRIPOD, in classical antiquities, any "three-footed" utensil or article of furniture The name is specially applied to. (1) a seat or table with three legs; (2) a stand for holding the caldron used for boiling water or cooking meat; (3) a sacrificial tripod or altar, the most famous of which was the Delphic tripod, on which the Pythian priestess took her seat to deliver the oracles of the god, the seat being formed by a circular slab on the top, on which a branch of laurel was deposited when it was unoccupied by the priestess Another well-known tripod was the "Plataean," made from a tenth part of the spoils taken from the Persian army after the battle of Plataea. This consisted of a golden basin, supported by a bronze serpent with three heads (or three serpents intertwined), with a list of the States that had taken part in the war inscribed on the coils of the serpent The golden bowl was carried off by the Phocians during the Sacred War; the stand was removed by the emperor Constantine to Constantinople, where it is still to be seen in the Atmeidan (hippodrome), but in a damaged condition, the heads of the serpents having disappeared Tripods are frequently mentioned in Homer as prizes in athletic games and as complimentary gifts, and in later times, highly decorated and bearing inscriptions, they served the same purpose



ROMAN BRONZE TRIPOD IN MUSEUM AT NAPLES

TRIPOLI, the ancient *Oea,* formerly capital of the Turkish vilayet of Tripoli, and now of the Italian colony of Tripolitania, North Africa, situated in 32° 53′ 40″ N and 13° 11′ 32″ E on a promontory stretching out into the Mediterranean and forming a small crescent-shaped bay which shelters the harbour from the north winds The mean temperatures are often lower than in many Italian cities, owing to its situation Pop (1928) about 70,000, of whom about 20,000 were Italians, and 15,000 Jews The crenellated enceinte walls by which the city was surrounded had the form of an irregular pentagon, but have now been, to a considerable extent, demolished They dated from Roman times, but the earliest portions actually preserved belonged to the Byzantine period, and the greater part to the 16th century The citadel, dating from the time of the Spanish occupation, now serves as the residence of the governor, and here also is the archaeological museum The desert almost touches the western side of the city, while on the east is the verdant oasis of Meshia, where are still to be seen the tombs of the Caramanlian sultanas The aspect of the city is picturesque; the houses (many possessing beautiful gardens) rise in terraces from the seashore The Turkish quarter contains numerous mosques whose minarets and cupolas break the monotony of the flat-roofed and whitewashed houses The Pasha mosque (originally a church built by the Spaniards) has an octagonal minaret, but the most beautiful is the Gurgi mosque (1833). Many of the streets are arcaded Near the port stands a Roman triumphal arch, quadrifrontal in form, made entirely of white marble, and richly embellished with sculpture It was erected in A D 163

The modern part of the city, to the south-west of the old town, contains a number of official buildings, a cathedral, the Victory monument, theatres, hotels, etc , most of them along the fine new sea-front called Lungomare Conte Volpi, in honour of the former governor (1921–25). There is also a large tobacco factory, and important military buildings, artillery factories, supply base, hangars, etc , as well as a hospital

The harbour has been dredged to an adequate depth for an area of 1,200 ac., and the quays provided with modern appliances. In 1927, 1,603 ships, with a tonnage of 1,182,770, entered and cleared the port, representing a traffic (inward and outward) of 163,487 tons of merchandise and 58,725 passengers. There is regular communication by sea with Syracuse (via Malta), and also with Tunis, and with Misurata and the ports of Cyrenaica as far as Tobruk, and weekly air service has been instituted from Rome via Syracuse. There are productive saltworks, and beer is made from barley grown locally and in Cyrenaica.

The oasis of Tripoli is very fertile and beautiful; its total surface is about 25 sq m , and it contains about 4,000 houses, 8,500 wells and a million trees. At Sidi Mezri there is an important Governmental agricultural experimental station.

The ancient Oea (one of the cemeteries of which has been discovered) was probably founded by Phoenicians from Sicily. It became a Roman colony after the fall of Carthage It owed its importance in the middle ages and subsequently to the destruction of Sabratha and Leptis Magna by the Arab invasion in the 11th century In 1510 Tripoli was taken by Navarro; in 1530 it was granted to the Knights of St. John; but in 1551, it was lost again, and attempts to retake it, organized by Philip II of Spain and led by Andrea Doria, came to nothing, the expedition being defeated at Jerba It subsequently became a nest of pirates

TRIPOLI, a city in Syria, and the seat of administration of the sanjak of North Lebanon in French mandated territory, mod *Tarābulus* It is situated about 2 m inland from its port El-Mīna, to which it is joined by a tramway. Pop 36,000 (26,000 Muslims) Although there is no harbour, strictly speaking, there is safe anchorage on each side of the peninsula on which El-Mīna stands, and small craft can shelter behind an old Phoenician breakwater. The city has a French garrison, and a number of mission and other schools The chief industries are soap manufacture, sponge fishing, tobacco cultivation, and fruit growing It has an export trade in fruit (especially oranges), eggs and cotton

History.—Tripoli is known only by its Greek name Founded after 700 B C , it became in the Persian period the capital for the Phoenician triple federation—Sidon, Tyre and Aradus Each of the three had its own district in the "triple town," which at that time stood on the El-Mīna peninsula The Seleucids and Romans extended and embellished the city The Muslims took possession in A D 638 In 1109 it surrendered to Raymond of St Giles, after a five years' siege A great library founded by 'Ammār, the ruling family, and consisting, it is said, of 100,000 volumes, was consigned to the flames When Sultan Kalā ūn of Egypt took the town in 1289 it was destroyed, and a new city arose on the present site. Tripoli was often a disputed possession of the rival princes of Aleppo and Acre. In 1834 during the Egyptian conquest of Syria, it was made a centre of administration British cavalry and armoured cars took possession of it on Oct 13, 1918. It was incorporated in the State of Grand Liban by an *arrêté* of the French high commissioner (Gen Gouraud) on Aug 31, 1920. (E. Ro)

TRIPOLITANIA, an Italian colony in North Africa, with an approximate area of 360,000 sq m , mostly desert It is bounded on the north by the Mediterranean, on the west and south by Tunisia and French West and Equatorial Africa, and on the east by Cyrenaica (*q v*). Pop (1921) Europeans 20,716, of whom 18,093 were Italian: natives (1927) about 550,000, mostly Arabs, Berbers and Jews The chief towns, all on the coast, are Tripoli (*q v*) (pop 14,000) and Misurata (pop 14,000)

Economic Conditions.—The agricultural possibilities, especially those of the cultivation of grain on a large scale, are somewhat uncertain, owing to climatic conditions; while tropical cultivation (coffee, etc) would be impossible without costly irrigation works Arboriculture, on the other hand, is believed to have a very considerable future. it has been estimated that at least 20 million olive trees could be planted there, and vines, oranges and other fruit trees are also successful Date palms flourish, barley (for beer), henna, castor oil, esparto grass and tobacco are grown and salt, hides, wool and silk worms are produced. Since 1918, 389,620 ac. of land concessions have been taken up by Italian immigrants. and there would be room, it is thought, for as many as 100,000 selected Italian farmers and their families. The afforestation of the sand dunes has been begun, with tamarisk, mimosa and eucalyptus. Sponge fisheries (40 tons in 1927) and tunny fisheries (500 tons) are carried on. The Government has built a railway along the coast westward from Tripoli to Zuara

(75 m.) and begun a line eastwards to Homs, which runs as far as Tagiura (13 m). Another railway (31 m.) runs inland from Tripoli to El 'Azizia, and is to be continued to Gharitani and the Jebel. Motor roads run from Bu-Chemmex on the Tunisian frontier, through Zuara and Tripoli, to Homs, Misurata and Sirte, and southwards as far as Misda and Bu Njem, forming the first portion of the two caravan routes to Murzuk, by Tachertiba (where the route to Ghat, and thence to Kano, branches off), and by Sokna and Zuila (where the route to Kufra diverges). Another route runs from Tripoli to Ghadames and thence to Ghat Revenue is largely derived from import duties, which give preference to Italian products The value of imports in 1922 was £985,000, while that of exports was only £145,000. In 1926 the value of imports was £2,112,000 and of exports £323,000 The colony has been a considerable burden to the Italian Treasury, largely through military expenditure The military establishment in 1926–27 was some 17,000 men, of whom 4,800 were Italians. Tripoli comprises four distinct regions—Tripoli proper, the Aujila oases, Fezzan (*q v*) and the oases of Ghadames and Ghat—which with the intervening sandy and stony wastes occupy the space between Tunisia and Cyrenaica

Physical Features.—For some distance east of Tunisia the seaboard is low and sandy with various oases (Zauia, Zanzur, the oasis of Tripoli itself, etc), and is often regarded as a part of the Sahara, which, however, begins only some 80 m. farther south, beyond the Jebels Nefusi, Yefren and Gharian The "Jebel," as this system is locally called, terminates eastwards in the Tarhona heights of the Homs (Khoms) coast district, has a mean altitude of about 2,000 ft and culminates in the Takut (Tekuk) volcano (2,800 ft) nearly due south of the capital It is not a true mountain range, but rather the steep scarp of the Saharan plateau, which encloses southwards the Jefara coast plains, and probably represents the original coast-line The Gharian section is scored in places by the beds of intermittent coast streams, and on its lower slopes is clothed with a rich sub-tropical vegetation. Gharian, some 65 m south from Tripoli by motor, and 2,350 ft above sea-level, is the seat of the commandant of the southern territory

South of these escarpments, the vast Hammada el-Homra, the "Red Hammada," an interminable stony table-land covering some 40,000 sq m occupies the whole space between Tripoli proper and the Fezzan depression The now uninhabited and waterless Hammada formerly drained through several large rivers, such as the Wadis Targelat (Uani, Kseia), Terrgurt, Sofejin, Zemzem and Bel, north-eastwards to the Gulf of Sidra (Syrtis major) Southwards the table-land is skirted by the Jebel Welad Hassan, the Jebel es-Suda, the Jebel Morai-Yeh, and other detached ranges, which have a normal west to east trend in the direction of the Aujila oases, rising a little above the level of the plateau, but falling precipitously towards Fezzan The Jebel es-Suda (Black Mountains), most conspicuous of these ranges, with a mean altitude of 2,800 ft, takes its name from the blackened aspect of its limestone and sandstone rocks, which have been subjected to volcanic action, giving them the appearance of basalt Eastwards this range ramifies into the two crescent-shaped chains of the Haruj el-Aswad and Haruj el-Abiad ("Black" and "White" Haruj) which rise some 700 ft. above the Red Hammada.

Beyond the barren Ghadama district in the north of the Hammada the dreary aspect of the wilderness is broken by several tracts under grass, corn and date-palms, and containing some permanent reservoirs in the beds of the Wadis Sofejin and Zemzem, where the plateau falls from a mean height of 2,000 ft to 1,000 and 530 ft respectively But it again rises rapidly southwards to a somewhat uniform level of 1,600 or 1,700 ft, and here the main caravan route from Tripoli to Murzuk and Lake Chad traverses for a distance of fully 130 m a monotonous region of sandstone, underlying clays, marls, gypsum and fossiliferous silicious deposits.

Ghat and Ghadames.—Ghat stands 2,400 ft above the sea, on the Wadi Aghelad in the Igharghar basin, and consequently belongs, not to the Fezzan depression but to the Saharan plateau. The Aghelad, or "Passage," trends north to the Iasawan valley along the east foot of the Tasili plateau, that is, the divide between the waters which formerly flowed north to the Mediterranean, west to the Atlantic, and south to the Niger and Chad basins Ghat, which is skirted eastwards by the Akakus range, is a sandy plain dotted over with clumps or groves of date-palms. In the centre is an open space where is held a great annual fair, and to this, combined with its position on one of the caravan routes across the desert, the oasis owes all its importance For several years, at the end of the 19th and beginning of the 20th centuries, the only caravan route used from the Niger countries to Tripoli was by way of Ghat, disturbances in Bornu and raids by Tuareg having closed all other routes There is, in the oasis, a population of perhaps 10,000 nearly all Ihajenen Tuareg, about half of whom live in the town of Ghat (350 m S of Ghadames and 250 S W of Murzuk), which appears to be a relatively modern place Ghadames (*q v.*) on the contrary, is ancient

Climate, Flora and Fauna.—The climate of Tripoli is very variable; cold nights often succeed warm days The rainfall in the northern regions varies from 5 in to 15 in a year—December, January and February being the rainy season. The mean temperature on the coast lands is 68°; it is 5° higher at Ghadames The flora in the greater part of the colony is Saharan, the date-palm being the characteristic tree The gum-yielding acacia, the tamarisk, sapan, mastic and pistachio are found in the wadis, and *shi* (wormwood) grows in clusters on the stony plateaus In parts of the coast belt the flora is more varied generally In these regions the laurel, myrtle and other evergreens are fairly common, and the oak, cypress, pine, carob and other tress occur, notably the olive, found also in the oases Other fruit trees are the almond, fig, pomegranate, quince and apricot

The larger wild animals are scarcely represented in Tripoli The wild boar is found in Jebel Akhdar, the hyena, fox and jackal in the deserts The mouflon, gazelle, hares, rabbits and marmots are among the commoner animals Reptiles include the horned viper and the gecko The characteristic animal is the camel, found only in the domesticated state Horses and cattle are bred, but the horses are not numerous, goats and a fat-tailed variety of sheep are kept in large numbers. Birds include the ostrich, vultures, hoopoes, wood pigeons and doves Bees are numerous and honey forms an article of export

Tripoli no doubt owes its stability in large measure to its position over against Sicily at the northern terminus of three great historic caravan routes, one of which runs due south to Lake Chad through Fezzan and Bilma, that is, across the narrowest part of the Sahara; another runs south-west through Ghadames and Ghat to Timbuktu and Kano, and the third south by east through Sokna to Wadai and Darfur East of Tripoli are the small seaports of Homs (Khons) and Lebda. while Misurata is more important both as a harbour and for its manufacture of carpets To the east of Misurata is the inhospitable sandy waste of the Gulf of Sidra (anc *Syrtis Major*) so much dreaded by sailors in antiquity The caravan trade consists largely in leather objects and Sudanese cotton fabrics but it has now lost much of its importance owing to the French occupation of Timbuktu and the building of the railway from Lagos to Kano (X)

See H Vischer, *Across the Sahara* (1910) for a description of a journey from Tripoli to Lake Chad *See* also R Calzini, *Da Leptis Magna a Ghadames* (1926); R Bartoccini, *Le Antichità della Tripolitania* (Milan, 1926), *La Rinascità della Tripolitania* (Milan, 1926).

HISTORY

Tripolitania, also commonly called Tripoli simply, was originally a Phoenician colony The wars between the Libyans and the ancient Egyptians do not come properly into the history of Tripolitania. (*See* Egypt) Before the colonization of the neighbouring territory to the east by the Greeks (*see* Cyrenaica) the Phoenicians appear to have founded the cities of Sabrata, Oea and Leptis Magna Oea, which stood between the other cities, became the capital of the country and was named Tripolis (the "Three Cities"). These towns commanded the trade of the central Sudan, caravans regularly crossing the Sahara, there at its narrowest The early history of the two regions, Cyrenaica and Tripolitania, was similar Cyrenaica passed from the Greeks to the Ptolemies

and from them to the Romans Tripolitania, adjoining westward Carthaginian territory, fell under the sway of Carthage and, following its fortunes, became eventually a Roman province.

In the 5th century both Tripolitania and Cyrenaica were conquered by the Vandals, whose power was destroyed by the Byzantine general Belisarius in the following century In the middle of the 7th century north Africa was overrun by the Arabs, and Christianity gave place to Islam From this period dates the decay of a civilization which had lasted about 1,000 years Tripolitania became subject to the successive rulers of Tunisia It was pillaged in 1146 by the Normans of Sicily In 1321 the Beni Ammar established an independent dynasty, which lasted with an interval (1354–69), during which two sovereigns of the Beni Mekki reigned, until 1401, when Tripolitania was reconquered by the Tunisians In 1510 Ferdinand the Catholic of Spain took the city of Tripoli, and in 1528 it was given to the knights of St John, who were expelled in 1553 by the Turkish corsairs Dragut and Sinan Thus the country fell to the Turks, though after the death of Dragut the connection with Constantinople seems to have weakened The Tripolitan pirates soon became the scourge of the Mediterranean, half the states of Europe seem at one time or other to have sent fleets to bombard the capital of the country, nor was piracy stopped until after the French occupation of Algiers in 1830 In 1714 Ahmed Pasha Caramanli achieved practical independence He and his descendants governed the country as a regency, the claims of the Porte being recognized by the payment of tribute, or "presents" In the early part of the 19th century the regency, owing to its piratical practices, was twice involved in war with the United States In May 1801 the pasha demanded from America an increase in the tribute ($83,000) which the Government of that country had paid since 1796 for the protection of their commerce from piracy The demand was refused and a naval force was sent from America to blockade Tripoli The war dragged on for four years, the Americans in 1803 losing the frigate "Philadelphia," the commander (Captain William Bainbridge) and the whole crew being made prisoners The most picturesque incident in the war was the expedition undertaken by William Eaton (*q v*), with the object of replacing upon the Tripolitan throne an exiled pasha, elder brother of the reigning sovereign, who had promised to accede to all the wishes of the United States Eaton, at the head of a motley assembly of 500 men, marched across the desert from Alexandria, and with the aid of American ships succeeded in capturing Derna Soon afterwards (June 3, 1805) peace was concluded, the reigning pasha relinquishing his demands, but receiving $60,000 (about £12,000) as ransom for the "Philadelphia" prisoners In 1815, in consequence of further outrages, Captains Bainbridge and Stephen Decatur, at the head of a squadron, again visited Tripoli and forced the pasha to comply with the demands of the United States

In 1835 the Turks took advantage of a civil war to reassert their direct authority They administered the country as an ordinary vilayet (province) under a pasha Turkish rule was marked by occasional, spasmodic, and mainly ineffective efforts to develop the country When in 1881 the French seized Tunisia the Turks were alarmed and greatly strengthened their garrison in Tripolitania. Disputes followed as to the extent of the Tripolitan hinterland, which the French endeavoured to circumscribe It was not only the French that the Turks had to fear. Italy had looked upon Tunisia as her heritage and, baulked in that direction, she now fixed her eyes upon Tripolitania and Cyrenaica. More or less definite understandings were reached on the subject with other European Powers interested. For another generation, however, the Turks remained undisturbed and under the impetus of the Pan-Islamic movement Turkish authority was pushed far south, a Turkish garrison even occupying the oasis of Bilma in 1910. Meanwhile, Germany was making endeavours to secure economic and, as a result, political predominance in both Tripolitania and Cyrenaica This led to action by Italy; war was declared upon Turkey in Nov. 1911 and both Tripolitania and Cyrenaica were declared to be under the full sovereignty of Italy. (For the war *see* ITALO-TURKISH WAR.) When the Treaty of Lausanne was signed in Oct. 1912 the Italians, however, held only the coast region, and they met with considerable opposition from the natives (Berbers and Arabs) in their occupation of the interior. But by Aug 1914 every place of importance in the vilayet, including Fezzan, was in Italian hands. Meanwhile in the coast districts the Italians had begun with great energy a big programme of public works, while towards the Arabs and Berbers they adopted a policy of confidence and trust.

Unfortunately, in Cyrenaica the war continued, the Turks having incited the Senussites to continue the struggle. (*See* SENUSSI.) In Sept 1914 the Fezzani, many of whom adhered to the Senussi sect, rose in revolt. Turkish, German and Senussi propaganda was very active throughout Tripolitania, and the declaration of war by Italy upon Austria (May 28, 1915) was the signal for a general rising After some hesitation the Italians, in view of the situation in Europe, abandoned the whole country, with the exception of the seaports of Tripoli and Homs (Khoms) Another seaport, Zuwara, was reoccupied in Aug 1916 Meanwhile, a brother of the Senussi chief ruled in Fezzan; Suleiman el Baruni, a Berber chieftain who had given much trouble in 1912–13, reappeared (Sept 1916) with a firman from the sultan of Turkey appointing him governor-general of the vilayets of Tripoli, Tunis and Algiers; Ramadhan el Shtewi, another powerful chieftain, established a so-called republic of Tripoli and ruled at Misurata, which place became a German submarine base There was, however, little cohesion and much jealousy among the opponents of Italy

Such was the state of chaos in the country at the end of the World War, and the Italians were then in no mood to undertake the reconquest of Tripolitania by force There was little real improvement in the situation until Giuseppe Volpi became governor in Aug 1921 Under his direction a campaign, which began in Jan 1922 with the reoccupation of Misurata, was conducted to a successful issue by the end of 1923 Thereafter, by wise and conciliatory measures and by a bold policy of economic reconstruction, Volpi restored order and a degree of prosperity to a large part of the country, though Fezzan was still troubled by rival factions In the latter part of his governorship Volpi had the full support of the Fascist Government For his services he was created Count Volpi of Misurata. On resigning his post in July 1925 he became minister of finance in the Italian cabinet. His successor as governor was General de Bono

In 1927–28 systematic military operations were carried out by the Italians which resulted in the occupation of the district—long a no man's land—at the eastern end of the gulf of Sidra, where Tripolitania and Cyrenaica meet By these operations the Italians came into effective control of all the region north of the Sahara. A visit paid by the king and queen of Italy to Tripoli and other towns in April 1928 may be taken to mark the completion of the task of establishing order and security in the colony. (*See* further CYRENAICA and SENUSSI)

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TRIPOLITSA, officially *Tripolis*, a town of Greece, capital of the nomarchy of Arcadia, and the seat of an archbishop, in a plain over 2,000 ft above sea-level, 22 m. S W. of Argos. The name refers to the three ancient cities of Mantineia, Pallantium and Tegea, of which Tripolitsa is the modern representative. It does not stand on any ancient site. Before the War of Independence it was the capital of the Morea and the seat of a pasha, with about 20,000 inhabitants; but in 1821 it was sacked by the insurgents, and in 1825 its ruin was completed by Ibrahim Pasha. The town has since been rebuilt.

TRIPOLYE (Komsomolye) a town of Russia on the Dnieper river, 56 km. south of the city of Kiev, with which it has steamer communication. It is famous for its painted pottery of late Neolithic date; its site and others in the district were explored by Chwojka and the name Tripolye was given to the culture

there represented. This highly developed civilization probably dates from about 2750 B.C. Two types of pottery have been discovered, Tripolye A, the grooved type, being the more common. Tripolye B, or painted pottery, is thought to be an imported product and both are considered to be contemporary.

Tripolye is mentioned in 1093 and later was inhabited by refugees from Kiev, after the capture of that city by the Mongols In the 17th century Tripolye was a fortress, and the remains of its walls still stand, as do two old churches built in the Ukrainian style. During the 1917–20 civil war it was the headquarters of the bandit chief Zeleny, who drowned 100 victims in the Dnieper. A battle then ensued between the Communist Youth party (Komsomol) and the bandits and the town was re-named Komsomolye in memory of the Communist victims.

See M. Rostovtzeff, *Iranians and Greeks in South Russia*, 1922. H. J. E. Peake, and H. J. Fleure, *Priests and Kings*, 1927. V, G Childe, *The Dawn of European Civilization*, 1925. E H Minns, *Scythians and Greek*, 1913 *In Russian*. V. Chwojka, Article in vol. i. p 736 of the Report of the XI. Russian Arch. Congress at Kiev, 1899, published in Moscow in 2 vols., 1901 and 1902. V. Chwojka, *The Ancient Dwellers in the Middle Dnieper*, Kiev, 1913. Gorodtsov, *Bytovaya Arkheologia*, Moscow, 1910. *Report of the Historical Museum of Moscow*, 1916.

TRIPTOLEMUS, an agricultural hero of Eleusis, first priest of Demeter, and founder of the Eleusinian mysteries. His name is of doubtful meaning ("he who ploughs or toils thrice"; *i.e*, diligently?); in some legends he is the inventor of the plough In the best known legend (Apollodorus, i) Triptolemus was the son of Celeus, king of Eleusis, and Metaneira. Demeter, during her search for her daughter Persephone, arrived at Eleusis in the form of an old woman. Here she was hospitably received by Celeus, and out of gratitude would have made his son Demophon immortal by anointing him with ambrosia and destroying his mortal parts by fire; but Metaneira, happening to see what was going on, screamed out and disturbed the goddess. Demophon was burnt to death, and Demeter, to console his parents, took upon herself the care of Triptolemus, instructed him in everything connected with agriculture, and presented him with a wonderful chariot, drawn by dragons, in which he travelled all over the world, spreading the knowledge of her gifts. In another account (Hyginus, *Fab.* 147) Triptolemus is the son of Eleusinus, and takes the place of Demophon in the above narrative, but does not die. In the Homeric hymn to Demeter, Triptolemus is simply one of the nobles of Eleusis, who was instructed by the goddess in her rites and ceremonies. The Attic legend represented him as one of the judges of the underworld He is often represented in art, and formed the subject of a play (now lost) of Sophocles. His altar and threshing-floor were shown on the Rarian plain near Eleusis; hence he is sometimes called the son of Rarus.

See Preller-Robert, i., 767, and the classical dictionaries.

TRIPTYCH, a painting, carving or other decorative design, executed on three compartments or panels, so constructed that the two wings may fold on hinges over the centre-piece (Gr. τρίπτυχος, three-fold). The backs of the wing-pieces are often also painted, carved or otherwise decorated The subject of the side-pieces are usually appropriate and subsidiary to that of the centre. The triptych is most frequently designed as an altarpiece. An earlier use of the term is for a set of three wooden or ivory writing-tablets, hinged or otherwise fastened together, the central tablet being waxed on both sides for the impression of the *stilus* or writing implement. the outer tablets only on the inside. The three tablets thus formed a small book.

TRIPURA (formerly called *Hill Tippera*), a feudatory State of India, adjoining the British district of Tippera, in Bengal. Area, 4,116 sq m.; pop. (1921) 304,437; estimated revenue Rs. 2,971,000 (including revenue from estates in British India). Tripura comprises six parallel ranges of hills running from north to south, at an average distance of 12 m. apart. The hills, of which the highest is 3,200 ft. above sea-level, are covered for the most part with forest and bamboo jungle, while the low ground abounds with trees of various kinds, canebrakes and swamps. The forests shelter wild elephants, bison, tigers, leopards and deer. The principal crop and food staple is rice. Half the population consists of Tiparas, a tribe of Mongolian origin. The capital is Agartala (pop. 7,743), where there is an Arts college.

Tripura represents the remnant of an ancient kingdom which at various times extended in the north to Kamrup and in the east to Arakan. Ralph Fitch, who travelled through the country in 1585, noted that "the king of Tippara had almost continual wars with the Arakanese." The country now included in the Tippera district was conquered by the Mughals and annexed in 1733, but Tripura still remained under its own line of rulers. When the East India company obtained the *diwani* or financial administration of Bengal in 1765, they placed a Rajah on the throne, and, since 1808, each successive ruler has received investiture from the British government. The present ruler is H H. Maharajah Manikya Bir Bikram Kishore Deb Barman Bahaden, who succeeded in 1923.

The District Magistrate of Tippera is ex-officio Political Agent for the State, and the governor of Bengal acts as Agent of the Governor-General for supervising the administration.

TRISECTRIX: *see* CURVE, SPECIAL.

TRISTAN or **TRISTRAM,** one of the most famous heroes of mediaeval romance. In the earlier versions of his story he is the son of Rivalin, a prince of north-west Britain, and Blancheflor, sister to King Mark of Cornwall. Rivalin is killed in battle, and Blancheflor, after giving birth to a son, dies of grief. The boy is brought up as his own by Roald, or Rual, seneschal of the kingdom, who has him carefully trained in all chivalric and courtly arts With the possible exception of Horn, Tristan is by far the most accomplished hero in the whole range of knightly romance; a finished musician, linguist and chess-player, no one can rival him in more knightly arts, in horsemanship or fencing. He has besides, the whole science of *vénerie* at his fingertips. In fact, Tristan is the "Admirable Crichton" of mediaeval romance; there is nothing he cannot do, and that superlatively well—it must be regretfully admitted that he is also a most accomplished liar. Being kidnapped by pirates, Tristan is carried to Cornwall where he finds his way to the court of his uncle, King Mark, who is at first unaware of his identity, but, on learning it, joyfully accepts him as nephew and heir. He defeats the Irish giant, Morholt, who comes to claim the tribute payable every third year by Cornwall, but is desperately wounded in the encounter. Set adrift in a boat, Tristan is carried by the waves to Ireland, where he is healed by the queen, sister to Morholt. Later on he returns to ask the hand of the princess Iseult for his uncle, King Mark, and, having slain a dragon which is devastating the country, succeeds in his quest. On the homeward journey Tristan and Iseult, by misadventure, drink of the love-potion prepared by the queen for her daughter and King Mark. Henceforward the two are bound to each other by an imperishable love which dares all dangers and makes light of hardships. The greater part of the romance is occupied by plot and counter-plot; Mark and the courtiers seeking to entrap the lovers, who by their wiles escape the snares laid for them. Finally, the two are discovered under circumstances which admit of no evasion, and Tristan is obliged to flee to Brittany. There, believing himself to be forgotten, he weds Iseult of the White Hand, daughter of the duke, but makes her his wife only in name. Wounded by a poisoned weapon he sends to Iseult of Ireland to come and heal him. If she accedes to his request the ship on which she embarks is to have a white sail, if she refuses, a black. Actuated by jealousy, his wife, who has discovered his secret, seeing the ship approach on which Iseult is hastening to her lover's aid, tells him that it carries a black sail Tristan, turning his face to the wall, dies, and Iseult, arriving too late to save her lover, yields up her life in a final embrace.

Whether or not this beautiful story reposes upon a genuine historic tradition, the legend of Tristan and Iseult was one of the most popular themes of mediaeval romance; it was translated into many tongues, and the episodes are preserved in miniatures, carvings and embroideries. The earliest form of the story is still a matter of debate. Prof. Zimmer held that the main incidents were of historic origin, dating from the period of the Viking rule in Ireland. The name of Iseult's father, Gormond, is certainly Scandinavian, and she herself is noted for her golden hair; she is a northern, not a Celtic, princess The name of Tristan, on the

other hand, has been referred to the Pictish Drustan, and the story is now generally admitted to be of insular origin. Some think that the story was first told in the form of short episodic *lais*, which were later on woven into longer poems. On the other hand that distinguished scholar, M. Bédier, maintains that there was but one poem at the root of all the varying versions of the *Tristan* story, and that that work, composed in the 12th century by an unknown Anglo-Norman poet, was of such force that it determined for all time the form of the tradition There certainly was an important *Tristan* poem, composed in the 12th century by an Anglo-Norman named Thomas, which was translated into German, English and Scandinavian. Only fragments now remain, but they are sufficient to show that the original was a work of outstanding merit The German translation, by Gottfried von Strassburg, which seems to have followed the original closely, is a very beautiful poem and one of the classics of the middle ages

Besides the version of Thomas we have a fragment by a certain Béroul, also an Anglo-Norman, and a German poem by Eilhart von Oberge, both of which derive from a common source There also exists in two mss a short poem, *La Folie Tristan*, relating how Tristan, disguised as a fool, visits the court of King Mark This poem is valuable, as, relying upon the sufficiency of his disguise, Tristan audaciously gives a *résumé* of his feats and of his relations with Iseult, in this agreeing with the version of Thomas The "Gerbert" continuation of the *Perceval* contains the working over of a short *Tristan* poem, called by him the *Luite Tristan*, the latter part, probably a distinct poem, shows Tristan, in the disguise of a minstrel, visiting the court of Mark

Finally, in consequence of the popularity of the cyclic version of the Arthurian romances, the original *Tristan* story was worked over in prose form, and incorporated with the final version of the Arthurian legend, where it served to swell the already unwieldy bulk of the romantic *corpus* to an impossible extent Little of the primitive story is here preserved, and its original tragic beauty is obscured by an interminable series of "banal" adventures It was in this form that Malory knew it Fortunately for the present generation the genius of Richard Wagner, inspired by the text of Gottfried von Strassburg, has restored the story to its earlier form, and enshrined it in imperishable music

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TRISTAN DA CUNHA, the general name for a group of three small volcanic islands belonging to Great Britain, situated in the south Atlantic, the summit of the largest being in 37° 5′ 50″ S, 12° 16′ 40″ W. They are midway between Cape Colony and South America The islands rise from the submarine elevation which runs down the middle of the Atlantic The depth between the islands is in some places over 1,000 fathoms.

Tristan, the largest and northernmost island, has an area of 16 sq.m, is nearly circular in form, about 7 m in diameter, and has a volcanic cone (7,640 ft), usually capped with snow, in the centre. Precipitous cliffs, 1,000 to 2,000 ft., rise from the ocean on all sides, except the north-west, where there is an irregular plateau of about 12 sq m, 100 ft. above the sea. A stream crosses the northern end of the plateau, falling over the cliff edge in a fine cascade. The crater of the central cone contains a fresh-water lake about 150 yd in diameter. This and other crater lakes are said never to be frozen over

Inaccessible island, the westernmost of the group, is about 20 m. from Tristan. It is quadrilateral in form, the sides being about 2 m long, with cliffs about 1,000 ft., its highest point (1,840) is on the west. At the base of the cliffs in some places are narrow fringes of beach.

Nightingale island, the smallest and most southern of the group, is 10 m from Inaccessible island Its area is not more than 1 sq. m. Its coasts are surrounded by low cliffs, from which there is a gentle slope up to two peaks (1,100 ft. and 960 ft. high). There are two small islets—Stoltenkoff (325 ft) and Middle (150 ft.) —and several rocks adjacent to the coast.

The rocks of Tristan da Cunha are basalt, porphyritic basalt, dolerite, augite-andesite, palagonite, volcanic tuff and ashes. A block of gneiss in the crater indicates a continental foundation of the island The caves in Nightingale island indicate that it has been elevated several feet On almost all sides the islands are surrounded by a broad belt of kelp, the gigantic southern seaweed (*Macrocystis pyrifera*), through which a boat may approach the rocky shores even in stormy weather There is no good anchorage in rough weather

The prevailing winds are westerly. December to March is the fine season The climate is mild and on the whole healthy, the temperature averaging 68° Fahr in summer, 55° in winter—sometimes falling to 40° Rain is frequent; hail and snow fall occasionally on the lower grounds The sky is usually cloudy. The islands have a cold and barren appearance. The tide rises and falls about 4 ft

History.—The islands were discovered in 1506 by the Portuguese admiral Tristão da Cunha. Thereafter the islands (which were uninhabited) were occasionally visited by outward bound ships to the Indies Attempts to form settlements were made by the Dutch in 1656, and by the English East India company a few years later, but the first permanent inhabitant was one Thomas Currie, who landed on the island in 1810. At this time American whalers frequented the neighbouring waters and, in the same year, an American named Lambert and a man named Williams made Tristan their home, but they were drowned while out fishing in May 1812 Currie was joined by two other men and they busied themselves in growing vegetables, wheat and oats, and in breeding pigs Owing to the fact that the islands were used as a base for American cruisers raiding British merchant ships, the islands were formally annexed to Britain as dependencies of Cape Colony on Aug 14, 1816. A temporary garrison was placed on Tristan, and when it left, William Glass, his wife and two children and two masons were left behind, and shipwrecked mariners, coloured women from Cape Colony, and British, Dutch, Italian and Asiatic settlers have since made their home there The settlers grew wheat (since made impossible owing to the ravages of rats) raised cattle, sheep and pigs, grew apples and peaches, and engaged in seal fishing. They had of necessity to make their settlement on the plain on the north-west of Tristan; here a number of substantial stone cottages and a church were built. It is named Edinburgh in memory of a visit in 1867 by the duke of Edinburgh In October 1873 the islands were carefully surveyed by the "Challenger" The visits of whalers were considerably reduced during the American Civil War, to the loss of the inhabitants of Tristan. In 1880, the population was 109, in 1885 15 men were drowned in a lifeboat disaster, in 1897, the population was 64, in 1909, 95 and in 1925, 130. They manage their own affairs without any written laws Frequent attempts have been made to induce some or all of the population to leave and land has been offered to them in South Africa, but has not been accepted. Their life is a hard one, their chief food is the potato and fuel is very scarce. The inhabitants are described as moral, without intoxicating liquors, religious, hospitable to strangers, well mannered and industrious, healthy and long lived They are daring sailors, and in small canvas boats of their own building voyage to Nightingale and Inaccessible islands. They knit garments from the wool of their sheep; are good carpenters and make serviceable carts. Guano occurs on Nightingale, Inaccessible and Gough islands, but does not appear to be worked.

Gough Island.—Gough island or Diego Alvarez lies in 40° 20′ S., 9° 44′ W, and is 250 m. S.S.E. of Tristan da Cunha. It is of volcanic origin, is rugged and mountainous, the highest peak rising to 4,380 ft. The island is about 8 m. long by 4 m. broad. Pre-

cipitous cliffs, from 200 to 1,000 ft. high, characterize the coast. They are divided by picturesque valleys. Streams fall over the cliffs into the sea in fine cascades. There are vast numbers of penguins and valuable guano deposits. It is also the home of numerous seals. Originally called Diego Alvarez, it derives its other name from a Captain Gough who visited it in 1731. It has been claimed as a British possession since the annexation of Tristan da Cunha. In 1904 Gough island was visited by the Antarctic exploring ship "Scotia" of the Bruce expedition, which discovered a rich marine fauna, two new buntings and three new species of plants It has no permanent population

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TRITON, the Greek merman, son of Poseidon and Amphitrite According to Hesiod (*Theog.* 930), he dwelt with his parents in a golden palace in the depths of the sea The story of the Argonauts places his home on the coast of Libya. When the Argo was driven ashore on the Lesser Syrtes the crew carried the vessel to Lake Tritonis, whence Triton, the local deity, guided them across to the Mediterranean (Apollonius Rhodius iv 1552) He was represented as human down to the waist, with the tail of a fish, but ancient artists portray other and more fantastic sea-creatures as well. His special attribute was a twisted seashell, on which he blew to calm or raise the waves Various stories (as Virgil, *Aen*, VI, 171, Pausanias, IX, 20, 4–5) represent him as jealous or violent

See F R Dressler, *Triton und die Tritonen* (Wurzen, 1892); Preller, *Griechische Mythologie* (4th ed 1894)

TRITUBERCULATA or **PANTOTHERIA,** a group of very small insect-eating mammals from the Jurassic rocks, characterized by the sharp-cusped lower molar teeth with an inwardly directed phalange (tuberculo-sectorial type) Some of them, such as *Amphitherium*, are, perhaps, the ancestors of all modern mammals except the platypus and echidna (Monotremata, *q v.*). *See* MAMMALIA, PALAEONTOLOGY

TRIUMPH, the highest honour bestowed in Rome upon a victorious general (Lat *triumphus*) It was only granted on certain conditions, relaxed in special cases Only those who held the office of dictator, consul, or praetor were entitled to the distinction, the war must have been brought to a definite conclusion, resulting in an extension of the boundaries of the state, the victory must have been gained over a foreign enemy The power of granting a triumph rested with the senate. Special legislation was necessary to keep the general in possession of the *imperium* on his entry into the city Without this, his command would expire and he would have no right to a triumph. He remained outside the city limits until the ordinance was passed, Lucullus on his return from Asia waited outside Rome three years

The triumph, a solemn procession, starting from the Campus Martius, passed through the city to the Capitol. The streets were adorned with garlands, and the procession was greeted with shouts of *Io triumphe* At its head were the magistrates and senate, followed by trumpeters and then by the spoils, (arms, standards, statues, etc, representations of battles, and of the towns, etc, of the conquered country). Next came the victims destined for sacrifice, especially white oxen with gilded horns They were followed by the prisoners kept to grace the triumph The chariot of the victorious general (*triumphator*) was crowned with laurel and drawn by four horses. The general was attired like the Capitoline Jupiter in robes of purple and gold; in his right hand he held a laurel branch, in his left an ivory sceptre surmounted by an eagle. Above his head the golden crown of Jupiter was held by a slave, who reminded him in the midst of his glory that he was a mortal man. Last came the soldiers shouting *Io triumphe*. On reaching the temple of Jupiter on the Capitol, the general placed the laurel branch on the lap of the image of the god, and offered the thank-offerings A feast of the magistrates and senate concluded the ceremony Under the empire only the emperors celebrated a triumph, because the generals commanded under the auspices of the emperors as lieutenants (*legati*), the only honour they received was the right of wearing the triumphal insignia (the robes of purple and gold and the wreath of bay leaves) on holidays The last triumph recorded is that of Diocletian (A D 302) A naval triumph was sometimes allowed for victories at sea, the earliest being that celebrated by C Duilius for his victory over the Carthaginians in 260 B C.

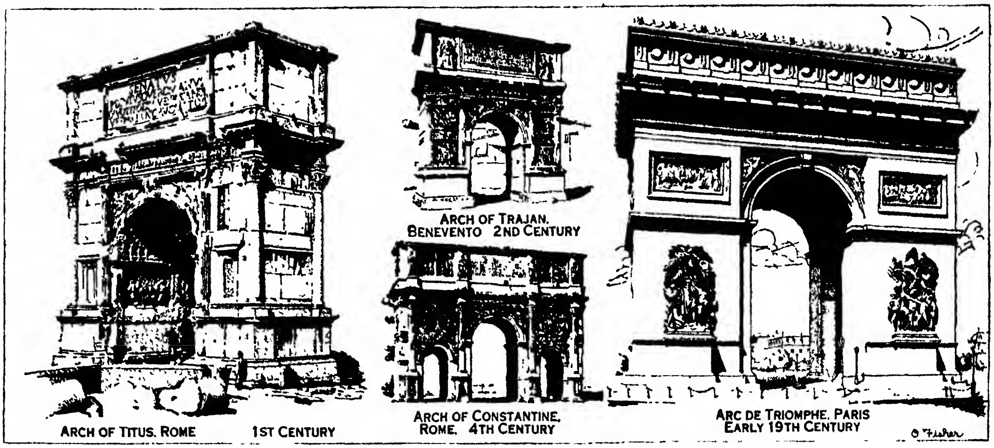
See Marquardt, *Römische Staatsverwaltung* (1884); Mommsen, *Römisches Staatsrecht* (1887), J E Sandys, *Companion to Latin Studies* (1921).

TRIUMPHAL ARCH, originally an arch built to commemorate a victory of a Roman general, but more commonly used, in a broader sense, for any monumental arch built for purely commemorative or even decorative purposes The term is also used for the great arch between the nave and apse or the nave and transepts of an early Christian basilica It is probable that temporary structures spanning a road or street were built by many peoples of antiquity to celebrate the homecoming of a victorious army, but it was the Romans who first made such arches permanent monumental structures, broadened their use for general memorial purposes, and even applied them to the monumental gates of cities and towns Obviously the building of such a structure as the developed Roman arch would occupy too much time to admit of its being used for the actual triumphal procession that it celebrated, it was, therefore, originally, probably a reconstruction in stone of an earlier, temporary archway

Although no existing triumphal arches are earlier than the empire, it is known that there was, in the Forum, close to the regia, an arch commemorating the victory of Fabius Maximus Allobrogicus over the barbarians of Savoy in 121 B C Augustus built a triumphal arch on the Via Sacra, commemorating the victory of Crassus over the Parthians From that time on there was hardly an emperor who did not build a triumphal arch somewhere in Rome The greater number of these have perished, but those of Titus (completed under Domitian *c* A D 80), of Septimius Severus (203–205) and that of Constantine (312), which incorporates much sculpture taken from the earlier arch of Trajan, still remain in good preservation. Many smaller monumental arches also exist in Rome Both emperors and private citizens built them in all the important centres of the empire Monumental gateways of triumphal arch type exist in many places in Syria, like that probably of the time of Hadrian at Palmyra, and certain city gates were given the importance of a triumphal arch, especially that of Autun, France (probably 3rd century A.D) and the Porta Nigra at Trier (4th century).

In the earlier arches, the arch is the most important element, usually with simple stretches of wall on either side The orders appear only as minor decorative features, either under the arch impost, as at Saintes, or as flat pilasters, carrying a crowning entablature, and placed at the corners of the structure, as at S Chamas Only in the arches of Augustus, as at Susa and Aosta, do engaged columns appear, and even then, still as minor decorative elements It was in the arch of Titus, at Rome, that the later definite arrangement was worked out, in which the columns project boldly, on high pedestals, and carry an entablature that casts a strong shadow Moreover, arch spandrils are sculptured, and the interior faces of the passage bear remarkable high relief panels, showing the seven branch candlestick and the other trophies of the capture of Jerusalem

In the triple arch of Septimius Severus, the attic projects out over the end columns, the inscription runs through from end to end, so that the central columns are left without apparent work to do. In the arch of Constantine, on the other hand, the free-standing columns have become, like the pilasters of the early examples, purely decorative features, and each supports a colossal statue, so that despite the crudity of much of the workmanship, this arch gives the most satisfactory effect of any



TYPES OF THE TRIUMPHAL ARCH FROM THE FIRST TO THE 19TH CENTURY

of the later arches in Rome. The Arch of Trajan at Timgad reveals another interesting attempt to relate free-standing columns to the body of an arch, by connecting the two columns of each outer pair with a curved pediment, the attic over the central arch running up to a higher level The triumphal arch of the early Christian basilica is chiefly remarkable as the position for some of the richest and most beautiful of the wall mosaics that were the chief form of interior decoration. (*See* BASILICA; BYZANTINE AND ROMANESQUE ARCHITECTURE; MOSAIC.)

There is an interesting early Renaissance triumphal arch at Naples (1453–70), to commemorate the entrance of Alphonso I. into Aragon, designed by Pietro di Martino The most interesting Renaissance and modern triumphal arches are, however, of later date The Porte Saint-Denis (1672–73), by Blondel and the Porte Saint-Martin (1674–75), by Bullet, both in Paris, depart from the Roman scheme and substitute trophies and reliefs for the orders which the Romans used Of the more Roman type, is the Arc de Triomphe du Carrousel, Paris (1805), by Percier and Fontaine, based on the arch of Septimius Severus The Sieges Thor at Munich (1843–50), by Gaertner and Metzger, and the Marble Arch in London, designed in 1828 by John Nash for an entrance to Buckingham palace, and moved to its present position in 1851, are both closely imitated from the Arch of Constantine The triple arch and screen at Hyde Park Corner, London (1828), by Decimus Burton, is a freer design, but still in the Roman manner Another noteworthy modern arch is the Washington Arch, New York, by McKim, Mead and White, originally constructed in temporary materials in 1889 in celebration of the 100th anniversary of Washington's inauguration, later reconstructed in marble and completed 1895 By far the largest of all triumphal arches and the most beautiful of modern examples is the Arc de Triomphe de l'Étoile at Paris (begun 1805 from designs by Chalgrin, but not completed till 1836). It is remarkable for its architectural proportions and the great scale and almost stark grandeur of its sculpture, which emphasizes its great width of 147 ft. and height of 160 feet Under the arch is the tomb of the "Unknown Warrior," over which burns, every night, the continuous "Flamme du Souvenir" (T. F. H.)

TRIVANDRUM, a city of southern India, capital of the state of Travancore, situated 2 m from the sea-coast Pop. (1921), 72,784 It is the residence of the maharaja, and contains an observatory, a museum and zoological gardens. Its chief fame centres upon an old temple in the fort, a great resort of pilgrims, round which the city grew up The city contains the maharaja's law college, a Sanskrit college, a woman's college, technical and training schools and a hospital and medical school

TRIVIUM, in mediaeval educational systems, the curriculum which included grammar, rhetoric and logic (Lat for cross-road, *i.e.*, where three roads meet, from *tres*, three, and *via*, road). The trivium and the quadrivium (arithmetic, music, geometry and astronomy) together made up as the seven liberal arts.

TRNAVA, a town in Slovakia, Czechoslovakia, on the river Trnava, was transferred from Hungary by the Treaty of Trianon, 1920 It is a market town for a rich agricultural region Manufactures include sugar-refining, starch, beer, shoes and, oldest of all, cloth; fertilisers are also prepared. Pop (1923), 17,745

TRNOVO [TIRNOVO], a city and capital of a department in Bulgaria; 124 m E.N E of Sofia, on the river Yantra, on the Trans-Balkan railway, which joins the Sofia-Varna line at Gorna-Orehovitsa, 8 m N. of Trnovo Pop. (1926) 12,802. The city is remarkably situated The Yantra runs in a deep gorge, doubling first left, then right, round two promontories, which stand like high fortresses, surrounded by water on three sides. The first of these, the Tsarevitsa, is connected with the rest of the town by a high causeway, in part a bridge; the other, the Trapesitsa, is entirely isolated The inhabited town covers the two sides of the roof-like ridge which terminates in the Tsarevitsa. On the latter are a ruined tower, known as Baldwin's tower, where the Frank emperor is supposed to have been imprisoned, and behind it, the somewhat unimposing remains of the palace of the Asens (*q.v.*) Few of these ruins have been excavated. The Trapesitsa contains the fragments of several mediaeval churches in the Byzantine style.

Trnovo is believed to have been a Roman fortress; it was the birthplace of Tsar Šišman, and the home of the second Bulgar empire, proclaimed here 1185 by the brothers Peter and Ivan Asen, who were boyars of the Tsarevitsa and Trapesitsa. It was capital of Bulgaria 1186–1394, when it was adorned with great splendour; most of the relics were destroyed in the earthquake of 1911. It was the seat of the Bulgarian patriarchate from 1232 to its abolition in 1767 Trnovo was taken by the Turks on July 17, 1394. It remained, however, a commercial centre. It was captured by Russia in 1877. Prince Alexander of Battenberg was here proclaimed Bulgarian prince (1879). Here the Bulgarian constituent assembly sat, all meetings of the Grand Sobranye (*see* BULGARIA, *Constitution*) are held here, and the independent kingdom of Bulgaria was proclaimed in the church of the Forty Martyrs (Oct. 5, 1908). (C. A. M.)

TROAD: *see* TROY.

TROCHEE or CHOREE, literally the "running" or "dancing" foot (- ◡) (Gr. τρέχειν, to run, and χορός, a band of dancers). Trochaic metre is of several kinds, usually described by the number of *metra*, or groups of two trochees, which they contain,

as the dimeter:

Roma Roma, | cerne quanta
Comrades, leave me | here a little

consisting of two *metra* or four trochees The commonest form, especially in ancient drama, is the *tetrameter catalectic* or *septenarius* (four *metra* or eight trochees, lacking the final syllable), as

Roma Roma, | cerne quanta | sit deum benignitas
Comrades, leave me | here a little, | while as yet 'tis | early morn.

TROCHOPHORE or **TROCHOSPHERE**, the names applied to the free-swimming larval form of the segmented worms or Annelida (*q.v.*) and to the very similar (first) larval stage of the Lamellibranchia (bivalves) and Gastropoda (univalves) (*qq v.*) among the Mollusca (*q v.*)

TROCHU, LOUIS JULES (1815–1896), French general, was born at Palais (Belle-Ile-en-Mer) on March 12, 1815 He served as a captain in Algeria and as a colonel throughout the Crimean campaign He commanded a division in the Italian campaign of 1859 In 1866 he was employed at the ministry of war in the preparation of army reorganization schemes, and he published anonymously in the following year *L'Armée française en 1867*, a work inspired with Orleanist sentiment, which brought him into bad odour at court He left the war office on half-pay, and was refused a command in the field at the outbreak of the Franco-German War After the earlier disasters in 1870, he was appointed by the emperor first commandant of the troops of Châlons camp, and soon afterwards (Aug 17) governor of Paris and commander-in-chief of all the forces destined for the defence of the capital, including some 120,000 regular troops, 80,000 mobiles, and 330,000 National Guards He put Paris in a state of defence, and showed himself a master of the passive defensive At the revolution of Sept 4, he became president of the government of national defence. His "plan" for defending the city failed; the successive sorties were unsuccessful, and when capitulation became inevitable he resigned the governorship of Paris on Jan 22, 1871 to General Vinoy, retaining the presidency of the government until after the armistice in February. He was elected to the National Assembly by eight departments, and sat for Morbihan In July 1872 he retired from political life, and in 1873 from the army He published in 1873 *Pour la vérité et pour la justice*, in justification of the government of national defence, and in 1879 *L'Armée française en 1879, par un officier en retraite.* He died at Tours on Oct 7, 1896

TROELSTRA, PIETER JELLES (1860–), Dutch Socialist leader, was born at Leeuwarden and educated for the legal profession at the University of Groningen, but early abandoned it for politics and journalism He adopted Socialist opinions and becoming dissatisfied with the leadership of Domela Nieurenhuis, under whom Dutch Socialism had assumed an extremist complexion bordering on anarchism, he founded the Social Democratic Workers' Party in 1894 for the constitutional achievement of Socialism In 1913, the Liberal party offered the Socialists three seats in a government which would include in its programme universal suffrage and old age pensions. This Troelstra refused, on the assumption that the entrance of the Socialists into the government would strengthen the opposition to universal suffrage. His point of view was approved by the conference of the party. At the elections of 1918, as a result of the introduction of universal suffrage, the Socialists scored important gains, and under the influence of the German revolution, Troelstra, in a remarkable speech in the chamber, called upon the government to resign with a view to the formation of a socialist state. The leading members of his party repudiated his tactics but pressure was brought to bear upon the government, which resulted in the eight-hour day and other reforms. Thenceforward Troelstra's influence with the proletariat increased steadily, until in 1925, owing to failing health, he retired from politics

TROGIR or **TRAU**, a seaport of Dalmatia, Yugoslavia. Pop. (1921) 3,354. The town is built upon an island, connected with the mainland by a bridge The Venetian loggia is a fine specimen of a 16th century court of justice; and the cathedral is one of the glories of Dalmatia It is Hungarian Gothic, and founded in 1200, was only completed in 1450. Trau is a steamship station with a dockyard, and has some trade in fruit and wine, the fertile soil producing vines, figs, pomegranates and olives. The chief industries are the weaving of *rascia*, a coarse blue serge, and metal work.

Tragurium, by which name it was known to the Romans, was probably colonised about 380 B C by Syracusan Greeks from Lissa, and its name is sometimes derived from τρώγιλος, a place near Syracuse. In 998 it submitted to Venice; but in 1105 it acknowledged the supremacy of Hungary, while retaining its municipal freedom, and receiving, in 1108, a charter which is quoted by Lucio After being plundered by the Saracens in 1123, it was ruled for brief periods by Byzantium, Hungary and Venice. In 1242 the Tatars pursued Bela IV. of Hungary to Trau, but were unable to storm the island city, which remained in the possession of Hungary till 1413. The Italians attempted to take possession of the town at the close of the World War (1914–18), but were driven out by the inhabitants, 99% of whom are Slavs.

See T. G. Jackson, *Dalmatia, the Quarnero, and Istria* (Oxford, 1887); E. A. Freeman, *Sketches from the Subject and Neighbour Lands of Venice* (London, 1881), and G. Lucio, *Memorie istoriche in Tragurio, ora detto Trau* (Venice, 1673).

TROGLODYTES, "cave-dwellers," a name applied by ancient writers to different tribes in various parts of the world Strabo speaks of them in Moesia, south of the Danube (vii 318), in the Caucasus (xi. 506), but especially in various parts of Africa from Libya (xvii 828) to the Red Sea The troglodyte Ethiopians of Herodotus (iv. 183) in inner Africa, very swift of foot, living on lizards and creeping things, and with a speech like the screech of an owl, have been identified with the Tebus of Fezzan According to Aristotle (*Hist An* viii 12) a dwarfish race of Troglodytes dwelt on the upper course of the Nile, who possessed horses and were in his opinion the Pygmies of fable. But the best known of these African cave-dwellers were the inhabitants of the "Troglodyte country" (Τρωγλοδυτική) on the coast of the Red Sea, as far north as the Greek port of Berenice, as recorded by Diodorus (iii 31) and Photius (p 454 Bekker) from Agatharchides of Cnidus, and by Artemidorus in Strabo (xvi. 776)

They were a pastoral people, living entirely on the flesh of their herds, or, in the season of fresh pasture, on mingled milk and blood But they killed only old or sick cattle (as indeed they killed old men who could no longer follow the flock), and the butchers were called "unclean" They gave the name of parent to no man, but only to the cattle which provided their subsistence. They went almost naked; the women wore necklaces of shells as amulets They practised circumcision or an operation of a more serious kind The dead body, its neck and legs bound together with withies of the shrub called *paliurus*, was set up on a mound, and pelted with stones amidst the jeers of the onlookers, until its face was completely covered with them A goat's horn was then placed above it, and the crowd dispersed with manifestations of joy.

TROGON, the name of birds forming the family Trogonidae. The trogons are birds of moderate size, the smallest hardly bigger than a thrush, the largest less bulky than a crow The bill is wide at the gape, which is beset by recurved bristles They seize most of their food on the wing. Their flight is short, rapid and spasmodic. Their feet are weak and of a unique structure, the second toe, which in most birds is the inner anterior one, being reverted; in all other birds that have two toes before and two behind, the outer toe is turned backward. The plumage is beautiful and characteristic, and the glory of the group culminates in the quezal (*q v.*). The plumage is further remarkable for the absence of down and for the large size of its contour-feathers, which are extremely soft and so loosely seated as to come off in scores at a touch. The tail is a characteristic feature, the rectrices being often curiously squared at the tip The nidification of these birds is in holes of trees, wherein are laid without any bedding two roundish eggs, generally white, but certainly in one species (quezal) tinted with bluish green

The trogons form a very well-marked family of Coraciiform

birds placed near the colies (*see* MOUSE BIRD) and swifts (*q.v.*). The remains of one have been found in the Miocene of France. This discovery seems to account for the remarkable distribution of the trogons at the present day. While they chiefly abound in the tropics of the New World, they occur too in the tropical parts of the Old About sixty species are recognized, which J Gould in the second edition of his *Monograph* of the family (1875) divides into seven genera

TROGUS, GNAEUS POMPEIUS, Roman historian from the country of Vocontii in Gallia Narbonensis, nearly contemporary with Livy, flourished during the age of Augustus. The name Pompeius was adopted by his grandfather, who received the citizenship from Pompey. Trogus' books on natural history are frequently quoted by Pliny; his principal work, however, was *Historiae Philippicae* in 44 books, so called because the Macedonian empire founded by Philip is the central theme of the narrative. This was a general history of the world, or rather of those portions of it which came under the sway of Alexander and his successors. Of this great work, we possess only the epitome by Justin, the *prologi* or summaries of the 44 books, and fragments. But even in its present mutilated state it is often an important authority for the ancient history of the East Ethnographical and geographical excursuses are a special feature of the work

Fragments edit. by A. Bielowski (1853); *see* also, A H. L Heeren, *De Trogi P fontibus et auctoritate* (prefixed to C H. Frotscher's edition of Justin), A Enmann on the authorities used by Trogus for Greek and Sicilian history (1880); A von Gutschmid, *Über die Fragmente des Pompeius Trogus* (1857), M Schanz, *Geschichte der römischen Litteratur* (2nd ed, 1899), ii, where all that is known of Timagenes is given, and article JUSTIN

TROIA, a town and episcopal see of Apulia, Italy, in the province of Foggia, situated 1,440 ft above sea-level, 7 m N W of the station of Giardinetto-Troia, which is 16 m. S W of Foggia. Pop. (1921), 6,420 Troia occupies the site of the ancient Aecae, 12 m S of Luceria, on the Via Traiana. Troia was itself founded in 1017 by the Greek prefect Basilius Bugianus The cathedral dates from 1107, but the upper part of the façade with its rich sculptures, fine rose-window and polychromatic decoration, the choir apse and the interior were restored early in the 13th century The bronze doors, partly in relief and partly in niello (1119–1127) were cast in Beneventum by Oderisius

TROILUS, in Greek legend, son of Priam (or Apollo) and Hecuba. In the *Iliad* (xxiv, 257) he is already slain before the action of the poem commences According to a non-Homeric tradition (*e g*, Virgil *Aen* i 474), when a mere boy he fell by the hand of Achilles. In another account he was dragged to death by his own horses His death formed the subject of a lost tragedy by Sophocles The story of Troilus and Cressida (Caxton, Chaucer, Shakespeare, etc) is entirely mediaeval.

TROITSK, the name of several Russian settlements, the most important of which is the town of Troitsk in the Uralsk Area, in 54° 4′ N, 61° 35′ E, on the Ui, a tributary of the Tobol Pop (1926) 29,643 A fort was erected here in 1743, which became a centre for trade with the Kirghiz steppe and Turkestan A branch railway now links the town with Chelyabinsk and Sverdlovsk, and it is on the great Siberian road It has tanneries and flour-mills, the latter supplying the Ural mining district.

TROITSOKOSAVSK, a town of Asiatic Russia, in the Buriat-Mongol A S S R, in 51° 28′ N, 106° E, on the Kiakhta river near its junction with the navigable Selenga, which forms a waterway from Asiatic Russia to Mongolia Two miles south of it is Russian Kiakhta, on the frontier, which adjoins Chinese Kiakhta or Mai-mai-Chên, a walled town with a large market-place, and 10 m N, at the confluence of the Kiakhta and Selenga, is Ust-Kiakhta. It was formerly the great route by which Chinese tea entered Russia; and its December fair, when Russian leather, furs and wool were exchanged for tea, was very important From 1689 to 1727 the trade was a Government monopoly, but from then till 1860 trade was thrown open to private merchants and as all trade across the Chinese frontier was by law compelled to pass through it, the town increased greatly in importance. In 1860, however, the whole frontier was declared open, and Kiakhta declined; the Transbaikal railway further diminished its importance. The combined population of Troitsokosavsk and Kiakhta was only 8,903 in 1926. Gold and osmiridium are found in the district, and salt is worked. A railway is projected to link Verkhne-Udinsk with Kiakhta, and this might restore the prosperity of the town, as there is a great market for leather in Mongolia, which has no tanneries; raw hides are often sent via this route to be dressed and re-exported. The altitude is 2,600 ft, and the climate severe (average January temperature, −18 4° F, average July, 67·1° F, and of the annual rainfall of 11 in., 7·5 fall in July and August). The town was a storm centre in the post 1917 period, and was the scene of the massacre of 800 Bolshevik prisoners in 1920 by order of the Cossack ataman Semyonov.

TROJAN PLANETS, a group of asteroids revolving round the sun in the same period as Jupiter Joseph Louis Lagrange, in his essay on the problem of Three Bodies (1772), noted certain simple cases in which an exact solution could be found by elementary methods. In some of these the bodies remained in a rotating straight line; these cases are unstable, and of little practical importance, though it has been suggested that the *Gegenschein*, or Counterglow, may be due to particles connected in this manner with the sun and earth The most interesting case is that in which three masses (equal or unequal) S, J, T, whose centre of gravity is G, are situated at the angular points of an equilateral triangle. Then, if they are projected in the plane of the triangle, with velocities proportional to GS, GJ, GT, in directions making equal angles with GS, GJ, GT, in the same direction of angular motion, they will describe ellipses in the same period, exactly as though they were particles moving under accelerations directed towards G and proportional to their distances from G; further, the triangle SJT will remain equilateral throughout the motion, though it will vary in size unless the orbits round G are circular

This case, like the others, was regarded simply as a mathematical curiosity till the year 1906 On Feb 22 in that year Prof Max Wolf, in the course of the systematic search for new planets that is carried on by photography at Konigstuhl Observatory, Heidelberg, found a faint planet, provisionally lettered TG, which subsequently received the permanent number 588 and the name Achilles Its orbit was calculated by Dr Berberich at the Berlin Recheninstitut; he found that its period was almost exactly the same as that of Jupiter (11 86 years) Thereupon Prof Charlier, of Lund Observatory, noting that Achilles was about $55\frac{1}{2}°$ in front of Jupiter, as seen from the sun, suggested that this was an example in the heavens of the equilateral configuration which Lagrange had deduced by theory It was seen, of course, that the ideal conditions were not exactly fulfilled, the inclination of Achilles to the ecliptic is $10\frac{1}{4}°$, and its eccentricity $\frac{1}{6}$—much larger than the corresponding elements of Jupiter's orbit But it was conjectured that since the equilateral configuration is stable, these deviations would simply produce periodic oscillations about that configuration.

Achilles did not long remain the sole example of this type of motion; No 617 Patroclus was found in the same year, and 624 Hector in the following year. Three more members were subsequently found, 659 Nestor, 884 Priamus and 911 Agamemnon. Of these Achilles, Hector, Nestor, Agamemnon are about 60° ahead of Jupiter (greater longitude), while Patroclus and Priamus are 60° behind. It is unfortunate that the obvious plan was not followed of giving Greek names to those on one side, Trojan names to the other, but it would cause confusion to change now.

The Trojans seem to be among the larger members of the asteroid group. Their diameters, estimated from their light, are of the order of 150 miles, which is greater than that of Juno, one of the original four asteroids This diameter, however, is only one five-hundredth of that of Jupiter, so that, even if we assign to them double the density of Jupiter, the mass of each of them is only about one fifty-millionth of his. This is, of course, too small to produce any sensible effect on Jupiter, and the point G in the triangle may be taken as the centre of gravity of the sun and Jupiter. This is distant from the sun's centre by $\frac{1}{1048}$ of the side of the triangle, or 461,000 miles, which places it just outside the sun's surface. This is the point which would be the centre of revolution under the strict Lagrangian configuration It is obvious, however,

that the actual motion is far from exhibiting the Lagrangian simplicity and uniformity; the inclination of two of the Trojans is over 20°, and their eccentricities are also considerable.

The question of the stability of the motion under these conditions has engaged the attention of at least three mathematicians. The first in the field was L J. Linders, who followed a method indicated by Poincaré (*Leçons de Méc. Cél* §64), and obtained a first approximation to the resulting motion, which he found to be stable within certain limits of departure from the Lagrangian configuration He found that the period of revolution of a Trojan planet would oscillate between 4,222 and 4,442 days, that of Jupiter being 4,332 days, or 11·86 years The greatest departure in angle from the mean position is 17¼° He found that there would be long period oscillations whose duration is about 150 years. Prof E. W. Brown in 1911 studied the problem on the same lines as Prof. Sir G Darwin had used in his investigations on periodic orbits He treated the motion of Jupiter round the sun as exactly circular, and referred the motion of the asteroid to the revolving line joining Jupiter to the sun The nearest approach of the asteroid to Jupiter compatible with stability was found to be about two astronomical units, or 23½°. W M Smart (1917) carried Linders's work to a further order of approximation, but he still considered Jupiter as moving in a circle He showed that the oscillations of the Trojans could be divided into two classes: (1) those arising directly from the inclination and eccentricity of the Trojans; the period of these is about 12 years (2) a much slower oscillation, which may very approximately be represented as harmonic motion in an ellipse whose shorter axis is directed towards the sun, the longer axis being 18¾ times the length of the shorter The period in which this ellipse is described is 147·82 years, just 12½ times Jupiter's period of revolution

Two further papers by Prof E W Brown deal more directly with the actual Trojans than his earlier one, which deals with ideal cases. He reduced the theory to a numerical form, and showed his approximations suffice to represent the observations of Achilles, extending over many years, within a few seconds of arc. He also examined the stability of the motion, it is stable as far as the sun and Jupiter are concerned, but the action of other planets especially Saturn may in a very long period (of the order of a million years) cause the Trojans to approach too near to Jupiter, after which the character of their motion will be changed, and they will cease to be Trojans However, since the age of the planetary system is estimated as thousands of millions of years, and at least six Trojans still survive, it would seem that such disturbing action on Saturn's part can only under exceptional circumstances lead to the expulsion of a Trojan; otherwise none of them would survive, for it does not appear likely that Saturn can reverse its action, and turn non-Trojans into Trojans. Any asteroids that had once been Trojans would continue to make near approaches to Jupiter's orbit. It seems possible that the remarkable asteroid 944 Hidalgo (*see* MINOR PLANET) may once have been a Trojan, but no other asteroids are known that fulfil the conditions

The existence of the Trojans suggests that in the early days of the planetary system a large amount of scattered matter was circulating round the sun at the same distance as Jupiter, of which the Trojans have survived in virtue of the stability of their configuration. while the remainder has had its period changed or been absorbed by Jupiter.

Some may imagine that, as there are several Trojans on the same side of Jupiter with a common point as their centre of oscillation, there is some danger of collision between them. Such danger is very remote, for the length of their swings exceeds 100,000,000m , and these are performed in different directions; also the times at which they reach the ends of their swings are different, though the periods of the different swings are nearly the same for all of them.

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TROJAN WAR: *see* TROY.

TROLLE, HERLUF (1516–1565), Danish naval hero, was born on Jan. 14, 1516, at Lillo. At the age of nineteen Trolle went to *Vor Frue Skole* at Copenhagen, subsequently completing his studies at Wittenberg, where he adopted the views of Melanchthon, with whom he was in intimate correspondence for some years His marriage with Brigitte, the daughter of Lord Treasurer Mogens Gjoe, brought him a rich inheritance, and in 1557 he took his seat in the senate. Both Christian III and Frederick II had a very high opinion of Trolle's trustworthiness and ability and employed him in various diplomatic missions Trolle was, indeed, richly endowed by nature, and his handsome face and lively nature made him popular everywhere. His one enemy was his wife's nephew, Peder Oxe, the subsequently distinguished finance minister, whose narrow, grasping ways, especially as the two men were near neighbours, did not contribute towards family harmony In 1559 Trolle was appointed admiral and inspector of the fleet, and in 1563 he superseded the aged Peder Skram as admiral in chief On May 10 he put to sea with twenty-one ships of the line and five smaller vessels and, after uniting with a Lubeck squadron of six liners, encountered, off the isle of Öland, a superior Swedish fleet of thirty-eight ships under Jacob Bagge. Supported by two other Danish ships Trolle attacked the Swedish flagship "Makalos" (Matchless), then the largest flagship in northern waters, but was beaten off at nightfall The fight was renewed at six o'clock the following morning, when the "Makalos" was again attacked and forced to surrender, but blew up immediately afterwards, no fewer than 300 Lubeck and Danish sailors perishing with her The Swedish admiral was captured, and the remnant of the Swedish fleet took refuge at Stockholm Despite the damage done to his own fleet and flagship "Fortuna" by this victory, Trolle, on Aug 14, fought another but indecisive action with a second Swedish fleet under Klas Horn, and kept the sea till Oct 13 Trolle spent the winter partly at his castle of Herlufsholm completing his long cherished plan of establishing a school for all classes, and partly at Copenhagen equipping a new fleet for the ensuing campaign On June 1, 1565, he set sail with twenty-eight liners, which were reinforced off Femern by five Lubeck vessels Klas Horn had put to sea still earlier with a superior fleet and the two admirals encountered off Fehmarn on June 4 The fight was severe but indecisive, and both commanders finally separated to repair their ships Trolle was severely wounded in the thigh and shoulder, but he insisted on being the last to receive the surgeon's attention. He died of his wounds at Copenhagen on June 25

TROLLHÄTTAN, a town of Sweden in the district (*län*) of Elfsborg, 45 m by rail N by E of Gothenburg Pop. (1926), 15,923 It lies on the left (east) bank of the Gota at the point where that river descends 108 ft in the course of nearly a mile by the famous falls of Trollhattan (six in number) and several rapids The scenic setting of the falls is not striking, but the great volume of water, nearly 18,000 cu ft. per second, renders them most imposing The narrowed river here surrounds several islands, on either side of one of which (Toppo) are the first falls of the series, Toppo and Tjuf. These are 42 ft. in height. The water-power is used in rolling-mills, a cellulose factory and other works The electric works supply power to Gothenburg and other Swedish towns. (*See* GOTA)

TROLLOPE, ANTHONY (1815–1882), English novelist, was born in London, April 24, 1815 He came of a family which engaged in literary pursuits His father, THOMAS ANTHONY TROLLOPE (1774–1835) was a learned but unbusinesslike barrister, who spent much time on an *Encyclopedia Ecclesiastica* and gave up law for farming, with ruin as the result. His mother, FRANCES MILTON TROLLOPE (1780–1863) went with her husband to Cincinnati to retrieve their fortunes by running a fancy-goods shop, and coming back disappointed achieved notoriety and roused violent resentment by her caustic book, *Domestic Manners of the Americans* (1832) She afterwards wrote some fifty novels and books of travel, and maintained the family by her literary earnings, her best novel being *The Vicar of Wrexhill* (1837) and *The Widow Barnaby* (1839), a fair second (See *Frances Trollope, her Life and Literary Work*, 1895, by her daughter-in-law.) Her

eldest son, THOMAS ADOLPHUS TROLLOPE (1810–92), was a popular writer of novels and miscellaneous works, largely on Italian subjects, his adopted home being in Florence. His second wife, FRANCES ELEANOR TROLLOPE, also a novelist, collaborated with him in *Homes and Haunts of Italian Poets* (1881)

Anthony, who was the third son, gave an unvarnished account of his unhappy youth in his *Autobiography* (which was edited by his son Henry M Trollope in 1883), an extraordinarily candid book that had a disillusioning effect on too fervid admirers by giving away the secrets of his workshop It probably caused the long eclipse of his fame, which has recently been followed by a striking renewal During the family impecuniosity, he was a day-boy at Winchester and Harrow, and suffered pangs through his shabby and dirty appearance, and the unpopularity and general discouragement which were the result. He reached the verge of manhood almost as ignorant as if he had had no schooling at all, yet he tried to start in life by taking the post of classical usher in a private school in Brussels But he received the offer of a clerkship in the General Post Office, London, and after a farcical pretence at an examination was appointed (1834) For the seven years of his service here, his salary was small, he was in debt, troubled with awkward love-affairs, and often in hot water with his superiors. Then he was transferred to Ireland (1841) as a surveyor's clerk, with a moderate salary but liberal allowances and the duties of a sort of travelling inspector. The change brought out a business capacity hitherto unsuspected He enjoyed a comfortable income, he had time in spite of a busy life to indulge freely in hunting, he consorted with people of all classes and began to stock his memory for the long-cherished purpose of trying his hand at fiction, and in 1844 he married an English lady, Rose Heseltine, whom he had met in Ireland, and established himself in a house at Clonmel

Trollope's first two novels, *The Macdermots of Ballycloran* (1847) and *The Kellys and the O'Kellys* (1848), failures though they proved, are examples of his thoroughness in making himself acquainted with a given sphere of life, as he was afterwards to do with clerical society, political life, and legal affairs, and also of his aptitude for developing a good story casually heard. The first is dark and pathetic, the second has many sparkling scenes; neither is the work of a Carleton or Banim, but both steer clear of the mere stage Irishman of Lever and Lover Trollope persevered, but a historical novel, *La Vendée* (1850) deservedly fell flat

A chance visit to Salisbury Close gave him his idea for *The Warden* (1855), the simple, touching, but humorous story of a precentor in a cathedral town, who out of sensitiveness to public criticism resigns the well-paid office of warden to an ancient charity. Mr Harding and his blustering son-in-law Archdeacon Grantly reappear, with other clerical dignitaries, their wives, families and friends, including the famous "Bishopess." Mrs Proudie, the unctuous and pushful Mr Slope, and the epicurean Dr Stanhope and his disreputable children, in *Barchester Towers* (1857) The "Barsetshire Chronicles" were thus launched, bringing their author praise and, in due time, substantial profit Trollope was now inspector of rural deliveries for the south-west of Ireland, with a roving commission that suited his tastes, scope for improvements on which he prided himself, and plenty of time for hunting He is said to have been the inventor of the pillar-box His ability and his experience of Post Office business led to his being sent on a mission to the West Indies (1858), which gave him material for a travel-book, *The West Indies and the Spanish Main* (1859) Other official journeys took him to Egypt (1858), the United States (1862), Australia and New Zealand (1871–72), and South Africa (1878), and resulted in further gossipy narratives and several tales He got himself transferred to England (1859), taking charge of the eastern postal district and settling in a house at Waltham Cross He retired from the Post Office (1867), out of annoyance at being passed over for promotion. Trollope was instrumental in starting the *Fortnightly Review* (1865), edited the *St Paul's Magazine* (1868), rather disastrously, and was a contributor to *Cornhill, Blackwood* and other periodicals. He stood for Beverley (1868), but only acquired useful experience for future novels of political life.

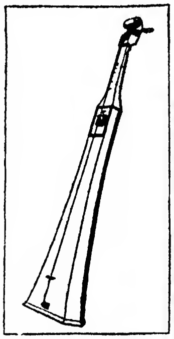
All this time he was steadily writing fiction. The first of his books to bring him remuneration was *The Three Clerks* (1858), a poor novel of the Civil Service which sold for £250. But before long, he tells us in the *Autobiography,* he was earning on the average £4,500 a year, and in one instance he received £3,525 for a single book. An enormous output—for, besides more than fifty novels he wrote much else, and believed that no writer had made a larger contribution to letters in an equal space of time—was rendered possible by a methodical apportionment of the 24 hours. He rose regularly at 5.30 A M, wrote steadily for two hours and a half, at the rate of 250 words every quarter of an hour, and thus calculated each book as so many days' work, which was carefully checked off as it proceeded Yet he found leisure to hunt three times a week during the season, played whist daily, and had plenty of time for social enjoyments He lived in London for about eight years (1872–80), and then removed to the village of Harting, under the Sussex Downs He was staying in town when he died of paralysis, Dec 6, 1882.

Trollope was a big, bluff, vociferous person, whose blustering and overbearing ways offended some, but whose John Bull philistinism did not conceal an essential honesty and good nature and a tender heart He thought *Pride and Prejudice* the greatest novel in the language, and he idolized Thackeray; but he was as far from the exquisite art of the one writer as from the perfect mastery and irony of the other With perhaps too much fidelity to the usual and commonplace, he depicted the great middle class as it was in mid-Victorian times He was a "character-monger" of first-rate quality, who showed his personages moving in their own little spheres, and as he widened his circle of characters took in a larger sweep until he embraced almost as large and diversified a world as that surveyed by Thackeray Among the characters that stand out, along with the two or three already mentioned, Mr Crawley, the grimly pathetic hero of *The Last Chronicle of Barset,* the wicked but delightful Signora Neroni, Lucy Robarts, the best of many admirable heroines (unless Lady Glencora be preferred to that place), her husband, Mr Plantagenet Palliser, afterwards Duke of Omnium, Lady Lufton, and that shrewd and downright person Miss Dunstable, with such different examples of the unattractive in life turned to artistic account as Mr. Sowerby and Mr Chaffanbrass—these make a notable gallery and are only a selection from the catalogue Other characters show uncertainty of touch and a failure of motivation Trollope was best at a sort of coarse or at any rate very broad comedy, but he also had a command of real pathos Tragedy was outside his scope He revelled in mankind's idiosyncrasies, but shirked the closer scrutiny into the byways of conscience, just as he was shy of the spiritual questions which must, surely, have played some part in the lives of his clerical personages George Eliot, his contemporary, would have dealt with Mr Harding and Mr Crawley in a totally different way

Besides *The Warden* and *Barchester Towers*, the Barchester series comprises —*Dr. Thorne* (1858), *Framley Parsonage* (1864), *The Small House at Allington* (1864), and *The Last Chronicle of Barset* (1867) The best of Trollope outside that series, besides such as are named above, are probably *Orley Farm* (1862), *Can You Forgive Her* (1864), *Phineas Finn* (1869) and its sequel *Phineas Redux* (1874), *The Claverings* (1867), *The Belton Estate* (1866), *He Knew He was Right* (1869), *The Vicar of Bullhampton* (1870), *The Eustace Diamonds* (1873), *The Way We Live Now* (1875), *The American Senator* (1877), *The Duke's Children* (1880), *Ayala's Angel* (1881) and *Mr Scarborough's Family* (1883) Trollope's *Autobiography* was edited by his son (1883) The best biography is T H. S. Escott's *Anthony Trollope, His Work, Associates and Literary Originals* (1913) which may be supplemented by Michael Sadleir's *Trollope, a Commentary* (1927), H. Walpole's *Trollope* ("English Men of Letters," 1928), Leslie Stephen's *Studies of a Biographer,* IV. (1902), Henry James's *Partial Portraits* (1888), and Professor Saintsbury's "Trollope Revisited" (*Essays and Studies by members of the English Association,* VI., 1920). (E. A. BA.)

TROMBA MARINA or MARINE TRUMPET, an obsolete bowed instrument about 6ft. in length, with an outline somewhat recalling that of an elongated cricket bat. It consisted of a body and neck in the shape of a truncated cone resting on a triangular base. In the days of Michael Praetorius (1618), its

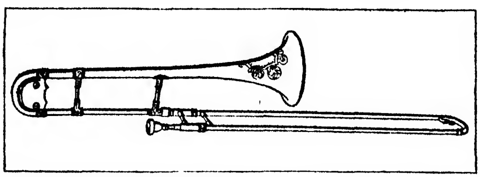
length was 7ft. 3in. and the three sides at the base measured 7in., tapering to 2in. at the neck. These measurements varied considerably, as did also the shape of the body and the number of strings. The bridge had the curious feature that a portion of its foot was left loose so that it vibrated against the belly with every movement of the bow, producing a trumpet-like timbre. It is to this feature, in conjunction with its general resemblance in contour to the marine speaking-trumpet of the middle ages, that the name of the instrument is doubtless due, though other derivations have been suggested. In Germany, at the time when the trumpet was extensively used in the churches, nuns often substituted the tromba marine, whence the name *Nonnengeige.* The instrument, whose tone was not beautiful, fell into disuse during the first half of the 18th century.



FROM GALPIN, "OLD MUSICAL INSTRUMENTS"
THE TROMBA MARINA, AN OBSOLETE STRING INSTRUMENT

TROMBONE, an important member of the brass wind family of musical instruments formerly known as sackbut (*q v.*). The trombone is characterized by the slide, consisting of two parallel cylindrical tubes, over which two other cylindrical tubes, communicating at their lower extremities by means of a short semicircular pipe, slips without loss of air. The outer tube, therefore, slides upon the inner, thereby altering the total length of tube and so modifying the pitch. When the slide is closed the instrument is at its highest pitch. To the upper end of one of the inner tubes is fastened the cup-shaped mouthpiece and to the end of the other tube is fixed the bell-joint, on the proper proportions of which depend the acoustic properties of the instrument.

Sound is produced on the trombone, as on the horn, by means of the lips stretched like a vibrating reed across the cup mouthpiece from rim to rim; the acoustic principles involved are the same for both instruments. By overblowing, *i e*, by the varying tension of the lips and pressure of breath, the harmonic series is obtained, which is effective between the second and the tenth harmonics, the fundamental being but rarely of practical use. There are seven positions of the slide on the trombone, each giving a theoretical fundamental tone and its upper partials a semitone lower than the last, and corresponding to the seven shifts on the violin and to the seven positions on valve instruments. These seven positions, which give a complete chromatic compass of two octaves and a sixth, are found by drawing out the slide a little more for each one.



BY COURTESY OF BOOSEY & CO., LONDON
THE TROMBONE, FORMERLY KNOWN AS THE SACKBUT, CHARACTERIZED BY ITS SLIDING TUBES

The quality of tone varies greatly in the different instruments and registers. The alto trombone has neither power nor richness of tone, but sounds hard and has a timbre between that of a trumpet and a French horn. The tenor and bass have a full rich quality suitable for heroic, majestic music. The contra-bass trombone, formerly little in request in the concert hall, is required for some modern orchestral music.

Besides the slide trombone, which is most largely used, there are the valve trombones, and the double-slide trombones. The former in which the slide is replaced by three pistons permit more brilliant execution than the slide instruments, but their tone is inferior. In the double-slide trombone the sliding branches are doubled and their length accordingly halved, thereby making the instrument more compact and lessening the length of the shifts, though demanding greater nicety in the adjustment of the slide.

The evolution of the trombone from the buccina is referred to in the article on the sackbut (*q v*), the name by which the earliest draw or slide trumpets, and subsequently the trombones, were known in England.

Of all wind instruments the trombone has perhaps been least modified in form, changes have occasionally been attempted, but for the most part with only trifling success. The application of ventils or pistons was made for the first time in 1818, in Germany, but instruments of this kind, though extensively used, have never superseded the original sliding type.

TROMP, the name of two famous Dutch admirals.

1. MARTIN HARPERTZOON TROMP (1597–1653) was born at Brielle, South Holland. At the age of eight he made a voyage to the East Indies in a merchantman, but was made prisoner and spent several years on board an English cruiser. On making his escape to Holland he entered the navy in 1624, and in 1637 was made lieutenant-admiral. In February 1639 he surprised, off the Flemish coast near Gravelines, a large Spanish fleet, which he completely destroyed, and in the following September he defeated the combined fleets of Spain and Portugal off the English coast—achievements which placed him in the first rank of Dutch naval commanders. On the outbreak of war with England Tromp appeared in the Downs in command of a large fleet and anchored off Dover. On the approach of Blake he weighed anchor and stood over towards France, but suddenly altered his course and bore down on the English fleet, which was much inferior to his in numbers. In the engagement which followed (May 19, 1652) he had rather the worst of it and drew off with the loss of two ships. In November he again appeared in command of eighty ships of war, and a convoy of 300 merchantmen, which he had undertaken to guard past the English coast. Blake resolved to attack him, and, the two fleets coming to close quarters near Dungeness on Nov 30, the English, after severe losses, drew off in the darkness and anchored off Dover, retiring next day to the Downs, while Tromp anchored off Boulogne till the Dutch merchantmen had all passed beyond danger. The statement that he sailed up the Channel with a broom at his masthead in token of his ability to sweep the seas is probably mythical. In the following February (1653), while in charge of a large convoy of merchantmen, he maintained a running fight with the combined English fleets under Blake, Penn and Monk off Portland to the sands of Calais, and, though baffling to some extent the purposes of the English, had the worst of the encounter, losing nine ships of war and 30 or 40 merchantmen. On June 3, he fought an indecisive battle with the English fleet under Richard Dean in the Channel, but the arrival of reinforcements under Blake on the following day enabled the English to turn the scale against him and he retired to the Texel with the loss of seventeen ships. Greatly discouraged by the results of the battle, the Dutch sent commissioners to Cromwell to treat for peace, but the proposal was so coldly received that war was immediately renewed, Tromp again appearing in the Channel towards the end of July 1653. In the hotly contested conflict which followed with the English under Monk on the 29th Tromp was shot by a musket bullet through the heart. He was buried with great pomp at Delft, where there is a monument to his memory.

2. CORNELIUS VAN TROMP (1629–1691), the second son of the preceding, was born at Rotterdam on Sept 9, 1629. At the age of 19 he commanded a small squadron charged to pursue the Barbary pirates. In 1652 and 1653 he served in Van Galen's fleet in the Mediterranean, and after the action with the English fleet off Leghorn on March 13, 1653, in which Van Galen was killed, Tromp was promoted to be rear-admiral. On July 13, 1665 his squadron was, by a hard stroke of ill-fortune, defeated by the English under the duke of York. In the following year Tromp served under De Ruyter, and on account of De Ruyter's complaints of his negligence in the action of Aug. 5, he was deprived of his command. He was, however, reinstated in 1673 by the stadtholder William, afterwards king of England, and in the actions of June 7, and 14, against the allied fleets of England and France, manifested a skill

and bravery which completely justified his reappointment In 1675 he visited England, where he was received with honour by King Charles II In the following year he was named lieutenant-admiral of the United Provinces He died at Amsterdam, on May 29, 1691, shortly after he had been appointed to the command of a fleet against France Like his father he was buried at Delft

See H de Jager, *Het Geslacht Tromp* (1883); and T. de Liefde, *Great Dutch Admirals* (trans. 1873)

TROMSÖ, a seaport of Norway, capital of the *amt* (county) and *stift* (diocese) of the same name on the north-western coast Pop (1927) 11,241 It stands on an islet between Kvalö and the mainland The town has fish oil factories, tanneries, and makes boots and shoes; also boats for the fishing and whaling The buildings, many of wood, include the town hall and a museum Sealskins and other furs, dried and smoked fish, and whale and seal oil, are exported, and the herring fishery is very productive

TRONDHJEM (trŏnd'yĕm) or Throndhjem, a city and seaport of Norway, chief town of the diocese of Trondhjem and the county of South Trondhjem, 384 m by rail N. of Oslo. Pop (1927) 55,716 It lies on the Trondhjem fjord on a peninsula between the fjord and the River Nid The houses are principally of wood The principal building is the cathedral, dating in part from the close of the 11th century, but chiefly of the 12th and 13th centuries It suffered from repeated fires, chiefly in the 17th century but was restored and is now the finest church in Norway and the scene of the coronation of the Norwegian sovereigns The port has regular communication with all the Norwegian coast towns; also Hull, Newcastle, Hamburg, etc, and trades in timber, wood pulp, oil, fish, copper, etc The industries include shipbuilding, fish-curing, and there are saw-mills and machine shops

Trondhjem, originally Nidaros, to which name it reverted as from January, 1930, was founded by Olaf Tryggvason, who built a royal residence and a church here in 996 It was made an archbishopric in 1152, and was the capital until 1380. The city attained its highest development about the latter half of the 13th century, by which time it had become an important pilgrimage centre and had 15 churches It sustained frequent sieges Its importance declined about the time of the Reformation, but during the present century, as a port with modern facilities and a considerable trade, it has grown rapidly Since 1921 it has been connected with Oslo by the Dovre railway

TROON, municipal burgh, seaport and watering-place of Ayrshire, Scotland Pop (1921) 9,474 It is situated 6 m N by W of Ayr, and 35 m S W of Glasgow by the L M S railway It has a fine natural harbour with a breakwater 3,000 ft long, and two graving docks Shipbuilding is the leading industry, coal the chief export, and iron the chief import

TROPHY (Gr. *τρόπαιον*), a memorial of victory set up on the field of battle at the spot where the enemy had been routed It consisted of captured arms and standards hung upon a tree (preferably an olive or an oak) and booty heaped up at its foot, dedicated to the god to whom the victory was attributed If no suitable tree was at hand, a lopped trunk was fixed in the ground on an eminence The tree or trunk bore an inscription containing the names of the god and the combatants, a list of the booty and the chief incidents of the battle In the case of a naval victory the trophy, composed of the beaks of ships, was set up on the nearest beach and consecrated to Poseidon It was regarded as a sacrilege to destroy a trophy, since it was dedicated to a god

To facilitate reconciliation with their conquered foes, neither the Macedonians nor the Romans in early times erected such trophies The Romans showed a preference for setting up the memorials of victory in Rome rather than on the field of battle: such were the trophies of Marius recording his victories over Jugurtha and the Cimbri and Teutones In imperial times their place was taken by columns or triumphal arches (*see* ROME: *Archaeology*)

TROPICAL AGRICULTURE. Modern industry receives from tropical regions two-thirds of the sugar entering international trade From the tropics come the world's bananas, pineapples, dates, vegetable oils; the indispensable beverage materials, coffee, cacao, and tea; sisal and henequen, and related fibres, abaca, jute, kapok; quinine, camphor, and other medicinal materials; dyes, and tannins. Numerous other products extensively used in the tropics may yet become better known in northern countries, such as the cassava (manioc, yuca, tapioca), plantains, yams, taro, dasheens, and other root crops, palm sugar, the beverages maté and kola; and the valuable fruits, avocado, mango, papaya, durian, mangosteen, etc.

Table Showing Production of Some Important Tropical Crops

		World Production
Sugar	(Season 1927-28)	25,326,035 long tons
Coffee	(Year 1928)	36,095,000 bags of 60 kilos
Tea	(„ 1927)	3,955,000 metric quintals
Cacao	(„ 1928)	505,281 „ tons
Crude rubber	(„ 1928)	653,833 long tons
Rice	(„ 1928)	854,486,000 metric quintals
Sisal	(„ 1928)	239,000 tons

Many important crops which originated in the tropics are now extensively cultivated in temperate and sub-tropical zones. Among these are oranges and other citrus fruits, cotton, maize, melons, beans, sweet potatoes, and tobacco. There are still hundreds of little known species of fruits, nuts, oil plants, gums, and fibres awaiting development.

Forest products are among the oldest known tropical exports. The tropics have long been the source of the world's precious cabinet woods, such as mahogany, Spanish cedar, rosewood, satinwood, and many others They have provided many useful forest by-products, chief among which are rubber, balata, and gutta-percha essential for cable insulation, chicle, and other gums So wide has been the demand for tropical forest products that the world no longer depends wholly for its supply on the wild forests, but now produces rubber, mahogany, and other forest materials from plantations, often grown in association with food crops.

When compared with farming methods in North America and Europe, tropical agriculture is characterized by the employment of much hand labour, using crude, simple tools, and by a very limited use of labour-saving implements The production per capita is small and the standards of living low. As a result, in most tropical countries native methods of tilling the soil are extremely primitive The land is often in communal or tribal ownership and agriculture becomes a shifting, nomadic procedure, in which patches of forest are cut and burned and a mixture of crops planted. At the end of a few years the land is abandoned and another patch cleared and cultivated

Within the last century plantation or estate systems have been introduced by Europeans and Americans for the production of export crops of sugar, rubber, coffee, fruits, and fibres, under modern scientific methods, with native labour and white management Conspicuous in this field are the sugar plantations of Java, Hawaii, Cuba, and Porto Rico; the rubber estates of Java and Sumatra, Malaya, and Ceylon; the banana industry of the Caribbean region, where one company alone cultivates 450,000 acres of land in six or eight countries, operates 1,600 m of railroads and a large fleet of ships, has two sugar mills and a refinery, and maintains a chain of excellent hospitals and a research division with scientific laboratories and experimental fields

Under the leadership of scientific methods, a revolution in tropical agriculture is in progress. Great changes are being wrought. Enormous improvements have been achieved by breeding varieties of plants and live stock and by the culture of crops and the curing, processing, preservation and shipment of tropical products. Experiment stations are maintained in almost every country. Notable instances of the latter are found in Java, Sumatra, and Hawaii. Tropical industries attain success in the proportion that they employ and liberally support scientific research. Thus, the Dutch in Java have originated disease-resistant sugar canes with higher sugar content; they have improved cinchona and transplanted quinine production from the Andean countries, and are now producing a better palm oil than Africa. Rubber, in like manner, has been taken from the Amazon to the Orient

It has been predicted that northern countries will eventually be unable to produce sufficient food for their increasing population and that the tropics will supply this deficiency. The importance of the rôle the tropics are destined to play in this production

of foodstuffs for the northern races is a complex and still unsettled problem. Among the factors are the vast areas of undeveloped land in tropical America, Africa, and portions of the middle East (Borneo, New Guinea, Sumatra); the tendency of the native people to multiply as health conditions improve; the increasing importation of northern foodstuffs into tropical countries; and the disinclination of northern races to change their food habits and to consume tropical vegetables, fruits, and cereals.

On the other hand, the tropics can be depended upon to supply the world with all its prospective needs of rubber, sugar, vegetable oils, beverages, hard fibres, spices, and similar tropical commodities. In fact, these can be grown on a relatively limited area, and their culture can not be greatly extended without glutting markets and depressing prices below the cost of production.

Consult the articles on RUBBER, SUGAR, COFFEE, RICE, TEA, etc., and on INDIA, BRAZIL, EAST INDIES, WEST INDIES, CEYLON, etc.

See O W. Barrett, *The Tropical Crops;* J. C. Willis, *Agriculture in the Tropics.* (W. A. OR.)

TROPICAL MEDICINE. As medicine advances from the status of an art to that of a science, so do the bounds which demarcate tropical medicine become more faint Few major diseases are restricted to the lower latitudes, and tropical medicine, as here considered, embraces all those maladies which, for some reason, prevail especially in the tropics, though not necessarily limited thereto. Some diseases lightly regarded to-day as essentially tropical are merely commensurate with a primitive stage of civilization, and consequent unhygienic conditions Bubonic plague smouldered in England for centuries, every few years flaring up to epidemic degree, and ceased as an endemic infection only about 1679. Cholera was common enough in John Wesley's day to demand a paragraph in his little volume on household remedies The Londoner of Charles II 's time could enjoy a jest in *Hudibras* unintelligible to anyone not familiar with the stages of a malaria paroxysm.

The present stimulus to the special study of tropical medicine comes from the spread of commerce from causes far back in history and from the ever-growing complexity of modern conditions.

Special Problems of Tropical Medicine.—Liability to contract disease in the tropics is not due in the main to inherent change in the individual, but to circumstances generally favouring a luxuriance of animal life The causative organisms of some diseases, *e g*, malaria and yellow fever, depend for their propagation on insects most numerous and active in tropical conditions; warmth and humidity are essential for the development of hookworm larvae in the soil; and in such surroundings bacterial life in general flourishes most abundantly Though exceptions to these rules spring to the mind—typhus fever, a louse-borne disease, reaches its maximum range under cold weather conditions, and the factors governing the transmission of common colds and coughs determine the spread of pneumonic plague. The newcomer to the tropics is faced by all these potential dangers.

Preventive medicine has done him one great disservice Born in pre-hygiene times, he would almost certainly have acquired a natural immunity to a variety of diseases which nowadays in his own country he escapes, but to which the native, surviving childhood, is relatively immune. This resistance to disease, previously believed a racial characteristic, is now generally considered a personal immunity gained by the individual during early life. As regards this aspect of malaria in natives, Christopherson has shown that in hyper-endemic areas children pass through a period of acute infestation lasting for about two years. During this time manifestations of the disease are practically continuous. A stage of immune infestation is then reached which lasts through childhood into adult life. Whatever the nature of the immunity it is sufficient to enable adults, under conditions that lead to intense infection in the child, to live infected but without suffering appreciably from sickness due to malaria.

The northern sojourner in the tropics may complicate the problems of tropical medicine, already sufficiently involved, by an unwillingness to adapt his regimen and habits to new surroundings. Therefore, physiological changes, including alterations in the functioning of the endocrine glands, may result, with a consequent train of morbid symptoms. Native customs and modes of life evolved by the empiricism of years, may repay study. A temporary adoption of the Indian fashion of wearing the shirt outside the trousers has in practice averted the threatened onset of heat stroke The early inhabitants of Northern Africa cooled their houses by structural devices which modern architects might copy and adapt to the needs of European residents

Methods of Tropical Medicine.—Accurate diagnosis is essential to the correct treatment of any disease; this is no new knowledge—"as sayeth the prince of physic Avicenna: 'How shouldest thou hele a sore and not yknow the cause?' " The aim of modern medicine is to prevent rather than to cure, and in like manner a close study of causation is a requisite preliminary to wise and successful prevention Therefore a basic knowledge of bacteriology, entomology and other branches of medical parasitology is a necessary part of the training prescribed for students of tropical medicine Not every species of *Anopheles* can be infected with malaria, nor are the breeding habits of all the malaria-carrying anophelines the same A system of drainage which eradicates malaria in one locality may have no effect in another, and actually may intensify the disease in a third Slight changes in the chemical reactions of water may prevent mosquito breeding, a discovery likely to have far-reaching results in malaria prevention. And thus the importance of these ancillary sciences to tropical medicine becomes more obvious every day

Further, statistical data, when investigated and scrutinized by exact methods and correlated with clinical observations, may yield valuable information regarding the nature and origin of disease. If a malady is found to be periodic, the climatic and physical changes associated with the rise and fall of the infection may indicate the causal agents, and when their identity is established effective measures may be taken against them Rogers' researches show that cholera begins to spread only when the degree of atmospheric humidity has reached a certain figure; in consequence, the possible commencement of an epidemic can be foreseen and appropriate prophylactic measures undertaken in advance. Already tropical research has achieved great triumphs, and when the true economy of preventive medicine is realized more fully in tropical administration, the return in increased efficiency will multiply

Results.—Before the last decade of the 19th century, the agent responsible for the spread of malaria (*q v*) was unknown No eye had seen the bacillus of plague; and fleas were thought merely unpleasant creatures, rather less scandalous than lice Yellow fever mosquitoes besported themselves unheeded, except in so far as they might disturb an afternoon's siesta. But when Patrick Manson argued that some biting insect serves as intervenient host for the nematode parasite of man, *Filaria bancrofti*, and turned his theory into proven fact, he stood like Cortez on a peak in Darien, viewing a new world. Following on Manson's example and advice, and faced by difficulties which would have disheartened most, Ross carried out his laborious researches and finally *Anopheles* was incriminated as the vector of malaria.

In the old yellow fever (*q.v*) days, a king's ship, the *Tiger* cruised off Barbados, and out of a complement of 220, buried 600 men dead of yellow fever within two years; the commander, as he reported, "still pressing men out of the merchant ships that came in, to recruit his number in the room of those that died daily." The heroic work of Reed and his collaborators proved that this infection is transmitted through the bite of a mosquito, *Aëdes argenteus* (*Stegomyia fasciata*), and Noguchi's indication of a causative micro-organism apparently confirmed their work. Fortunately the peculiar breeding habits of the insect vector render it relatively easy to control, and in the West Indies to-day yellow fever is little more dreaded than in England

Ankylostomiasis (hookworm) (*q v.*), which reduced the vitality and lowered the efficiency of millions of people, has been laboriously investigated Firm, constant, but inexpensive measures of sanitation prevent infection, and recent close study of the free-living stages of the worm points to still more effective methods of control. Schistosomiasis yields to the antimony treatment elaborated by Christopherson, and the labours of Miyairi and Suzuki and Leiper, showed that the parasites develop in water snails

vulnerable to attack

Prior to recognition of the curative properties of intra-venous antimony, kala azar (*q v*), which decimates rich populous tracts of Bengal and Assam, killed over 90% of those attacked The disease is in process of investigation by a special commission, and the mode of transmission, so far baffling identification, is likely to be revealed If the active agent proves to be a species of "sand-fly," as has been surmised, the success of the hygienic methods adopted in practice will be explained.

The progress of physiological knowledge in the special branch of endocrinology has secured success in the treatment of cases of sprue (*q v*), where the restoration of the calcium content of the blood has been effected by the administration of parathyroid extract

Cholera and plague may be stayed by prophylactic vaccines, and the results of anti-typhoid inoculation were one of the medical triumphs of the World War The incidence of tropical liver abscess has been enormously reduced by the use of emetine, and the special "liver-abscess-days"—earmarked for surgical operations—once a feature of some tropical hospitals, are now a thing of the past Synthetic chemistry adds to the resources of the scientific physician of tropical diseases; "Bayer 205" and tryparsamide in the treatment of African sleeping sickness have given hopeful results, while new antimony compounds are replacing tartar emetic for intravenous medication, seemingly with all its advantages and none of its drawbacks Thus the diseases which take so heavy a toll of human life are one by one yielding to science and coming under control, and the outlook to-day is brighter than even the most optimistic would have dared to prophesy some thirty years ago In honouring the men who thus have extended the science of medicine, we should not forget those of old time who caught glimpses of truth, often through a glass darkly, but at times with a clearer vision

Problems of the Future.—Even should science succeed in finding a cure for every tropical disease, still other problems await solution Can the individual be protected and enabled to work as efficiently as in a temperate zone? Can impairment of his vitality and nervous energy be prevented and normal health and longevity secured? Whether or not the tropics can be made a safe home for white settlers depends largely on the extent to which local administration will initiate and maintain effective and scientific systems of sanitation, and will educate the indigenous population into ways of cleanliness and order. Panama sanitary methods, dependent on abundant capital and a soldierly precision of enforcement, are possible only in limited and specially favoured areas And in certain tropical localities it is notorious that the practice of sanitary law bears little relationship to the excellence of the principles embodied in the statute-book

When all these difficulties have been faced and overcome, and the life of white settlers modified in matters of housing, diet, work and play to meet their altered physical environment, there remains the great question Can a white race settle permanently in a tropical country and after several generations still retain its original stamina and mental vigour? In spite of thousands of years of colonization this question still awaits a final answer Heretofore the results of disease—chronic malaria and ankylostomiasis stunting body and mind—moral decay, consequent on association with lower or even debased native modes of life, have been confused inextricably with the effects of climate

The unfavourable factor in tropical climates has been variously identified as the heat, or light, rays of the sun, the depressing monotony of an equable temperature, or a high relative humidity, the last admittedly trying, and affecting both comfort and efficiency. Even so, the individual can be trained to withstand a degree of temperature intolerable before acclimatisation, but whether continued exposure to such temperatures results in some subtle change in the nervous system, with loss of vigour and driving power, is a matter of dispute Whatever the responsible agency, certainly some diminution in vitality commonly occurs, as is evidenced by the accepted practice of granting home leave to government servants and to staffs of business concerns, and this from no motives of philanthropy but because it pays.

(*See* also ANTHROPOLOGY, APPLIED, COLOUR AND RACE PROBLEMS.) (W. P MACA)

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TROPICAL REVOLVING STORMS, a generic term, in meteorology, used for those disturbances of the general circulation of the atmosphere where the winds, often of destructive violence, are characterized by a combined circular and centrifugal movement Such revolving storms have received a variety of names in different parts of the world (*See* CYCLONE; HURRICANE; TORNADO and TYPHOON) Many descriptions and explanations of them have been given For comprehensive, regionally arranged bibliography *see* Shaw and Austen, *Manual of Meteorology* (1926)

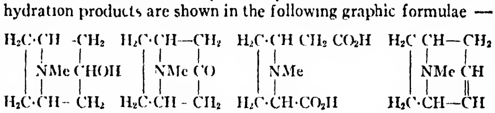
TROPIC-BIRD, a genus (*Phaethon*) of sea-birds of the order Steganopodes with webbed feet and long forked tails The flight is by rapid strokes of the wing The yellow-billed tropic bird (*P flavirastris*) has the widest range, inhabiting the Atlantic, Indian and Pacific oceans, and breeding on trees in various islands, including the Bermudas It lays a single pinkish-white egg, mottled with brownish-purple The plumage is white, with black patches *P. aethereus* is larger and lacks the yellow bill. It does not occur in the western part of the Indian ocean *P rubricauda* is still larger and has a red tail and a roseate tinge to the rest of the plumage It is confined to the Pacific and Indian oceans The tropic-birds form the family *Phaethontidae*

TROPINE (Tropanol), one of the simpler chemical products into which the poisonous alkaloid atropine (*q v*) is converted by the action of acids or alkalis Tropine is also poisonous but no longer retains the property of dilating the pupil of the eye It crystallises in colourless plates melting at 63° C and boiling at 229° C It is very hygroscopic and readily soluble in water. It is a strongly basic substance forming crystalline salts with acids When warmed with sodium in amyl alcoholic solution, tropine is transformed into a stereoisomeride, melting at 108° C, and boiling at 240° C, identical with the pseudo-tropine (ψ-tropine) obtained from the alkaloid tropa-cocaine with hydrochloric acid

The chemical constitution of tropine, $C_8H_{15}ON$, is revealed by the following reactions With chromic acid it is oxidised successively to tropinone and tropinic acid

Tropinone (Tropanone) has been synthesised from succindialdehyde, calcium acetonedicarboxylate and methylamine (R Robinson, 1917), whereas tropinic acid by exhaustive methylation furnishes an unsaturated dicarboxylic acid reducible to *n*-pimelic acid, $CO_2H\,[CH_2]_5\,CO_2H$

On dehydration with fuming hydrochloric acid tropine yields the oily base tropidine (tropene), an unsaturated compound combining with hydrogen halides and reducible to hydrotropidine which is also an oil The relationships of tropine to its oxidation and dehydration products are shown in the following graphic formulae —

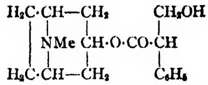


Tropine Tropinone Tropinic acid Tropidine

Tropic Acid, $C_6H_5{\cdot}CH(CH_2{\cdot}OH){\cdot}CO_2H$, the other decomposition product of atropine, is a hydroxy-acid readily converted by dehydrating agents into atropic acid, $C_6H_5\,C(CO_2H){:}CH_2$, which has been synthesised from acetophenone (hypnone) by the following series of reactions:—

$$C_6H_5{\cdot}CO{\cdot}CH_3 \xrightarrow{PCl_5} C_6H_5.C\,Cl.CH_2 \xrightarrow{KCN}$$
$$C_6H_5{\cdot}C(CN){:}CH_2 \xrightarrow{H_2O} C_6H_5{\cdot}C(CO_2H)\,CH_2$$

Tropine and tropic acid combine to form a salt, tropine tropate, losing water to yield atropine which may therefore be represented by the following formula.—



Atropine

Other organic acids can take the place of tropic acid in this condensation with tropine, and the products, the acyltropines, are termed *tropeines*. Certain of these possess the mydriatic action exhibited by atropine. (G. T. M.)

TROPISMS, forced movements of an organism (or of a large part of an organism) in response to external stimuli which bring about obligatory physiological reactions which are related to the direction in which the stimulus reaches the organism. A good illustration is the familiar phenomenon of plants turning to the sun, which De Candolle called heliotropism (1835). It is now known to have its counterpart in some animals. The tropistic mode of behaviour includes positive and negative thermotropism, towards or away from a source of heat, positive and negative geotropism, towards or away from the direction of a gravitational stimulus; galvanotropism, towards or away from electrical radiations, chemotropism, in relation to chemical reagents, rheotropism, in relation to currents, and so forth The essential characteristics of tropisms are their relation to the direction of the stimulus, and their obligatoriness The young eel or elver is not trying to swim up-stream; it is physiologically forced to keep dead against the current. The physiological constitution of its body is such that it automatically adjusts itself towards securing equal pressure-stimulation on its two sides The clarifying of the concept of tropisms is mainly due to Jacques Loeb, and part of his definition may be quoted. "These tropisms are identical for animals and plants The explanation of them depends first upon the specific irritability of certain elements of the body surface, and second, upon the relations of symmetry of the body. Symmetrical elements at the surface of the body have the same irritability, unsymmetrical elements have a different irritability Those nearer the oral pole possess an irritability greater than that of those near the aboral pole These circumstances force an animal to orient itself towards a source of stimulation in such a way that symmetrical points on the surface of the body are stimulated equally In this way the animals are led without will of their own either toward the source of stimulus or away from it" While engrained tropisms are eventually quite involuntary or forced reactions to external stimuli, it does not follow that there was no psychical factor in their racial evolution Care must be taken not to exaggerate the rôle of "pure tropisms"; and one may even ask if there are any A noteworthy fact is the reversibility of many tropisms, for the same animal may show a positive or a negative reaction to temperature, light, gravity or an electric current, the direction varying according to (*a*) the strength of the stimulation, (*b*) the internal physiological state, and (*c*) the coincident influence of the other factors. (*See* PSYCHOLOGY, COMPARATIVE.)

See S J Holmes, *Studies in Animal Behaviour* (Boston, 1916); J. Loeb, *Forced Movements, Tropisms, and Animal Conduct* (Philadelphia and London, 1918). (J. A Th)

TROPPAU: *see* OPAVA

TROPPAU, CONGRESS OF, a conference of the allied sovereigns or their representatives to discuss a concerted policy with regard to the questions raised by the revolution in Naples of July 1820. At this congress, which met on Oct. 20, 1820, the Emperor Alexander I of Russia and Francis I. of Austria were present in person; King Frederick William III. of Prussia was represented by the crown prince (afterwards Frederick William IV). The three eastern powers were further represented by the ministers responsible for their foreign policy: Austria by Prince Metternich, Russia by Count Capo d'Istria, Prussia by Prince Hardenberg. Great Britain, on the other hand, which objected on principle to the suggested concerted action against the Neapolitan Liberals, sent no plenipotentiary, but was represented by Lord Stewart, ambassador in Vienna. France, too, had given no plenary powers to her representatives.

In a series of conferences—to which the representatives of Great Britain and France were not admitted, on the excuse that they were only empowered to "report," not to "decide"—was drawn up the famous preliminary protocol signed by Austria, Russia and Prussia on Nov. 19 The main pronouncement of the "Troppau protocol" is as follows: "States which have undergone a change of government due to revolution, the results of which threaten other States, *ipso facto* cease to be members of the European Alliance, and remain excluded from it until their situation gives guarantees for legal order and stability If, owing to such alterations, immediate danger threatens other States the powers bind themselves, by peaceful means, or if need be, by arms, to bring back the guilty State into the Great Alliance.

No effort was made by the powers to give immediate effect to the principles enunciated in the protocol; and after its promulgation the conferences were adjourned, it being decided to resume them at Laibach in the following January (*see* LAIBACH, CONGRESS OF)

BIBLIOGRAPHY.—*See* W Alison Phillips, *The Confederation of Europe* (2nd ed. 1919) and the bibliography to ch. i. of vol x. of the *Cambridge Mod. Hist.*, p. 787.

TROSSACHS, THE (Gaelic, "the bristled country," a crude allusion to its physical features), a defile in the south-west of Perthshire, Scotland. It is a narrow, beautifully wooded glen, of no great depth, extending from Loch Achray to Loch Katrine, and continued thence by a strip on the north-eastern shore to a point above the now submerged Silver Strand opposite to Ellen's Isle—a total distance of 2½ m It is situated 8 m. W of Callander and 5 m. N of Aberfoyle, between the steep green slopes of Ben Venue (2 393 ft) on the south-west and the precipitous craigs of Ben A'an (1,750 ft) on the north-east The region has been famous for its beautiful scenery since the appearance of Sir Walter Scott's *The Lady of the Lake* and *Rob Roy* with their vivid descriptive passages.

TROTSK (Gatchina), a town in the Leningrad Area of the Russian S F S R, in 59° 33′ N, 30° 7′ E, situated among the lakes and pine forests on the banks of the Izhora river It was originally a Swedish estate presented by Peter I to his sister. Catherine II. gave it to Prince Orlov, and a castle and grounds were constructed by the Italian architect, Rinaldi, in 1770 Later it became a military camp, and, towards the end of the 18th century, a summer residence of the tsars Near the palace is the priory built by Lvov in 1797 for the Knights of Malta, of which order Paul I was Grand Master. In the civil wars following 1917, Gatchina was used as a base by Kornilov and Kerensky in 1917, and Yudenich in 1919 In 1923 it was re-named after Trotsky.

See *Guide to the Soviet Union* (Moscow, 1925) in English.

TROTSKY, LEV DAVIDOVICH (1879–), Russian politician, whose real name was Bronstein, was born near Elizavetgrad, the son of middle-class Jews. He was educated at the Peter and Paul *Real Schule* in Odessa and at the university of that town. He was arrested as a revolutionary in 1898, and soon after exiled to Eastern Siberia. In 1902 he escaped to England by means of a forged passport in the name of Trotsky (which name he used thenceforward) In London, despite his youth, he soon became an important member of the small body of social democrats which included Plekhanov and Lenin He collaborated with the latter and others in the publication of *Iskra* (Spark), the most famous of the Russian revolutionary newspapers. In 1905 he returned to Russia, was elected a member of the St. Petersburg Soviet of Workers' Deputies and was chairman of the meeting at which the whole Soviet was arrested. He was exiled to Tobolsk but escaped immediately on his arrival in Siberia and went to Vienna, where he worked for the *Arbeiter Zeitung* and the *Pravda* He also worked in a chemical factory. In 1910 he attended the Social Democratic congress at Copenhagen, defending a position of his own, midway between that of the Bolsheviks and that of the Mensheviks. In 1913 he was in Constantinople as a war correspondent. The following year found him in Zurich and Paris, taking part in the publication of a revolutionary paper. He wrote a book on the origins of the World War, published in German, and was sentenced to eight months'

imprisonment. But he opposed the War not only in Germany but in the Allied countries, and in 1916 was expelled from France. He was arrested by the Spanish authorities on crossing their frontier but was allowed to leave for America, where he edited the Russian revolutionary *Novy Mir* (The New World).

When the revolution broke out in March 1917 Trotsky's friends and subscribers to the paper collected the money for his journey to Russia. He was, however, arrested by the British authorities and taken ashore at Halifax, where he was interned until the Russian Provisional government asked for his release. He arrived in Petrograd soon after Lenin He was the leader of a small party of social democrats and soon joined the Bolsheviks but did not actually become a member of the Bolshevik party until July 1917, when he was arrested for being concerned in the rising which took place in that month He played a part hardly less important than that of Lenin in organizing the Bolshevik revolution in 1917 and became People's Commissar for foreign affairs in the new Soviet Government

Trotsky was the most important figure in the Russian delegation during the negotiation of the Brest-Litovsk peace treaty. Believing that the moral effect of the revolution had already been such that the Germans would be unable to force their troops to move against Russia, he met the oppressive German demands with the statement that Russia would not sign a treaty on such terms but that she considered the War to be at an end and would demobilize her troops The Germans thereupon continued their advance. Lenin had disagreed with Trotsky, considering that the risk was too great since at that time the Germans could easily have taken Petrograd After a series of debates, Trotsky announced that he now sided with Lenin and by a majority of one it was decided to sign an even more unfavourable treaty than that previously refused Trotsky was replaced by Chicherin as Commissar for foreign affairs and took over the Commissariat of war. In spite of opposition he made great use of officers of the old régime in organizing a new Red army. The results obtained were used to justify the employment of "bourgeois" technical experts in the factories. When he had made a new army that showed itself superior to those of the Whites his energies were used in preventing the complete collapse of the railways. In 1920 he organized as "labour armies" the troops that were not needed for war

Until the introduction of the new economic policy Trotsky urged industrial conscription, but wholeheartedly accepted the new policy which made such measures impossible. During the Polish war of 1920, he opposed the disastrous advance on Warsaw but was overruled by Lenin In the autumn of 1923 he adopted a position that made it possible for the "old guard" of the Communist leaders to accuse him of canvassing for the support of the younger men He was violently attacked by Stalin, Zinoviev and others Many of his friends were shifted from their posts and he himself was on the way to the Caucasus to take a cure, when Lenin died. Throughout the revolution the names of Lenin and Trotsky had been coupled and the death of the one seemed to leave the other alone in the field This was not really so Seniority counts for much in the Communist party and the older leaders never forgot that Trotsky had only joined the party in 1917. The campaign to discredit him was continued. He lost his post as Commissar of war. When he returned from the Caucasus he was given work of small political significance, being made head of the committee for the development of electric power in Russia In 1925 he resigned from this post and was made head of the Central Committee for Concessions In Nov 1927 he was expelled from the Communist party for his anti-party activities, and in Jan 1928 he was exiled to Viernie in Turkestan. He was subsequently banished and went to Constantinople (1929)

Trotsky was, after Lenin, the most brilliant of the revolutionary leaders He wrote a number of books on the history of the revolution, on Lenin, on the civil war and on the relations between revolution and literature, besides essays on questions of the day For this *Encyclopædia* Trotsky wrote the biography of Lenin. (A. Ra.)

Works in English: *Defence of Terrorism* (1920); *The Lessons of October* (1925); *Lenin* (1924); *Where Is Britain Going?* (1926), American edition *Whither England?* (1925); *Towards Socialism or Capitalism?* (1926); *Problems of Life* (1924); *Literature and Revolution* (1925).

TROTZENDORFF (or Trocedorfius), **VALENTIN FRIEDLAND** (1490–1556), German educationist, called Trotzendorff from his birthplace, near Gorlitz, in Prussian Silesia, was born on Feb. 14, 1490, of parents so poor that they could not keep him at school Nevertheless he was sent to study at Görlitz, and became a schoolmaster there He resigned presently to study under Luther and Melanchthon, supporting himself meanwhile by private teaching He then became master in the school at Goldberg in Silesia, and in 1524 rector. There he remained three years, when he was sent to Liegnitz. He returned to Goldberg in 1531 and began that career which has made him the typical German schoolmaster of the Reformation period. He made his best elder scholars the teachers of the younger classes, and insisted that the way to learn was to teach. He organized the school in such a way that the whole ordinary discipline was in the hands of the boys themselves. Every month a "consul," twelve "senators" and two "censors" were chosen from the pupils, and over all Trotzendorff ruled as "dictator perpetuus." One hour a day was spent in going over the lessons of the previous day. The lessons were repeatedly recalled by examinations, which were conducted on the plan of academical disputations. Every week each pupil had to write two "exercitia styli," one in prose and the other in verse, and Trotzendorff took pains to see that the subject of each exercise was something interesting. The fame of the Goldberg School extended over all Protestant Germany, and a large number of the more famous men of the following generation were taught by Trotzendorff He died on April 20, 1556

See Herrmann, *Merkwurdige Lebensgeschichte eines beruhmten Schulmanns, V F Trotzendorffs* (1727), Frosch, *V F Trotzendorff, Rektor zu Goldberg* (1818); Pinzger, *V. F Trotzendorff* (with the Goldberg portrait, and a complete list of his writings, 1825), Koehler, *V F Trotzendorff, ein biographischer Versuch* (1848), G Bauch, *Valentin Trozendorf und die Goldberger Schule* (1921). The biographical facts appear to be derived from a funeral or memorial oration delivered by Balthasar Rhau in the university of Wittenberg on Aug 15, 1564, and published in an edition of Trotzendorff's *Rosarium* (1565).

TROUBADOUR, the name given to the poets of southern France and of northern Spain and Italy who wrote in the *langue d'oc* from the 12th to the 14th centuries. In Provençal the word is spelt *trobaire* or *trovador*, and is derived from the verb *trobar*, to find, or to invent (Fr. *trouver*) The troubadour was one who invented, and originally improvised, poetry, who "found out" new and striking stanzaic forms for the elaborate lyrics he composed.

The earliest troubadour of whom anything definite is known is Guilhem IX. (b 1071), count of Poitiers and duke of Aquitaine, whose career was typical of that of his whole class, for "he knew well how to sing and make verses, and for a long time he roamed all through the land to deceive the ladies." The high rank of this founder of the tradition was typical of its continuation; by far the largest number of the troubadours belonged to the noble class, while no fewer than 23 of their number were reigning princes Among them is a king of England, Richard I, who is believed to have written in *langue d'oil* as well as in *langue d'oc*, and who has left at least one canzo, that written in prison, of remarkable beauty. These noble troubadours were distinguished by their wealth and independence from those who made their song their profession, and who wandered from castle to castle and from bower to bower But whether dependent or independent, the poets exercised a social influence paralleled by nothing before it in the history of mediaeval poetry. They had great privileges of speech and censure, they entered into questions of politics, and above all they created around the ladies of the court an atmosphere of cultivation and amenity which nothing had hitherto approached. The troubadour was occasionally accompanied by an apprentice or servant, called a *joglar*, who provided a musical setting for the poet's words, and sometimes sang the songs.

There were recognized about 400 troubadours, during the whole period in which they flourished, from Guilhem de Poitiers down

to Guiraut Riquier (*c.* 1230–94). Several ms. collections of biographies have been preserved, and from these we gain some idea of the careers of no fewer than 111 of the poets. The principal source of the lives of the troubadours is a collection, by various hands, made towards the middle of the 13th century. Of these Uc of Saint Cyr (*c.* 1200–40), himself a troubadour, was certainly one of the authors. Another, but unreliable, source of information is the *Vies des plus célèbres et anciens poètes provencaux,* published by Jehan de Notredame or Nostradamus, in 1575. Even the numerous genuine biographies are often embroidered with fantastic and whimsical statements which make a severe demand upon the credulity of a modern reader. One late troubadour, Rambaud of Orange, left a commentary on his own poems, and Guiraut Riquier one on those of a fellow troubadour, Guiraut of Calanson (1280) This proves the poetry of Provence to have passed early into the critical stage, and to have been treated very seriously by those who were proficient in it This is further shown by the respect with which the Provençal poets are mentioned by Dante, Petrarch and others.

The verse form most frequently employed by the troubadours was the *sirventés*, a term which is earliest met with in the second half of the 12th century The troubadours also employed the *ballada,* which was a song with a long refrain, not much like the formal ballade of the north of France; the *pastourella;* and the *alba.* This last took its name from the circumstance that the word *alba* (dawn) was repeated in each stanza. This was a morning-song, as the *serena*, a later invention, was an evensong The *planh* was a funeral elegy, composed by the troubadour for the obsequies of his protector, or for those of the lady of his devotion Most interesting of all, perhaps, was the *tenson,* which was a lyrical dialogue between two persons, who discussed in it, as a rule, some point of amorous casuistry, but sometimes matters of a religious, metaphysical or satirical nature The troubadours were essentially lyrical (*see* PROVENÇAL LITERATURE).

The biographies of the troubadours, which throw an unparalleled light upon mediaeval literary life, may perhaps be most conveniently treated in connection with the courts at which each group of them flourished It is in Poitou that we trace them first. where Guilhem, count of Poitiers, who reigned from 1087 to 1127, was both the earliest patron and the earliest poet of the school The daughter of Guilhem X carried on her grandfather's tradition. This was Eleanor of Aquitaine, at whose court Bernart of Ventadour rose to eminence This poet seems to have been the son of a kitchen-scullion in the castle of Eble II. viscount of Ventadour. Eble, himself a poet, was early impressed by the talents of his serving-boy, and trained him to be a poet. The beautiful wife of Eble, the viscountess Agnes of Montluçon, encouraged the suit of the youthful Bernart; indeed, they had secretly loved one another from their childhood. The poems which this passion inspired are among the most admirable lyrics which have come down to us from the middle ages The husband at last discovered the intrigue and exiled Bernart from Ventadour The troubadour took shelter with Eleanor of Aquitaine, who became in 1152 the queen-consort of Henry II of England, himself a protector of poets.

Henry, eldest son of Henry II, was the patron of another eminent troubadour, Bertran de Born, viscount of Hautefort in Perigord. Dante saw Bertran de Born in hell, carrying his severed head before him like a lantern, and compared him with Achitophel, who excited the sons of David against their father This referred to the subtle intrigues by which the troubadour had worked on the jealousy existing between the three sons of the king of England. The death of Prince Henry (1183) produced from Bertran de Born two *planhs,* which are among the most sincere and beautiful works in Provençal literature. The poet was immediately afterwards besieged in his castle of Hautefort by Richard Cœur de Lion, to whom he became reconciled and whom he accompanied to Palestine. He grew devout in his old age, and died about 1205.

There were poetesses in the highly refined society of Provençe, and of these by far the most eminent was Beatrix, countess of Die, whose career was inextricably interwoven with that of another noble troubadour, Rambaut III., count of Orange, who held his court at Courthézon, a few miles south of Orange. Rambaut said that since Adam ate the apple no poet had been born who could compete in skill with himself, but his existing lyrics have neither the tenderness nor the ingenuity of those of his illustrious lady-love. The poems of Beatrix are remarkable for a simplicity of form rare among the poets of her age Marcabrun (*c* 1120–95), from whose pen some 40 poems survive, was an innovator and a reformer, to him the severity of classical Provençal style is mainly due, and he was one of the first to make use of that complex form which was known as the *trobar clus* He posed as a violent misogynist—"I never loved and I was never loved" Marcabrun expresses great affection for "that sweet poet," Jaufre Rudel, prince of Blaye, whose heart turned, like the disk of a sunflower, towards the Lady of Tripoli Little else than that famous adventure is known about the career of this ultra-romantic troubadour, except that he went as a crusader to the Holy Land, and that his surviving poems have so mystical a tone that Jaufre Rudel has been suspected of being a religious writer who used the amorous language of his age for sanctified purposes, and whose "Princess Far-away" was really the Church of Christ. Peire d' Alveona (Peter of Auvergne), like Marcabrun, was of mean birth, son of a tradesman in Clermont-Ferrand, but he was handsome and engaging, and being the first troubadour who had appeared in the mountain district, "he was greatly honoured and fêted by the valiant barons and noble ladies of Auvergne" It is believed that Peire's poems were produced between 1158 and 1180. He flourished at the court of Sancho III, king of Castile, and afterwards at that of Ermengarde, viscountess of Narbonne

It is doubtless owing to the repeated praise which was given by Dante, in the *Inferno* and elsewhere, to Arnaut Daniel that this name remains the most famous among those of the troubadours He was a knight of Riberac, in Perigord, and attached himself as a troubadour to the court of Richard Cœur de Lion Dante calls Daniel the "smith," the finished craftsman, of language, and it is evident that it was the brilliant art of the Provençal's elaborated verse which delighted the Italian His invention of forms of verse (*see* SESTINA), in particular, dazzled the great Italian Dante was curiously anxious to defend Arnaut Daniel as being a better artist than his immediate rival, Giraut de Bornelh; critical posterity, however, has reversed this verdict. Giraut laments, in his poems, the brutality of the age and the lawlessness of princes. A troubadour of the same district of south-western France was Arnaut de Mareuil, to whom is attributed the introduction into Provençal poetry of the amatory epistle

Peire Vidal of Toulouse was the type of the reckless and scatterbrained troubadour His biographer says that he was "the maddest man in all the world." His early life was a series of bewildering excursions through France and Spain At Marseilles he made a mortal enemy of Azalais, the wife of Viscount Barral de Baux, from whom he stole a kiss (1180) He committed a thousand follies; among others, being in love with a lady called Louve (she-wolf), the poet dressed himself as a wolf, and was hunted by a pack of hounds in front of the lady's castle. Folquet of Marseilles was a troubadour of Italian race, the son of a merchant of Genoa; Dante met Folquet in paradise, and gives an interesting notice of him It is in the *sirventés* of Folquet that critics have seen the earliest signs of that decadence which was so rapidly to destroy Provençal poetry.

Gaucelm Faidit came from Uzerche, in the Limousin He seems to have been a wandering minstrel of gay and reckless habits, and to have been accompanied by a light-o'-love, Guillelma Monja, who was the object of much satire and ridicule Another troubadour, Raimbaut of Vaquières, passed the greater part of his life at the same court of Montferrat; he devoted himself to the Lady Beatrix, sister of the marquis. The most celebrated of the Italian troubadours was Sordello, born at Mantua, at the beginning of the 13th century, who owes his fame to the benevolence of later poets, from Dante to Robert Browning

We have now mentioned the troubadours who were most famous in their own time, and on the whole modern criticism has

been in unison with contemporary opinion There are, however, still one or two names to be recorded The English historian of the troubadours, Dr. Hueffer, gave great prominence to the writings of Guillem de Cabestanh (or Capestang). This was a knight of Roussillon, who made love to Seremonda, countess of Castel-Roussillon The lady's husband slew him in a paroxysm of jealousy and, having cut out his heart, had it delicately cooked and served to his wife's dinner When Seremonda had eaten her lover's heart, her husband told her what she had done, and she threw herself out of the window and was killed Feeling grew so strong that the surrounding nobles, with Alfonso, king of Spain, at their head, hunted the murderer down and killed him The bodies of the lady and the troubadour were buried side by side, in the cathedral of Perpignan, and became the objects of pilgrimage

The great cause of the decadence and ruin of the troubadours was the struggle between Rome and the heretics This broke out into actual war in June 1209, when the northern barons, called to a crusade by Pope Innocent III, fell upon the Albigenses and pillaged Béziers and Carcassonne. Most of the protectors of the troubadours were, if not heretics, indulgent to the heretical party, and shared in their downfall. The poets, themselves, were not immediately injured, but the darkness began to gather round them as the ruin of Languedoc became more and more complete, culminating with the siege of Toulouse in 1218. The greatest name of this period, which was the beginning of the end, is that of Peire Cardenal, of Le Puy. He was protected by Jacme I, king of Aragon, having apparently fled from Narbonne and then from Toulouse in order to escape from the armies of Simon de Montfort He was the inventor of the moral or ethical *sirventés;* and the author of singularly outspoken satires against the clergy Another troubadour of this time was Guillem Figueira, the son of a Toulouse tailor, an open heretic who attacked the papacy with extraordinary vigour, supported and protected by Raimon II. Figueira was answered, strophe by strophe, by a female troubadour, Gormonda of Montpellier The ruin of the southern courts, most of which belonged to the conquered Albigensi party, continued to depress the troubadours, whose system was further disintegrated by the establishment of the Inquisition The genial and cultured society of Provence and Languedoc sank rapidly into barbarism, and there was no welcome anywhere for secular poets.

The last of the French troubadours was Guiraut Riquier (*c.* 1230–94), who was born at Narbonne, and found protection at the Spanish court of Alfonso X the Learned Riquier, in a *sirventé* of about 1285, gives pathetic expression to his sense of the gathering darkness, which makes it useless and almost unbecoming for a troubadour to practise his art, while of himself he mournfully confesses· "Song should express joy, but sorrow oppresses me, and I have come into the world too late" Guiraut Riquier passed away about 1294, and left no successor behind him

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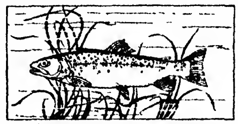
TROUBRIDGE, SIR THOMAS, BART. (*c.* 1758–1807), English admiral, was educated at St Paul's school, London, and entered the navy in 1773. Having seen some service in the East Indies, he was taken prisoner by the French in 1794. In Feb. 1797 he commanded his ship, the "Culloden," at the battle of Cape St. Vincent In the following July he assisted Nelson in the unsuccessful attack on Santa Cruz. He served in the Mediterranean and was created a baronet in 1799; from 1801 to 1804 he was a lord of the admiralty, being made a rear-admiral just before his retirement. In 1805 Troubridge was given a command in the East and he went out in the "Blenheim" He was drowned in the wreck of the "Blenheim" off Madagascar, in Jan. 1807.

TROUPIAL, a collective name suggested by Ridgway for the American family Icteridae, which includes the North American orioles, meadow-larks, cowbirds, grackles and blackbirds and the Central American caciques

TROUT (*Salmo trutta*), a fish closely related to the salmon, but with a larger mouth, the maxillary extending to below the posterior edge of the eye in fish 6 in long well beyond the eye in larger ones, and with the caudal fin less emarginate In the sea the trout ranges from Iceland and northern Europe to the Bay of Biscay, but as a fresh-water fish occurs in the countries north of the Mediterranean eastwards to Greece, and in Corsica, Sardinia and Algeria a trout from the mountains of south-east Morocco has been described by Pellegrin as *Salmo pallaryi* (*Bull Mus*, Paris 1922) The trout of the Black, Caspian and Aral seas and their tributaries have smaller scales The sea-trout is silvery, with X-shaped blackish spots; it ascends rivers to breed and forms fresh-water colonies in every river and lake that it enters, the presence of trout in the Mediterranean countries indicates that in glacial times sea-trout frequented the Mediterranean The river and lake trout show great differences in size and coloration and many specific names have been given, but it seems clear that all are but varieties of the one main species In large lakes a weight of 50 lb may be attained, whereas in some small mountain streams a fish of 4 oz is exceptional; the coloration varies from silvery white to blackish, with spots that may be few or many, stellate or rounded, black, brown or red



TROUT (SALMO TRUTTA)

In eastern North America the name trout is given to a char (*Salvelinus fontinalis*) and in the west this name is given to the steelhead (*S gairdneri*) of the Pacific coast and its numerous fresh-water derivatives, which exhibit just as much diversity in coloration as the trout of Europe and have received even more specific names; the best known is the rainbow trout (*S irideus*). These trout of the Pacific slope have the caudal fin spotted, and often a red band along the side of the body; their relationship to the trout of Europe is not very close, their nearest allies being the various other Pacific species of *Salmo*, which are generally termed salmon

For trout-fishing *see* ANGLING

TROUVÈRE, the name given to the mediaeval poets of northern and central France, who wrote in the *langue d'oil* or *langue d'oui* The trouvères flourished abundantly in the 12th and 13th centuries They were court-poets who devoted themselves almost exclusively to the composition and recitation of a particular kind of poetry, the subject of which was some refinement of love.

The first appearance of trouvères seems to date from 1137, when Eleanor of Aquitaine, herself the granddaughter of an illustrious troubadour, arrived in the court of France as the queen of Louis VII, speaking the Poitiers dialect of the *langue d'oc* She was queen for 15 years (1137–52), the period during which the southern influence was strongest in the literature of northern France, and the successive crusades tended to produce relations between the two sections of poetical literature The northern poets rarely approach the grace and delicacy of the troubadours, while their verse shows less ingenuity and less variety. The earliest trouvères, like Conon de Béthune and Hugues de Berze, in writing their amatory lyrics, were, however, certainly influenced by what troubadours had written

The poetical forms adopted by the trouvères bore curious and obscure names, the signification of which is still in some cases dubious. The rotruenge was a song with a refrain; the serventois

was, in spite of its name, quite unlike the sirventes of the troubadours and had a more ribald character; the estrabot was allied to the *strambotto* of the Italians, and was a strophic form "composed of a front part which was symmetrical, and of a tail which could be varied at will" (Gaston Paris).

The court poetry of the trouvères particularly flourished under the protection of three royal ladies. Marie, the regent of Champagne, was the practical ruler of that country from 1181 to 1197, and she encouraged the minstrels in the highest degree and discussed the art of verse with Chrétien of Troyes Her sister, Aélis or Alice, welcomed the trouvères to Blois, she was the protector of Gautier d'Arras and of Le Châtelain de Coucy Another Aélis, who became the second queen of Louis VII in 1160, received Conon de Béthune in Paris, and reproved him for the Picard accent with which he recited his poetry. At the end of the 12th century the refinement and elegance of the court-poets was recognized in the north of France by those who were responsible for the education of princes. A trouvère, Gui de Ponthieu, was appointed tutor to William III of Macon, and another, Philippe of Flanders, to Philippe Auguste. The vogue of the trouvères began during the third crusade, it rose to its greatest height during the fourth crusade and the attack upon the Albigenses The first 40 years of the 13th century was the period during which the courtly lyrical poetry was cultivated with most assiduity At first it was a purely aristocratic pastime, and among the principal trouvères were princes such as Thibaut IV. of Navarre, Louis of Blois and John, king of Jerusalem About 1230 the taste for court poetry spread to the wealthy bourgeoisie, especially in Picardy, Artois and Flanders Before its final decline, and after the courts of Paris and Blois had ceased to be its patrons, the poetry of the trouvères found its centre at Arras, where some of the most skilful of all the trouvères, such as Jacques Bretel and Adam de la Halle, exercised their art About 1280 the poetical system suddenly disappeared

The poet was invariably a lover, devoted to a married lady who was not his wife, and to whose caprices he was bound to submit blindly and patiently The progress of this conventional courtship was laid down according to certain strict rules of ceremonial; love became a science and a religion, practised by the laws of precise etiquette The *rondel* of Adam de la Halle (published in E de Coussemaker's edition, 1872) beginning

"À Dieu courant amouretes,
Car je m'en vois
Souspirant en terre estrange!"

marks perhaps the highest point to which the delicate, frosty art of the trouvères attained Music took a prominent place in all their performances, but little is known of the melodies which they used But enough has been discovered to justify the general statement of Tiersot that "we may conclude that the musical movement of the age of the trouvères was derived directly from the most ancient form of popular French melody" A precious ms in the Faculty of Medicine of Montpellier contains the music of no fewer than 345 part-songs attributed to trouvères

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TROUVILLE, a seaside town of north-western France, in the department of Calvados, on the English channel, 34 m. N E of Caen by rail. Pop. (1926) 5,869 Trouville stands at the mouth of the Touques on its right bank opposite Deauville. Its fine stretches of sand and excellent bathing make it the most frequented French resort on the channel. Deauville is well known for its race-course and villas The port, shared with Deauville and formed by the Touques, is entered by a channel between jetties with a depth at high tide of 17½ ft.; it is supplied with a half-tide dock, filled to scour the channel, and a floating dock, with average depth of 18 ft. Timber, coals and cement are imported The London and South Western railway company have a daily steamboat service from Havre to Trouville in connection with their Southampton and Havre boats.

TROWBRIDGE (troō'brĭj), a market town, Westbury parliamentary division, Wilts, England, 97¾ m. W by S. of London by the G W. railway Pop of urban district (1921) 12,130

Trowbridge was mentioned in Domesday under the name of Straburg, a manor held by one Brictric together with Staverton and Trowle, now both included within its limits The first reference to the "town" of Trowbridge occurs early in the 16th century; previous to that date mention is made of the manor and castle only. Trowbridge is now a non-corporate town It is now the chief centre of the West of England woollen industry and makes broadcloth and other woollen goods

TROY, a city of south-eastern Alabama, U S A, county seat of Pike county, on Federal highway 231, and served by the Atlantic Coast and the Central of Georgia railways. Pop. (1920) 5,696 (50% negroes), estimated locally at 8 500 in 1928. It is the seat of a State Normal School (1887); the trade centre of a rich agricultural region, producing especially cotton, cattle, hogs and peanuts, and has several manufacturing industries. The city was founded in 1823.

TROY, a city of eastern New York, U S A, the county seat of Rensselaer county; on the east bank of the Hudson river, 7 m above Albany, at the mouth of the Mohawk It is on Federal highway 9 and the State Barge canal, and is served by the Boston and Maine, the Delaware and Hudson, the New York Central and electric railways, motor-bus and truck lines and river steamers. Pop (1920) 72,013 (83% native white); 1928 local estimate 75,000. Across the river are Cohoes and Watervliet, connected with Troy by bridges, and Schenectady is only 15 m. north-west The city has a water front of 7 m. and an area of 9 32 sq m., rising from the river to hills on the east 400 ft high Its seven parks cover 276 acres. The Catskill mountains are visible on the south-western horizon. Troy is at the head of steamboat navigation on the Hudson Two rapid streams, Poesten kill and Wynants kill, flowing into the Hudson from the east through deep ravines, furnish water-power, and hydro-electric current also is available Troy has long been an important industrial and commercial city It is the principal centre in the United States for the manufacture of collars, and among its other leading products are shirts, men's clothing, surveying instruments, abrasives, valves, hydrants, bells, chains, brushes and automobile parts. The aggregate factory output in 1927 was valued at $76,880,913 Among the educational institutions in the city are the Rensselaer Polytechnic institute, founded in 1824 by Stephen Van Rensselaer of Albany, the oldest school of science with a continuous existence in the country.

The site of Troy was part of the Van Rensselaer manor grant of 1629 In 1659 it was bought from the Indians, with the consent of the patroon, by Jan Barentsen Wemp, and in 1707 it passed into the hands of Derick van der Heyden In 1777 Gen Philip Schuyler had his headquarters on Van Schaick's island, in the Mohawk and Hudson. After the close of the Revolution there was an influx of settlers from New England, a town was laid out on the Van der Heyden farm; in 1789 the name of Troy was adopted in town-meeting; in 1793 the county seat was established here; in 1794 the village was incorporated, and in 1816 it was chartered as a city. A newspaper, *The Farmer's Oracle*, began publication in 1797 In 1812 a steamboat line was established between Troy and Albany, and in 1825 the Erie canal was opened. During the War of 1812 Troy filled large contracts for army beef. Puddling works were opened in 1839, and for many years the city was the centre of the iron and steel industry of New York. The second Bessemer steel works in the United States was established here in 1865. During the Civil War Troy supplied much cannon and ammunition, and made the armour-plate and part of the machinery for the "Monitor" The last steel and iron works discontinued operations about 1896. The collar industry dates its origin from 1819, when Hannah Lord Montague of Troy had the ingenious idea of making separate collars for her husband's shirts. The idea spread, and in 1829 Ebenezer Brown, a local

merchant, had collars made to sell in his store. The manufacture of cuffs was begun in 1845. After the introduction of the sewing machine in 1852 the industry grew rapidly, reaching its peak about the time of the World War. The city had a population of 28,785 in 1850; 39,235 in 1860; 56,747 in 1880; 60,651 in 1900; 76,813 in 1910. In 1820, 1854 and 1862 it suffered from destructive fires.

TROY, a city of western Ohio, U S A, the county seat of Miami county; on the Dixie highway and the west bank of the Great Miami river, 20 m. N of Dayton It has a landing field, and is served by the Baltimore and Ohio and the Big Four railways, interurban trolleys and bus lines Pop. (1920) 7,260 (92% native white); 1928 local estimate 9,000. Troy was settled in 1807 and was chartered as a city in 1890.

TROY and **TROAD. The Troad** (ἡ τρῳάς), or land of Troy, is the north-west promontory of Asia Minor, between the valleys of the Caicus on the south and the Aesepus flowing into Propontis on the east. The eastern limit was variously defined by ancient writers Geographically, it is undoubtedly (as Strabo says) the range of Ida, which, from the north shore of the Adramyttian gulf, sends its north-western spurs nearly to the coast of the Propontis. The greatest length of the Troad from north-west at Cape Sigeum (Yeni Shehr), to the south-west at Cape Lectum (Babā Kale), is about 40 m ; the breadth, not much greater. The central area is drained by the Menderes (anc. *Scamander*), which rises in Ida and reaches the Hellespont east of Cape Sigeum.

Timber is supplied by pine forests on Mt. Ida. But the plains and hills are fairly wooded. Besides valonia oak, there are elm, willow, cypress and tamarisk, with lotus, galingale and reeds, as in Homeric days, about the streams The vine is cultivated; watermelons are abundant; cotton, wheat and maize are grown. Even under Turkish rule, the natural advantages of the land mitigated the poverty of its inhabitants; in antiquity it was fertile and populous.

Early History.—In Greek legend, Priam of Troy ruled all that is bounded by "Lesbos, Phrygia and the Hellespont" (*Il.* xxiv. 544). The Achaeans under Agamemnon destroyed Troy, and overthrew Priam's dynasty But there is Homeric prophecy that Aeneas and his descendants shall still rule over the Troes, in a passage probably later than the bulk of the book, and it is certain that in the 7th or 6th century B C. reputed descendants reigned somewhere in the Troad. Thracian tribes, including Bithynians and Treres, swept into Asia Minor from Europe in the 7th century B C., and the Ionian poet, Callinus, recorded the terror which they caused.

Greek Settlements.—The earliest and most important of the Greek settlements were Aeolic, mainly from Lesbos and Cyme in Aeolis; some may have been as early as the 13th century B C About 620 B.C. Athenians occupied Sigeum, and were resisted by Aeolic colonists from Mytilene, already established in that neighbourhood.

Chief Greek towns in the Troad were Ilium in the north, Assus (*q v*) in the south, and Alexandria Troas (*q.v.*) in the west. The site of the Greek Ilium is marked by the low mound of Hissarlik (Turk "place of fortresses") in the Trojan plain, about 3 m. from the Hellespont, the traditional site of Homer's "Troy." When Xerxes visited the Trojan plain, he "went up to the Pergamon of Priam," and sacrificed to the Ilian Athena. Ilium yielded to Dercyllidas in 399 B C, and was captured by Charidemus in 359 B.C, but was evidently still of small importance when, in 334 B.C, Alexander visited it on landing in the Troad In their temple of Athena the Ilians showed him arms which had served in the Trojan war, including the shield of Achilles. Either then or after the battle of Granicus, Alexander enlarged the town to be a "city," with political independence and exemption from tribute Lysimachus executed the intentions of Alexander when north-west Asia Minor fell to him in 301 B.C., building a wall 5 m. in circumference, incorporating decayed towns of the neighbourhood, and building a temple of Athena In the 3rd century B C. Ilium was the head of a federal league of free Greek towns, from Lampsacus on the Hellespont to Gargara on the Adramyttian gulf. In 278 B C. the Gauls, under Lutarius, occupied Ilium, but abandoned it. Forty years later (218 B C.) other Gauls brought by Attalus I. for his war against Achaeus, deserted his standard, pillaged the towns on the Hellespont, and besieged Ilium, from which, however, they were driven off by the troops of Alexandria Troas. In the 2nd century B.C. Ilium was in decay; as Demetrius of Scepsis says, the houses "had not even roofs of tiles." The temple of Ilian Athena, however, retained its prestige; in 192 B.C. Antiochus the Great visited it before sailing to the aid of the Aetolians. In 190 B C., before the battle of Magnesia, Romans and Ilians were alike eager to recall the legend of Roman descent from Aeneas; Lucius Scipio offered sacrifice to the Ilian Athena; and after the defeat of Antiochus the Romans annexed Rhoeteum and Gergis to Ilium, "not so much in reward of recent services, as in memory of the source from which their nation sprang." The later history of Ilium is a catalogue of Roman benefactions, though, in 85 B C., when Fimbria took it, he left it in ruins; Sulla, however, was careful to rebuild it; Augustus confirmed its ancient privileges and gave it new territory, Caracalla (A D 211–217), like Alexander, paid honours to the tomb of Achilles In the 4th century, the Ilians were attracting tourists by their pseudo-Trojan memorials. After the 4th century the place is lost to view.

Of the other ancient cities, *Neandria* seems to be rightly fixed at Mt. Chigri, not far from Alexandria Troas, remarkable for its fine view of the whole Troad. *Cebrene* has been located in the eastern part of the plain of Bairamich, *Palaeoscepsis,* farther east, on Ida, while the new *Scepsis* was near Bairamich. At Kulakli, south of the mouth of the Tuzla, Corinthian columns mark the temple of Apollo Smintheus (excavated in 1866 by Pullan) and (approximately) the Homeric *Chryse Colonae* was on the coast opposite Tenedos *Scamandria* was at Eneh, in the plain of Bairamich, and *Cenchreae* probably some way north of it. The shrine of Palamedes, *Polymedium,* has been discovered by J. T. Clarke between Assus and Cape Lectum, the sacred enclosure and the statue of Palamedes were on the acropolis. Clarke also found very ancient walls on Gargarus, the highest peak of Ida

The Site of Troy.—The traditional site, at the Hellenistic Ilium, is the mound of Hissarlik, on a spur between the main Scamander valley and its last tributary from the east (anc. *Simois*), about 3½ m. from the Hellespont and from the Aegean shore, north of Besika bay. The famous academic dispute concerning the site, which began about A D. 160 with Demetrius of Scepsis, may be regarded as settled by the discovery, made in 1893, of a fortress on the mound of Hissarlik, contemporary with the great period of Mycenae, and overlying the smaller and the earlier acropolis first identified by Schliemann in 1872 The rival ruins of a small hill fort on the Bali Dagh which, with another on an opposite crag, commanded the gorge where the Scamander descends into the plain neither accord with Homeric description nor challenge the remains at Hissarlik in importance

No site in the Troad accords completely with all the topographical clues ingeniously derived from the text of Homer. The hot and cold springs that lay just without the gate of "Troy" are no more to be identified with Bunarbashi, which wells out more than a mile from the Bali Dagh ruins, than with the choked conduits south of Hissarlik, opened by Schliemann in 1882. But the broader topography is recognizable in the modern plain of the Menderes. The old bed of that river is the Scamander, and its little tributary, the Dumbrek Su, is the Simois. In their fork lies Hissarlik or Troy. In sight of it are, on the one side, the peak of Samothrace (Il xiii 11–14); on the other Mt. Ida (Kaz Dagh: viii. 52). Hissarlik lies in the plain (xx. 216), easily reached by foes from the shore, or left and regained in a night by a Trojan visiting the Achaean camp (vii. 381–421).

Archaeological Investigation of Troy.—Schliemann's excavations at Hissarlik in 1872–74, supplemented and confirmed by W. Dörpfeld in 1891–94, established the existence of nine superposed settlements, as follows:—

1. On the virgin soil of the natural hillock a small village of the late Aegean Neolithic period, at the dawn of the Bronze age, contemporary with the upper part of the Cnossian Neolithic bed, includes what were supposed by Schliemann to be two primitive settlements. Thin walls of rough stones, bonded with

mud, reveal no house-plans, nor traces of fortress wall. Implements in obsidian and various kinds of stone, clay whorls, a little worked ivory, accompany dark monochrome pottery, hand-polished, with simple geometric decoration, incised and often filled with white

2. Superposed and comprehending a larger area, lies the "second city," better constructed and preserved, and twice rebuilt. Its massive fortress wall of rudely squared "Cyclopean" masonry suffered several restorations and eventual destruction, except on the south Double gates at south-east and south-west are well-preserved. The most complete and most important structures within are a *megaron* and vestibule of the type familiar in "Mycenaean" palaces, with one or more smaller replicas alongside it, like the "women's quarters" at Tiryns (*q v.*) and Phylakopi (*See* AEGEAN CIVILIZATION) This is the fortress proclaimed by Schliemann in 1873 to be the "Pergamos" of Troy, mainly because it perished by fire But this second stratum belongs to a primitive stage of local civilization preceding the "Mycenaean," which is the earliest recalled by the Homeric poems The pottery now shows the first rare use of paint, and of technique and fantastic forms parallel to those of the pre-Mycenaean Cyclades Trough-spouted vases are characteristic, and rude reproductions of human features are common in this ware, which seems all native. Bronze had come into use for implements, weapons and vessels; a hoarded treasure found in the ruins of the fortification wall includes much gold and silver But the forms are primitive and the workmanship very rude Personal ornaments are cut out of thin plate gold or built of coiled wire But some of the discs, bracelets and pendants, with advanced spiral ornament, found in 1878 and ascribed to this stratum, belong undoubtedly to the sixth or "Mycenaean." Rough fiddle-shaped idols, whorls, a little worked ivory and some lead make up a find, of whose early period (probably about 2000 B C) comparison of objects found elsewhere leaves no doubt This treasure is now deposited in Berlin with the bulk of Schliemann's collection

3, 4, 5 After the burning of the "second city," Hissarlik ceased for a time to have any considerable population. Three small village settlements have left their traces superposed and show only slight advances of material culture

6 The mound, however, occupied too important a site, in relation to the plain and the sea, to remain desolate, and it was occupied in the 14th or 13th century by a great fortress, while a city not yet explored, spread below This "sixth city" was first distinguished clearly by Dörpfeld in 1882, but Schliemann's drastic methods confused its commoner pottery and metal objects with those of lower strata; and some grey ware, to which Schliemann gave the name "Lydian" was alone referred to this sixth or "Lydian" city, in his *Troja* (1884) This ware has been compared with the "Minyan" fabric at Orchomenus, but also resembles the "Lausitz" pottery, which originated on the middle Danube, and was intruded into Macedonia at the close of the 12th century For years this "sixth city" was neglected.

In 1893, however, excavations in hitherto undisturbed ground outside the earlier fortress, exposed a wall of massive ashlar masonry resembling the fortifications of Mycenae itself, and "Mycenaean" walls at Phylakopi in Melos. With this wall occurred not only the grey ware, but painted potsherds unmistakably "Mycenaean"; and further search showed that such sherds were characteristic of "sixth city" deposits The inevitable inference is that this city imported contemporary "Mycenaean" ware to supplement its own ruder products. The area of its citadel is larger than the "second city," its buildings, which include a large *megaron*, are of finer construction. This was the most important city yet built on the mound It belonged to the "Mycenaean" age, which precedes the composition of the Homeric poems, and is reflected by them Therefore this is Homer's Troy.

Its remains, however, having been obliterated on the crown of Hissarlik, almost escaped recognition, for when, long afterwards, the Hellenistic Ilium was built, the top of the mound was cut away and the uppermost strata vanished. Thus we find them now on the southern slope of the mound only, but have no difficulty in estimating their original extent. Tombs and the outer quarters of this city will doubtless be found eventually.

7. The "sixth," or "Mycenaean" Troy, perished by violence like the "second city," but its inhabitants reoccupied its ruins, until, in early Hellenic times, the small unfortified settlement was established which maintained itself till the Homeric enthusiasm of Alexander the Great called a city again into being on Hissarlik

8 The Hellenistic Ilium, however, has left comparatively little trace; fortifications erected by Lysimachus are visible on the acropolis and in the plain A small Doric temple belongs to this city, and a larger one, probably dedicated to Athena, seems to be of Pergamene age Fragments remain of its metopes, representing Helios and a Gigantomachia Coins of this city show Athena on both faces, and inscriptions prove that Hellenistic Ilium was of some importance

9 Lastly, about the Christian era, the Graeco-Roman city built a theatre and an ornate gateway on the south-east slope, a large building on the south-west and others to north-east. This city seems to have decayed in the 5th century A D.

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The Legend of Troy.—In Greek legend, the oldest town in the Troad was that founded by Teucer, who was a son of the Scamander (a Cretan stream, according to Tzetzes) and the nymph Idaea. In his reign, Dardanus, son of Zeus and the nymph Electra, daughter of Atlas, in consequence of a deluge, drifted from Samothrace to the Troad, where he received land from Teucer, married his daughter Batea, and founded Dardania, at the foot of Mt Ida On the death of Teucer, Dardanus succeeded him, and called the whole land Dardania. He begat Erichthonius, who begat Tros by Astyoche, daughter of Simois. Tros called the country Troy and the people Troes (Trojans). By Callirrhoe, daughter of Scamander, Tros had three sons—Ilus, Assaracus and Ganymede From Ilus and Assaracus sprang two separate lines; Ilus, Laomedon, Priam, Hector; and Assaracus, Capys, Anchises, Aeneas. Ilus went to Phrygia, where he received, as a wrestling prize from the king of Phrygia, a spotted cow, with an injunction to found a city where she lay down The cow lay down on the hill of the Phrygian Atē; here Ilus founded Ilion; and Dardania, Troy and Ilion became one city. Desiring a sign from Zeus, Ilus prayed and found lying before his tent the Palladium, a wooden statue of Pallas, for which he built a temple. By Eurydice, daughter of Adrastus, he had a son, Laomedon, who married Strymo, daughter of Scamander (or Placia, daughter of Atreus or of Leucippus) In his reign, Poseidon and Apollo (or Poseidon alone), built the walls of Troy, but Laomedon withheld their reward. In his reign also, Heracles besieged and took the city, slaying Laomedon and his children, except one daughter, Hesione, and one son, Podarces. The life of Podarces was granted at the request of Hesione, on condition that Podarces first be a slave and then be redeemed by Hesione; she gave her veil for him; hence his name of Priam (Gr πριάσθαι, to buy). Priam married first Arisbe and afterwards Hecuba, and had 50 sons and 12 daughters. Among the sons were Hector and Paris, and among the daughters Polyxena and Cassandra. Paris, betrothed to Oenone, awarded the golden "apple of strife" to Aphrodite (who promised him the love of the fairest of women) and brought upon Troy the resentment of Hera and Athena Thereafter, Paris, visiting Sparta, found favour with Helen, heiress of

Tyndareus and wife of Menelaus, son of Atreus, and carried her to Troy To recover Helen, the Achaeans under Agamemnon, brother of Menelaus, besieged Troy for ten years In the tenth year Hector was killed by Achilles, and he by Paris At last a wooden horse was contrived in whose hollow many Achaean heroes hid themselves Their army and fleet then withdrew to Tenedos, feigning to have raised the siege The Trojans conveyed the wooden horse into Troy; in the night the Greeks stole out, opened the gates to their friends, and Troy was taken. *See* also HOMERIC POEMS.

See Homer, *Il.* vii. 452 *seq*, xx 215 *seq*, xxi 446 *seq*; Apollodorus ii. 6, 4, iii 12; Diodorus iv. 75, v. 48, Tzetzes, *Schol on Lycophron*, 29, 72, 1302; Conon, *Narrat* 21, Dionysius Halicarn, *Antiq Rom* i 68 *seq*. The *Iliad* deals with a period of 51 days in the tenth year of the war the *Odyssey* with the wanderings and homecoming of an Achaean leader, Odysseus For the wooden horse *see* Homer, *Od.* iv. 271 *seq.*; Virgil, *Aen* ii. 13 *seq*.

The Historical Background of the Trojan War.—The "Tale of Troy," with legends of heroes who "fought in the war," was popular already when the *Odyssey* (*see* HOMER) was composed, wherein, besides other allusions, minstrels sing lays about it, and the Sirens boast that they "know it all." From the 7th century B C., at least, it supplied subjects to vase painters and other craftsmen, and in the 5th, to the sculptors of the Aegina pediments (*see* GREEK SCULPTURE), and to Athenian dramatists. (*See* DRAMA *Greek*) Herodotus and Thucydides, like ancient writers generally, accepted the Trojan war as historical, though they criticized epic statements in detail, and Herodotus noted discrepancy between the *Cypria* and the *Iliad* Ephorus, and afterwards Strabo, marshalled geographical learning as commentary on the Achaean and Trojan "catalogues" in *Il.* ii; the scholars of Alexandria elucidated Homeric antiquities, those of Pergamum their topographical and historical background; Demetrius of Scepsis in the Troad, misdoubted, on geological grounds, the reputed site of Troy. Traditional genealogies, collated by Hecataeus (*q v*) and others, enabled Eratosthenes (*q v*) to date the "Fall of Troy" to 1194 B C., in the third generation before the "coming of the Dorians" and in the second after Laomedon's foundation Homeric references to Egypt (where Thebes, not Memphis, is the capital) and to Phoenicia (where Sidon is known, but not Tyre) supply a historical background for the war, not later than the 12th century; but the names of Egyptian kings (*Thôs, Thuôris*) in epic and classical tradition, are not identified. Pliny (36 64) alludes to a Rameses "in whose time Troy fell." Egyptian references, however, to repeated sea-raids into the Levant, between 1230 and 1190 B.C, depict a situation closely resembling Homeric descriptions; and the *Aquaiusha* (*Akhaywasha*), *Danauna, Tikkara* (*Tzakarai*) and probably other participants in these raids may be safely recognized as Achaeans, Danaans, and Teucrians in Greek tradition Hittite documents confirm the existence of an oversea régime called Akkhayawa, aggressive against south-west Asia Minor, one of whose leaders, Attarissyas, active in Caria and north Syria about 1230, was a contemporary, if not namesake, of Atreus, father of Agamemnon. Consequently, 19th century doubts as to the historical content of epic tradition, and attempts to discover "solar" and other mythological allegories in the personages and events of the war, are being superseded by recognition of a social and political régime historically assignable to the 13–12th centuries, of which the following are turning-points: (1) The establishment of the Trojans, with other Thraco-Phrygian peoples, in north-west Asia Minor before 1260 B.C. fully justifying the defensive alliance between the Hittite king and Rameses II. in 1271 B.C. (2) The consolidation of a dominion, of which the "sixth city" at Hissarlik was an important centre, the geographical range of Priam's vassals, from the Axius river to the Xanthus, and the memory of a great fight "on the Sangarius river" far inland, are instructive. (3) The overthrow of Hittite dominion by this new régime, about 1200 B C, followed by the land-and-sea-raids of 1197–94 as far as south Palestine, where they were stopped by Rameses III. (4) The counterparts, west of the Aegean, of the dynasty Laomedon-Priam-Hector, are the "divine born" kingships (Pelops-Atreus-Agamemnon, Aeacus-Peleus-Achilles, and the like) established by adventurers of unknown antecedents, and foreign names, from Ithaca and Aetolia to Crete and Rhodes, and as far north as Thessaly; their distribution closely covering that of the "Late Mycenaean" settlements, which are surely dated archaeologically to these generations, in Egypt, Cyprus and Palestine. (5) Whether the destruction of the "sixth city" resulted from an attack of this "Achaean" confederacy of the south-west Aegean on the Hellespontine citadel of its Thraco-Phrygian cousins, or directly from those Danubian representatives of the "Lausitz" culture which characterizes the "seventh city," and is recognizable as a disturbing factor in Macedonia also, later in the 12th century, cannot at present be determined; nor the value of the synchronism between the attack on Troy and the great sea-and-land-raids towards Egypt, of which the tale of Tithonus and Memnon may preserve echoes. (6) Traditions of the establishment of settlements, eventually Greek, round the margins of the Late Mycenaean world, are so numerous, and coherent both with Homeric and with archaeological evidence, that they may be accepted as an essentially historical counterpart of the situation described in the *Odyssey;* which, however, was transformed as profoundly by the "coming of the Dorians" as the Mycenaean world had been by the irruption of the "divine born" adventurers five generations before Between those two crises lies the "Heroic Age" of the Aegean, of its central episodes one is the struggle between Argos and Thebes, ended by the tragic fall of the Cadmeian dynasty, the other is the Trojan war, as disastrous to the victors as to the conquered (J L MY)

The Mediaeval Legend of Troy.—The mediaeval *Roman de Troie,* exercised greater influence in its day and for centuries after its appearance than any other work of the same class Just as the *chansons de geste* of the 10th century were the direct ancestors of the prose romances which afterwards spread throughout Europe, so, even before Heliodorus and Achilles Tatius, there were quasi-histories, which reproduced in prose, with more or less exactness, the narratives of epic poetry. The Ἡρωικός of Flavius Philostratus (*fl* 3rd century A D) is a discourse on 26 heroes of the war A fictitious journal (*Ephemeris*), professing to give the chief incidents of the siege, and said to have been written by Dictys of Crete, a follower of Idomeneus, is mentioned by Suidas, and was largely used by John Malalas and other Byzantine chroniclers This was abridged in Latin prose, probably in the 4th century, under the title of *Dictys Cretensis de bello Trojano libri VI* It is prefaced by an introductory letter from a certain L Septimius to Q. Aradius Rufinus, in which it is stated that the diary of Dictys had been found in his tomb at Knossos in Crete, written in the Greek language, but in Phoenician characters. The narrative begins with the rape of Helen, and includes the adventures of the Greek princes on the return voyage. With Dictys is always associated Dares, a pseudo-historian of more recent date Old Greek writers mention an account of the destruction of the city earlier than the Homeric poems, and in the time of Aelian (2nd century A D.) this *Iliad* of Dares, priest of Hephaestus at Troy, was believed to be still in existence. Nothing has since been heard of it; but an unknown Latin writer, living between 400 and 600, took advantage of the tradition to compile *Daretis Phrygii de excidio Trojae historia,* which begins with the voyage of the Argo It is in prose and professes to be translated from an old Greek manuscript. Of the two works that of Dares is the later, and is inferior to Dictys. The matter-of-fact form of narration recalls the poem of Quintus Smyrnaeus In both compilations the gods and everything supernatural are suppressed; even the heroes are degraded The permanent success, however, of the two works distinguishes them among apocryphal writings, and through them the Troy legend was diffused throughout western Europe The Byzantine writers, from the 7th to the 12th century, exalted Dictys as a first-class authority, with whom Homer was only to be contrasted as an inventor of fables. Western people preferred Dares, because his history was shorter, and because, favouring the Trojans, he flattered the vanity of those who believed that people to have been their ancestors. Many mss. of both writers were contained in old libraries; and they were translated into nearly every language and turned into verse.

In the case of both works, scholars were long undecided whether a Greek original ever existed but fragments of the Greek text of Dictys have been recovered. (*See* DICTYS CRETENSIS) The Byzantine grammarian, Joannes Tzetzes (*fl.* 12th century), wrote a Greek hexameter poem *Iliaca* on the subject. In 1272, a monk of Corbie translated "sans rime *L'Estoire de Troiens et de Troie* (de Dares) du Latin en Roumans mot à mot" because the *Roman de Troie* was too long. Geoffrey of Waterford put Dares into French prose; and the British Museum has three Welsh mss. translations of the same author, of a much later period

For a thousand years the myth of descent from the dispersed heroes of the conquered Trojan race was a sacred literary tradition throughout western Europe. The first Franco-Latin chroniclers traced their history to the same origin as that of Rome, as told by the Latin poets of the Augustan era; and in the middle of the 7th century Fredegarius Scholasticus (*Rer. gall. script.* ii. 461) relates how one party of the Trojans settled between the Rhine, the Danube and the sea. In a charter of Dagobert occurs the statement, "ex nobilissimo et antiquo Trojanorum reliquiarum sanguine nati." This statement is repeated by chroniclers and panegyrical writers, who also considered the *History of Troy* by Dares to be the first of national books. Succeeding kings imitated their predecessors in giving official sanction to their legendary origin, Charles the Bald, in a charter, uses almost the same words as Dagobert, "ex praeclaro et antiquo trojanorum sanguine nati." In England a similar tradition had been early formulated, as appears from Nennius's *Historia Britonum* and Geoffrey of Monmouth The epic founder of Britain was Brutus, son, or in another tradition, great-grandson, of Aeneas, in any case of the royal house of Troy. The tradition, repeated in Wace's version of Geoffrey, by Matthew Paris and others, persisted to the time of Shakespeare Brutus found Albion uninhabited except by a few giants He founded his capital on the banks of the Thames, and called it New Troy. Otto Frisingensis (12th century) and other German chroniclers repeat similar myths About 1050 a monk named Bernard wrote *De excidio Trojae*, and in the middle of the 12th century Simon Chèvre d'Or, canon of the abbey of Saint-Victor, Paris, followed with another poem in leonine elegiacs on the fall of the city and the adventures of Aeneas, in which the Homeric and Virgilian records were blended.

About the year 1184 Benoît de Sainte-More (*q.v*) composed a poem of 30,000 lines entitled *Roman de Troie*. He derived his information chiefly from the pseudo-annals of Dictys and Dares, but we may justly consider the *Roman de Troie* as an original work From this source subsequent writers drew their notions of Troy, mostly without naming their authority and generally without even knowing his name. This is the masterpiece of the pseudo-classical cycle of romances. and in the Latin version of Guido delle Colonne it passed through every country of Europe.

The *De bello trojano* of Joseph of Exeter, in six books, a genuine poem of no little merit, was written soon after Benoît's work or about the years 1187–88. At first ascribed to Dares Phrygius and Cornelius Nepos, it was not published as Joseph's until 1620, at Frankfurt. It was directly drawn from the pseudo-annalists, but the influence of Benoît was considerable. Of the same kind was the *Troilus* of Albert of Stade (1249), a version of Dares, in verse, characterized by the old severity and affected realism. But these Latin works can only be associated indirectly with Benoît, who had closer imitators in Germany at an early period. Herbort of Fritzlar reproduced the French text in his *Lied von Troye* (early 13th century), as did also Konrad von Würzburg (d. 1287) in his *Buch von Troye* of 40,000 verses, which he himself compared to the "boundless ocean." It was completed by an anonymous poet. To the like source may be traced a poem of 30,000 verses on the same subject by Wolfram von Eschenbach; and Jacques van Maerlant reproduced Benoît's narrative in Flemish. The Norse or Icelandic *Trojumanna saga* repeats the tale with some variations.

In Italy, Guido delle Colonne, a Sicilian, began in 1270 and finished in 1287 a prose *Historia trojana*, in which he reproduced the *Roman de Troie* of Benoît, and so closely as to copy the errors of the latter. The vivacity and poetry of the Anglo-Norman trouvère disappear in a dry version. The immense popularity of Guido's work is shown by the large number of existing manuscripts In the 14th and the commencement of the 15th century four versions appeared in England and Scotland. The best known is the *Troy Book*, written between 1414 and 1420, of John Lydgate, who had both French and Latin texts before him An earlier and anonymous rendering exists at Oxford (Bodleian ms Laud Misc. 595) There is the *Gest Hystoriale of the Destruction of Troy* (Early Eng Text Soc, 1869–1874), written in a northern dialect about 1390, a Scottish version (15th century) by a certain Barbour, not the poet, John Barbour; and *The Seege of Troy*, a version of Dares (Harl ms 525 Brit Mus) The invention of printing gave fresh impetus to the spread of Guido's work. The first book printed in English was *The Recuyell of the Hystoryes of Troye*, a translation by Caxton from the French of Raoul Lefèvre

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TROYES, a town of France, capital of the department of Aube, 104 m. E S.E of Paris on the Eastern railway to Belfort Pop (1926) 55,897. The town stands in the wide alluvial plain watered by the Seine, the main stream of which skirts it on the east It is traversed by several small arms of the river, and the Canal de la Haute-Seine divides it into an upper town, on the left bank, and a lower town, on the right bank. The churches of the town are numerous, and especially rich in stained glass of the Renaissance period. St. Pierre, the cathedral, 13th to 16th centuries, consists of an apse with seven apse chapels, a choir with double aisles, on the right of which are the treasury and sacristy, a transept without aisles, a nave with double aisles and side chapels and a vestibule. There are stained glass windows of the 15th and 16th centuries The treasury contains some fine enamel work and lace The church of St Urban has windows dating for the most part, from the years 1265–80. Most of the old houses of Troyes are of wood, but some are of stone of the 16th century, notably the hôtels de Vauluisant, de Mauroy and de Marisy. The prefecture occupies the buildings of the old abbey of Notre-Dame-aux-Nonnains; the *hôtel-de-ville* dates from the 17th century

Troyes is the seat of a bishop and a court of assize. Its public institutions include a tribunal of first instance, a tribunal of commerce, a board of trade arbitrators and a chamber of commerce. It has a school of hosiery. The dominant industry in Troyes is the manufacture of cotton, woollen and silk hosiery, printing and dyeing of fabrics.

History.—At the beginning of the Roman period Troyes was the principal settlement of the Tricassi, from whom it derives its name. In the first half of the 4th century its bishopric was created as a suffragan of Sens. St Loup, the most illustrious bishop of Troyes, occupied the episcopal seat from 426 to 479 In the early middle ages the bishops were supreme in Troyes, but in the 10th century this supremacy was transferred to the counts of Troyes (*see* below), who from the 11th century were known as the counts of Champagne. Under their rule the city attained great prosperity Its fairs, which had already made it a prominent commercial centre, flourished under their patronage, while the canals constructed at their expense aided its industrial development. The union of Champagne with the domains of the king of France in 1304 was disastrous to the city, since one of the first measures of Louis le Hutin was to forbid the Flemish merchants to attend its fairs. For a short time (1419–25), during the Hundred Years' War, the town was the seat of the royal Government, and in 1420 the signing of the Treaty of Troyes was followed by the marriage of Henry V. of England with Catherine, daughter of Charles VI. in the church of St. Jean. In 1429 the town capitulated to Joan of Arc. The next 100 years was a period of prosperity, marred by the destruction of half the town by the fire of 1524. In the 16th

century Protestantism made some progress in Troyes, but in 1562, after a short occupation, the Calvinist troops were forced to retire, and in 1572 fifty Protestants were put to death. The revocation of the Edict of Nantes in 1685 was a severe blow to the commerce of Troyes, which was not revived by the re-establishment of the former fairs in 1697. The population fell from 40,000 to 24,000 between the beginning of the 16th century and that of the 19th century

See T Boutiot, *Histoire de Troyes et de la Champagne méridionale* (4 vols. Troyes, 1870–80), R. Koechlin and J. J. Marquet de Vasselot, *La Sculpture à Troyes et dans la Champagne méridionale au seizième siècle* (1900).

TROYON, CONSTANT (1810–1865), French painter, was born on Aug. 28, 1810, at Sèvres, near Paris, where his father was connected with the porcelain factory Troyon was an animal painter of the first rank, and was closely associated with the artists who painted around Barbizon Until he was twenty he laboured assiduously at the minute details of porcelain ornamentation. By the time he reached twenty-one he was travelling the country as an artist, and painting landscapes. Troyon was a favourite with Roqueplan, and became one of his pupils Roqueplan introduced Troyon to Rousseau, Jules Dupré, and the other Barbizon painters In 1846 Troyon went to the Hague, and saw Paul Potter's famous "Young Bull" From the studies he made of this picture, of Cuyp's sunny landscapes, and Rembrandt's masterpieces he evolved a new method of painting, and it is only in works produced after this time that Troyon's true individuality is revealed. Troyon died at Paris on Feb 21, 1865. All his famous pictures are of date between 1850 and 1864. In the Wallace Gallery in London are "Watering Cattle" and "Cattle in Stormy Weather"; in the Glasgow Corporation Gallery is a "Landscape with Cattle", the Louvre contains his famous "Oxen at Work" and "Returning to the Farm", while the Metropolitan Museum of Art and other galleries in America, contain fine examples. His "Vallée de la Toucque, Normandy," is one of his greatest pictures. Émile van Marcke (1827–1891) was his best-known pupil

See H Dumesnil, *Constant Troyon: Souvenirs intimes* (Paris, 1888); A Huntin, *"Troyon"* (1893), D. C. Thomson, *The Barbizon School of Painters* (London, 1890), W Gensel, *Corot und Troyon* (Leipzig, 1906)

TRÜBNER, WILHELM (1851–1917), German painter, was born at Heidelberg on Feb. 3, 1851. He studied at Karlsruhe, Stuttgart and afterwards with Diez at Munich, where he came under the influence of Leibl and the impressionist group He did not, however, join this or any other group, but went his own independent way, although he too aimed at achieving the effect of light and air in his painting, and worked with broad strokes of the brush For some years he made Munich his home. In 1896 he settled in Frankfurt and in 1903 was made professor at the Karlsruhe academy He died at Karlsruhe on Dec. 21, 1917 Trübner's colour was always warm and rich, but from the Frankfurt period onward he adopted a more restricted scheme and relied on strong contrasts in place of the tender intermediate tones of his earlier days He had an admirable sense of values and his landscapes are sometimes built up almost in the manner of Cézanne His portraits were also particularly successful.

His landscapes include the series of Heidelberg landscapes (1889) with the "View from the Castle" (Darmstadt); those painted at Chiamsee, and the later series at Amorbach and the Neuburg (1913). Among his portraits are those of the artist Schuch (Berlin), of his son in armour, and of the "Boy with Mastiff" (Dusseldorf)

See Fritz Knapp, *Kunstlerische Kultur des Abendlandes* III, pp. 330 *et seq.*

TRUCE OF GOD, an attempt of the Church in the middle ages to alleviate the evils of private warfare. The two measures which were adopted by the Church to remedy this evil—the *pax ecclesiae* or *Dei* and the *treuga* or *treva Dei*—are usually both referred to as the Truce of God, but they are distinct in character. The latter was a development of the former.

The *pax ecclesiae* is first heard of in the year 990 at three synods held in different parts of southern and central France—at Charroux, Narbonne and Puy. It enlisted the immediate support of the regular clergy, particularly the vigorous congregation of Cluny, and of William V. of Aquitaine, the most powerful lord of southern France, who urged its adoption at the councils of Limoges (994) and Poitiers (999). The peace decrees of these various synods differed considerably in detail, but in general they forbade, under pain of excommunication, every act of private warfare or violence against ecclesiastical buildings and their environs, and against certain persons, such as clerics, pilgrims, merchants, women and peasants, and against cattle and agricultural implements With the opening of the 11th century, the *pax ecclesiae* spread over northern France and Burgundy, and diocesan leagues began to be organized for its maintenance. The bishop, or count, on whose lands the peace was violated was vested with judicial power, and was directed, in case he was himself unable to execute sentence, to summon to his assistance the laymen and even the clerics of the diocese, all of whom were required to take a solemn oath to observe and enforce the peace. At the council of Bourges (1038), the archbishop decreed that every Christian 15 years and over should take such an oath and enter the diocesan militia The idea that peace is a divine institution seems to have given rise to a new name for the peace, the *pax Dei,* or peace of God.

The *treuga* or *treva Dei,* the prohibition of every act of private warfare during certain days, goes back at least to the Synod of Elne (1027) which suspended all warfare from noon on Saturday till prime on Monday. Like the *pax ecclesiae* it found ardent champions in the regular clergy, especially in Odilo (962–1049), the fifth abbot of Cluny, and soon spread over all France It penetrated Piedmont and Lombardy in 1041 and Normandy in 1042. By this time the truce extended from the Wednesday evening to the Monday morning in every week and also, in most places, lasted during the seasons of Lent and Advent, the three great vigils and feasts of the Blessed Virgin, and those of the 12 apostles and a few other saints The *treuga Dei* was decreed for Flanders at the Synod of Thérouanne (1063) and was instituted in southern Italy in 1089, probably through Norman influence. The bishop of Liège introduced it in Germany in 1082, and three years later a synod held at Mainz in the presence of the emperor Henry IV extended it to the whole empire. It did not extend to England, where the strength of the monarchy made it unnecessary. The popes took its direction into their own hands towards the end of the 11th century, and the first decree of the Council of Clermont (1095), at which Urban II preached the first crusade, proclaimed a weekly truce for all Christendom, adding a guarantee of safety to all who might take refuge at a wayside cross or at the plough The Truce of God was reaffirmed by many councils, such as that held at Reims by Calixtus II in 1119, and the Lateran councils of 1123, 1139 and 1179 When the *treuga Dei* reached its most extended form, scarcely one-fourth of the year remained for fighting, and even then the older canons relating to the *pax ecclesiae* remained in force The means employed for its enforcement remained practically the same: spiritual penalties, such as excommunication, special ecclesiastical tribunals, sworn leagues of peace, and assistance from the temporal power. The Council of Clermont prescribed that the oath of adherence to the truce be taken every three years by all men above the age of 12, whether noble, burgess, villein or serf. The results of these peace efforts were perhaps surprisingly mediocre, but it must be borne in mind that not only was the military organization of the dioceses always very imperfect, but Continental feudalism, so long as it retained political power, was inherently hostile to the principle and practice of private peace. The Truce of God was most powerful in the 12th century, but with the 13th its influence waned as the kings gradually gained control over the nobles and substituted the king's peace for that of the Church.

See Du Cange, *Glossarium, s.v. Treuga;* A. Kluckhohn, *Geschichte des Gottesfriedens* (Leipzig, 1857); J. Fehr, *Der Gottesfriede und die katholische Kirche des Mittelalters* (Augsburg, 1861); E. Sémichon, *La Paix et la trève de Dieu* (2nd ed. 1869); L. Huberti, *Studien zur Rechtsgeschichte des Gottesfrieden und Landfrieden,* Bd. i. *Die Friedens-Ordnungen in Frankreich* (Ansbach, 1892); E. Mayer, *Deutsche und französische Verfassungsgeschichte* (1899), vol. i.; A. Luchaire, "La Paix et la trève de Dieu," in E. Lavisse's *Histoire de France,* II 2, pp. 133–138 (1901) (C. H. H.)

TRUCK SYSTEM. The payment of the wages of workmen *in kind,* or in any other way than the unconditional payment of money, a practice known as the "truck system." Sometimes the workman was paid with "portion of that which he has helped to produce," but the more usual form was to give the workman the whole or part of his wages in the shape of commodities suited to his needs. There was also a practice of paying in money, but with an express or tacit understanding that the workman should resort for such goods as he required to shops or stores kept by his employer. The truck system led in many cases to grave abuses and was made illegal in Great Britain by the Truck Acts, under which wages must be paid in current coin of the realm, without any stipulations as to the manner in which the same shall be expended. (*See* LABOUR LEGISLATION.)

TRUFFLE, the name of several kinds of subterranean fungi of the family Ascomycetes. (*See* FUNGI.) Truffles have been famous for their esculent qualities from classical times. Several were recognized by the ancient Greeks and Romans; Theophrastus (*c.* 300 B C.) gives one of them a name which apparently refers to a common belief that truffles were produced by thunder. Pliny thought that they were amongst the most wonderful of all things in springing up and living without a root. There are numerous references to truffles in classical writings and Coelius Apicius gives six recipes for cooking them.

The subterranean Ascomycetes are usually placed in two main groups, the Tuberales and the Plectascales, depending upon the possession of fruit-bodies with or without an opening to the exterior during development The suggestion is that these have arisen along parallel lines A point of interest is that we also have subterranean forms of similar external appearance in Phycomycetes and Basidiomycetes

The best-known genus of the Tuberales is *Tuber,* which is mainly native to temperate regions. The different species range in size from that of a pea to that of an orange. A section of a young specimen shows a whitish homogeneous flesh which, as maturity is approached, becomes a rich dark colour showing a lighter "marbling." Microscopical examination reveals that the trama plates bearing the hymenium are thrown into elaborate folds (*venae internae*) whereas other plates of tissue which are light-coloured, sterile and joined either directly or indirectly to the exterior run between them (*venae externae*). This complicated arrangement is reached by a series of advances which may be traced in the allied genera. The spores of *Tuber* are large and are usually not more than four in an ascus; in the same fruit-body a range from one to four may usually be seen. These were the first ascospores to be observed, Tournefort described them in 1710–11 and Micheli figured them in 1729 It was a common belief that they became truffles merely by enlargement, though fermentation of the earth, exudations of branches and leaves, excretion of roots, gall production by insects were frequently regarded as reasonable explanations of their formation Truffles principally occur in open woodland on calcareous soil, being rare in or absent from sandy soil and pastures. They are usually associated with the roots of trees and are possibly mycorrhizal fungi.

The most valued truffle in French cookery is the Périgord truffle (*T. melanosporum*) which is said to have first gained favour towards the end of the 15th century. It is brownish black, roundish and covered with polygonal warts having a depression at their summit; the flesh (*gleba*) is first white, then brownish grey, and when mature becomes violaceous black, with white veins having a brown margin. The odour is well-marked and not unpleasant. The main French truffières are in Périgord and the Department of Vaucluse, though truffles are gathered throughout a large part of France. The truffle industry is an important one and about one-third of the gatherings are now exported; foreign trade began seriously about a century ago and before the World War reached to as much as £3,000,000 annually. As the truffles often occur at the depth of a foot it is difficult to detect them unaided. Truffles, when occurring near the surface of the ground, crack it as they reach full size and experienced gatherers are thereby enabled to locate them. Further, many species of fly live on truffles and in the morning and evening columns of small yellow flies (*Helomiza lineata,* etc.) may be seen hovering over the place where truffles are present.

Occasionally man is sufficiently "susceptible" to the scent of truffles to be able to locate them. Several kinds of animals, however, recognize the scent without difficulty. Truffle hunting is therefore carried on with their aid; pigs and dogs being generally used, though goats are said to be so trained in Sardinia

The truffle industry has proved so profitable in France that the government has taken in hand the reforesting of many large and barren areas, for many of the best truffle regions have become productive by the private planting of the appropriate trees. These are oaks (*Quercus coccifera, Q. Ilex* with admixture of *Q robur, Q. sessiliflora* and hazel); "si voulez des truffes, semez des glands" is an adage which has been handed on for generations Direct attempts at cultivation have so far proved unsatisfactory Calcareous ground is dug over and acorns or seedlings planted. Soil from truffle areas is usually spread about and the ground is kept in condition by light ploughing and harrowing. After three years clearings are made and the trees are pruned. Truffles if they are to appear do so only after five years or so; gathering begins then but it hardly pays until after from eight to ten years. The yield is at its maximum from five to twenty-five years later. *Tuber melanosporum* has not been recorded for England.

The English truffle is *T aestivum* which is found principally in beech woods It is bluish black, roundish and covered with coarse polygonal warts, the gleba is white when immature, then ochraceous and finally brownish with whitish, branched, labyrinthine markings It was formerly hunted on the south downs by the aid of mongrel terriers and was sold in Covent Garden (J. RM)

TRUJILLO or **TRUXILLO,** a seaport on the Atlantic coast of Honduras, in 15° 54′ N. and 86° 5′ W. Pop. (1925) about 2,000 The harbour, an inlet of the Bay of Honduras, is sheltered on the north by the promontory of Cape Honduras, it is deep and spacious, but insecure in westerly winds. Mahogany, dyewoods, sarsaparilla, cattle, hides and fruit are exported; grain, flour, hardware and rum are imported Trujillo was founded in 1524, and became one of the most prosperous ports of the new world, and the headquarters of a Spanish naval squadron During the 17th century it was frequently and successfully raided by buccaneers, and thus lost much of its commerce, which still more, in modern times, has been diverted to Puerto Cortés and to Puerto Castilla, across the bay

TRUJILLO, the capital and prefectural seat of the Department of La Libertad, in Peru, lies in lat 8° 7′ S and long 79° 9′ W, some 300 miles up the coast and north of Lima, the capital It is the second city in Peru in point of age, having been founded by Pizarro and his followers in the year 1537, and the third city in point of population, having approximately 40,000 inhabitants and only exceeded by Lima and Arequipa. It is 8 m by rail from Salaverry, its port on the Pacific ocean, and 4 m. from the coast at its nearest point

Trujillo serves the important mining region of Quiruvilca (copper) and Milluachaqui (gold and silver) which is now being exploited by the Northern Peru Mining and Smelting Company, a subsidiary of the American Smelting and Refining Company of New York, and growing quantities of bar-copper, gold and silver ores, concentrates and precipitates are being shipped It also serves two agricultural districts, that of the Valley of the River Moche and of the Valley of the Chicama, the last named being probably the most important sugar-cane growing district of Peru Much of the traffic that formerly passed through Trujillo from the Chicama valley is now being diverted to the port of Malabrigo or, as it is now called, Puerto Chicama

Though lying in the tropics, geographically, the climate is distinctly temperate due to the Humbolt current that sweeps up the west coast of South America from the Antarctic ocean to Punta Pariña, Peru, where it flows out to sea, the average temperature of this current being about 60° F An extended observation of meteorological conditions at Trujillo shows a maximum temperature of 85° F and a minimum of 55°, the mean variation between diurnal and nocturnal extremes being 10 degrees The

region is practically rainless and agriculture is carried on by irrigation from rains high up in the Andes which closely hug the coastline. Light rains occur at cycles of seven years and of greater importance at cycles of 31 years. One such period occurred in March 1925, when, between March 7 and the end of that month 15 5 in of rain fell, ten times more than the total rainfall for the seven year period 1918–24 inclusive These rains caused great damage to Trujillo and neighbouring towns and many houses were demolished and many people left homeless in a country where no provision for protection against rain exists.

Trujillo is served by a narrow-gauge railway line that connects it with its port—Salaverry—with a branch to Menocucho in the Moche valley, and a line to Ascope in the Chicama valley The city is the centre of a very rich and exceedingly interesting region from an anthropological and archaeological point of view, the ruined and deserted pre-Inca city, Chan-Chan, the capital of a civilization known variously as the Chimu, Mochica or Yunga, lies close by, and the Chicama valley, the lower Moche valley and the Valley of the River Viru are rich in remains of civilizations believed even to antedate that of the Yungas. Trujillo is approximately 22 hr by steamer from Callao, the port for Lima (O. Ho)

TRUJILLO, a town of Spain, in the province of Cáceres; on a hill 25 m east of Cáceres, and on the Tozo river, a subtributary of the Tagus Pop (1920), 11,476 Trujillo was a town of importance in the middle ages Pizarro, the conqueror of Peru, was born here about 1471, and his palace still stands In the oldest part of Trujillo are the remains of a castle said to be of Roman origin The Julia tower is also said to be Roman The Roman name for the town was Turgalium

TRUMAIAN, a small group of tribes of South American Indians, constituting an independent linguistic stock The Trumai live on the headwaters of the Xingu river in the State of Matto Grosso, Brazil

See K von den Steinen, *Durch Zentral Brasilien* (Leipzig, 1886) and *Unter den Naturvolkern Zentral Brasilien* (Berlin, 1894)

TRUMBIĆ, ANTE (1863–), Yugoslav statesman, was born at Split He became successively mayor of Split, and deputy for the city in the Dalmatian Diet, and after 1907 deputy in the Austrian Parliament. In 1905 he and his fellow Dalmatians, Pero Čingrija, Smodlaka and Supilo, as delegates of the Croat National party, worked for the renewed co-operation between Serb and Croat, which culminated in the resolutions of Fiume and Zara in 1905, and in the parallel negotiations with the Magyar coalition parties The programme of reform in Croatia, which was the basis of the agreement with Hungary, was soon frustrated by the intransigent attitude of the Wekerle Government. The Dalmatian Croats, notably Trumbić and Supilo, consistently endeavoured to improve their relations with the Italians and to combat the constant efforts of Vienna to set the two races at variance

On the eve of the World War Trumbić crossed the frontier to Venice, where he was joined by Supilo and several other Croat and Serb leaders The first winter of the war he spent in Rome, hoping to win Italian official support But Sonnino's anti-Slav policy and the secret agreement concluded between Italy and the Entente at the expense of the Yugoslavs in the spring of 1915, forced him to transfer his centre of operations to France and England The Yugoslav committee, of which Trumbić was president, was formally constituted in May 1915 in London. In the summer of 1917 he and others negotiated with the exiled Serbian government in Corfu and representatives of all the Serbian parties, the so-called "Declaration of Corfu," which provided the basis for a united Yugoslav State. Trumbić met representative Italians in Dec 1917 and March 1918, and shared in the arrangements for the congress of oppressed nationalities, held in Rome in April In Oct 1918 Trumbić was appointed foreign minister in the Yugoslav provisional government and peace delegate in conjunction with Pašic and Vesnić. He was unable to win support for Yugoslav claims from the Entente, which considered itself still bound to Italy by the secret Treaty of London. The Yugoslavs were obliged to come to a direct agreement with Italy, and the Treaty of Rapallo was signed in Nov. 1920.

Trumbić's long absence in Paris, coupled with the policy of abstention pursued by the Croat Peasant party under Radić, placed him at a fatal disadvantage when the question of the new constitution came up in 1921. Trumbić voted in the minority and thereafter drifted steadily into stronger opposition to the new régime in Yugoslavia. His group formed part of the coalition "bloc" which was in power from July to Oct. 1924, and for a time he effected a working alliance with Radić and committed himself to federalism and even republicanism The sudden *volte face* of Radić after the elections of 1925 left Trumbić somewhat isolated, as the leader of the newly constituted "Croat Federalist Peasant party."

TRUMBULL, JOHN (1750–1831), American poet, was born in what is now Watertown, Conn, where his father was a Congregational preacher, on April 24, 1750 At the age of seven he passed his entrance examinations at Yale, but did not enter until 1763; he graduated in 1767, remained at the college studying, and in 1771–73 was a tutor He spent a year in Boston in the office of John Adams, and after 1774 practised law in Connecticut He was State's Attorney in 1789, a member of the Connecticut assembly in 1792 and 1800, a judge of the superior court in 1801–19, and finally a judge in the supreme court of errors The last six years of his life were spent in Detroit, Mich, where he died on May 10, 1831. While studying at Yale he had contributed in 1769–70 ten essays, called "The Meddler," imitating *The Spectator*, to the *Boston Chronicle*, and in 1770 similar essays, signed "The Correspondent" to the *Connecticut Journal* and *New Haven Post Boy* While a tutor he wrote his first satire in verse, *The Progress of Dulness* (1772–73), an attack in three poems on educational methods of his time His great poem, which ranks him with Philip Freneau and Francis Hopkinson as an American political satirist of the period of the Revolutionary War, was *M'Fingal*, of which the first canto, "The Town Meeting," appeared in 1776 (dated 1775) This canto, about 1,500 lines, contains some verses from "Gage's Proclamation," published in the *Connecticut Courant* for Aug 1775, it portrays a Scotch Loyalist, M'Fingal, and his Whig opponent, Honorius, apparently a portrait of John Adams This first canto was divided into two, and with a third and a fourth canto was published in 1782 After the war Trumbull was a rigid Federalist, and with the "Hartford Wits," David Humphreys, Joel Barlow and Lemuel Hopkins, wrote the *Anarchiad*, a poem directed against the enemies of a firm central government

See the memoir in the Hartford edition of Trumbull's *Poetical Works* (1820); J H. Trumbull, *The Origin of "McFingal"* (Morrisania, New York, 1868); and the estimate in M C Tyler's *Literary History of the American Revolution* (New York, 1897)

TRUMBULL, JOHN (1756–1843), American artist, was born at Lebanon (Conn), on June 6, 1756, the son of Jonathan Trumbull (1710–1785), governor of Connecticut He graduated at Harvard in 1773, served in the War of Independence, rendering a particular service at Boston by sketching plans of the British works, and was appointed second aide-de-camp to Gen Washington and in June 1776, deputy adjutant general to Gen. Gates, but resigned from the army in 1777. In 1780 he went to London to study under Benjamin West, but his work had hardly begun when the news of the arrest and execution of Major André, who was deputy adjutant general in the English army, suggested the arrest of Trumbull as having been an officer of similar rank in the Continental army; he was imprisoned for seven months. In 1784 he was again in London working under West, in whose studio he painted his "Battle of Bunker Hill" and "Death of Montgomery," both of which are in the Yale School of Fine Arts.

In 1785 Trumbull went to Paris, where he made portrait sketches of French officers for "The Surrender of Cornwallis," and began, with the assistance of Jefferson, "The Signing of the Declaration of Independence," well-known from the engraving by Asher B. Durand. These paintings, with "The Surrender of

Burgoyne" and "The Resignation of Washington," were bought by the United States Government and placed in the Capitol at Washington. Trumbull's "Sortie from Gibraltar" (1787), owned by the Boston Athenaeum, is now in the Boston Museum of Fine Arts, and a series of historical paintings, the "Trumbull Gallery," by far the largest single collection of his works (more than 50 pictures), has been in the possession of Yale college since 1831, when Trumbull received from the college an annuity of $1,000

His portraits include full lengths of Gen Washington (1790) and George Clinton (1791), in the City Hall of New York—where there are also full lengths of Hamilton and of Jay; and portraits of John Adams (1797), Jonathan Trumbull, and Rufus King (1800); of Timothy Dwight and Stephen Van Rensselaer, both at Yale; of Alexander Hamilton (in the Metropolitan Museum of Art, New York city, and in the Boston Museum of Fine Arts, both taken from Ceracchi's bust); a portrait of himself painted in 1833; a full length of Washington, at Charleston, South Carolina; a full length of Washington in military costume (1792), now at Yale; and portraits of President and Mrs Washington (1794), in the National Museum at Washington Trumbull's own portrait was painted by Stuart and by many others.

He died in New York on Nov 10, 1843

See his *Autobiography* (1841); J F Weir, *John Trumbull, A brief Sketch of His Life, to which is added a Catalogue of his Works* (1901). and John Durand, "John Trumbull," *American Art Review*, vol ii, pt. 2, pp 181–191 (Boston, 1881).

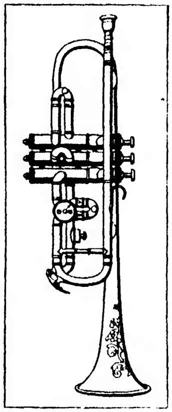
TRUMBULL, JONATHAN (1710–1785), American political leader, was born at Lebanon (Conn), on Oct 12, 1710 He graduated at Harvard in 1727, and began the study of theology, but in 1731 engaged in business with his father He next studied law, was elected to the assembly in 1773, and held public office almost continuously afterward He served for seven years in the assembly, being speaker for three years; for 17 years as county judge of Windham county, for 22 years (after 1740) as governor's assistant, for two years as deputy-governor (1767–69), and for three years (1766–69) as chief justice of the colony In 1769 he was elected governor and continued in office until his voluntary retirement in 1784. During the War of Independence he was a valued counsellor of Washington The story that the term "Brother Jonathan," a sobriquet for the United States, originated in Washington's familiar form of addressing him seems to be without any foundation. After the war Trumbull was a strong Federalist He died in Lebanon on Aug 17, 1785

His public papers have been printed in the Massachusetts Historical Society's *Collections*, 5th series, vols ix., x (Boston, 1885–88), and 7th series, vols. ii, iii. (1902). *See* I. W. Stuart, *Life of Jonathan Trumbull, sen* (Boston, 1859).

TRUMPER, VICTOR (1877–1915), Australian cricketer, was born at Sydney, N S W, on Nov 2, 1877, and died there of Bright's disease on June 28, 1915 His first appearance against England was in a second-class match against Stoddart's team in 1894–95. In 20 seasons of first-class cricket, 1894–1914, he made 17,000 runs for an average of 45 His first visit to England, in 1899, was moderately successful, his next, in 1902, was a triumphal progress "From start to finish of the season, on every sort of wicket, against every type of bowling, Trumper entranced the eye, inspired his side, demoralized his enemies, and made run-getting appear the easiest thing in the world" (H S. Altham, *History of Cricket*). It was apparent at once that there had arisen a batsman of a class apart, whose supremacy, even in that golden age of batting, was comparable to that of "W.G" He came again in 1905, and 1910; in all he made six centuries for Australia against England, and his first wicket partnerships with R. A. Duff were long a thorn in England's side. Trumper was also a fine out-field, and could bowl fast for a short time. Trumper's batting was of that supreme type which defies description. The only adequate idea of his style is to be derived from a wonderful series of photographs in Beldam and Fry's *Great Batsmen* (1905). With his accurate timing and placing, and his speed on his feet, he had all bowlers at his mercy. "No one ever played so naturally," Warner has said of him, "batting was just part of himself." He had a charming personality and was the most beloved of cricketers. Perhaps the best tribute to his greatness is that every new batsman of high promise in Australia is hailed as "a second Trumper"

See M. A. Noble, *The Game's the Thing* (London and Australia, 1926); *Scores and Biographies*, vol xv. (1925).

TRUMPET, in music, a brass wind instrument with cup-shaped mouthpiece and a very characteristic tone It consists of a brass or silver tube with a narrow cylindrical bore except for the bell joint, forming from ¼ to ½ of the whole length, which is conical and terminates in a bell of moderate diameter. The tube of the trumpet is doubled round upon itself to form a long irregular rectangle with rounded corners A tuning slide consisting of two U-shaped cylindrical tubes fitting into each other is interpolated between the bell joint and the long cylindrical joint to which the mouthpiece is attached



BY COURTESY OF BOOSEY & CO, LONDON

THE TRUMPET, SHOWING THE MODERN FORM EQUIPPED WITH VALVES

The mouthpiece consists of a hemispherical cup with a rim across which the lips stretch. The shape of the cup, and more especially of the bottom, in which is pierced a hole communicating with the main bore, is of the greatest importance on account of its influence on the tone quality and on the production of the higher harmonics It is recognized that the shallower and smaller the cup the more easily are the higher harmonics produced; the sharper the angle at the bottom of the cup the more brilliant and incisive is the timbre, given, of course, the correct style of blowing The diameter of the cup varies according to the pitch and to the lip-power of the player who chooses a cup to suit him.

There are three principal kinds of trumpets. (1) the natural trumpet, mainly used in cavalry regiments, in which the length of the tube and pitch are varied by means of crooks, (2) the slide and double-slide trumpets, in which a chromatic compass is obtained, as in the trombone, by double tubes sliding upon one another without loss of air; (3) the valve trumpet, similar in its working to all other valve instruments The first and second of these alone give the true trumpet timbre The tone of the valve trumpet approximates to that of the cornet; nevertheless, it is now almost universally used

In the trumpet the notes of the harmonic series from the 3rd to the 10th or 16th upper partials are produced by the varied tension of the lips and pressure of breath called overblowing. The fundamental and the second harmonic are rarely obtainable, and are therefore left out of consideration, the next octave from the 4th to the 8th harmonics contains only the 3rd, 5th and minor 7th, and is therefore mainly suitable for fanfare figures based on the common chord. The diatonic octave is the highest and its upper notes are only reached by very good players on trumpets of medium pitch.

The lituus (*q.v.*) or cavalry trumpet of the Romans seems to have vanished with the fall of the Roman empire Its successor, the cavalry trumpet of the 15th and succeeding centuries, was evolved from the straight *busine*, an instrument traced, by means of its name no less than by the delicate proportions of its tube and the shape of the bell, to the Roman buccina (*q v.*) The bending of the tube of the trumpet in three parallel branches, thus creating its modern form, has usually been claimed for a Frenchman named Maurin (1498–1515) But the transformation was really made much earlier, probably in the Low Countries or north Italy; in any case it had already been accomplished in the bas-reliefs of Luca della Robbia intended to ornament the organ chamber of the cathedral of Florence where a trumpet having the tube bent back as just described is very distinctly figured And this shape the instrument retained for more than 300 years.

Later crooks and slides were introduced, then keys, and finally

ı 1815, Stölzel made the first completely satisfactory chromatic ·umpet by the invention of the ventil or piston. (*See* MOUTH-IECE; VALVE; and WIND INSTRUMENTS.)

TRUMPETER or **TRUMPET-BIRD,** a South American ird of the *Psophiidae* family, so called from the sound it tters. The family contains the single genus *Psophia* with half-a-ozen species, differing in little but colour and size. The range f several species seems to be separated by rivers (Wallace, *'eogr. Distr. Animals*) and in this connexion it may be observed ıat the birds seldom fly, though they run very fast. The best ıown species, *P crepitans,* inhabits Guiana and is about the ze of a large barn-door fowl, but with longer legs and neck. he plumage is black with the exception of the green and violet ·flections on the tips of the neck-feathers and a brown and grey ıtch on the back. The legs are bright green and the bird lays hite eggs, about the size of a bantam's egg.

Although the trumpeters must undoubtedly be accorded the .nk of a distinct family, *Psophiidae,* like so many other South merican birds they seem to be the less specialized descendants , an ancient generalized group—perhaps the common ancestors the *Rallidae* and *Gruidae.* The structure of the trachea, though fferent from that described in any Crane (*q v.*), suggests an ırly form of the structure which in some of the *Gruidae* is so arvellously developed, for in *Psophia* the windpipe runs down ıe breast and belly immediately under the skin to within about ı inch of the anus, whence it returns in a similar way to the ont of the sternum, and then enters the thorax. Analogous in-ances of this formation occur in several other groups of birds ɔt at all allied to the *Psophiidae.*

TRUNK (Fr *tronc,* Lat. *truncus,* cut off, maimed), properly e main stem of a tree from which the branches spring, espe-ally the stem when stripped of the branches; hence, in a trans-rred sense, the main part of a human or animal body without e head, arms or legs It is from this last sense that the term runk-hose" is derived These were part of the typical male ıstume of the 16th century, consisting of a pair of large puffed ıd slashed over-hose, reaching from the waist to the middle of e thigh, the legs clad in the long hose being thrust through em; the upper part of the body was covered by the jerkin or cket reaching to the thigh (*see* COSTUME). The word "trunk" applied to the elongated proboscis of the elephant is due to a ıstaken confusion of French *trompe,* trump, with "trunk," mean-g the hollow stem of a tree. A somewhat obscure meaning of 'ench *tronc, i.e*, an alms-box, has given rise to the general use "trunk" for a form of travellers' luggage.

TRURO, THOMAS WILDE, 1ST BARON (1782–1855), rd chancellor of England, was born in London on the 7th of ıly 1782, being the second son of Thomas Wilde, an attorney e was educated at St Paul's School and was admitted an attor-y in 1805 He subsequently entered the Inner Temple and was lled to the bar in 1817, having practised for two years before a special pleader Retained for the defence of Queen Caroline 1820 he distinguished himself by his cross-examination and d the foundation of an extensive common law practice. He st entered parliament in the Whig interest as member for ewark (1831–1832 and 1835–1841), afterwards representing orcester (1841–1846). He was appointed solicitor-general in 39, and became attorney-general in succession to Sir John fterwards Baron) Campbell in 1841. In 1846 he was appointed ief justice of the common pleas, an office he held until 1850, ıen he became lord chancellor, and was created Baron Truro Bowes, Middlesex He held this latter office until the fall of e ministry in 1852 He died in London on the 11th of November 55. His son Charles (1816–1891) succeeded as 2nd baron, but the death of his nephew the 3rd baron in 1899 the title became tinct.

Lord Truro was the uncle of JAMES PLAISTED WILDE, BARON :NZANCE (1816–1899), who was appointed a baron of the court exchequer in 1860, and was judge of the court of probate and vorce from 1863 to 1872. In 1875 he was appointed dean of the urt of arches, retiring in 1899 He was created a peer in 1869, t died without issue, and the title became extinct.

TRURO, an episcopal city and municipal borough of Cornwall, England, 11¾ m. N. of Falmouth, on the G.W.R. Pop. (1921) 10,843. It lies in a shallow valley at the junction of the Kenwyn and Allen at the head of Falmouth harbour. Truro (Trueret, Treurok, Treueru) was a comparatively small manor in Domes-day held by Jovin of Count Robert of Mortain. Its municipal charter dates from Richard Lucy the chief justiciar who held the demesne lands. Reginald earl of Cornwall, by an undated charter, added other privileges Henry II. confirmed them. A new charter was given in 1589. From 1295 to 1885 Truro had separate parlia-mentary representation, returning two members. The cathedral church of St. Mary was begun in Early English style in 1880. The episcopal see, founded in 1876, covers the former arch-deaconry of Cornwall in the diocese of Exeter, the area including the whole of the county of Cornwall, with a small portion of Devonshire. There are tin-smelting works and potteries. Small vessels can lie at the quays, though the harbour is dry at low water. China clay is the chief export.

TRURO, the chief town of Colchester county, Nova Scotia, on the Salmon river, near the head of Cobequid Bay, 61 m. from Halifax by rail. Pop (1921), 7,562 It is an important junction on the Canadian National and Dominion Atlantic railways, and the thriving centre of a lumbering and agricultural district.

TRUSS, in engineering and architecture, a combination of structural members, usually straight, and so arranged in one plane that by being connected at their ends they form a rigid frame on which to support a roof, floor, bridge or other similar weight In the theoretically perfect truss the component parts are so designed as to enclose between themselves rigid triangles and so arranged that every member is stressed only in the direc-tion of its own length, either in compression or tension, with no bending forces present. This, the controlling ideal of modern truss design, governs in the design of those trusses which are purely structural, or designed primarily from the utilitarian standpoint In ordinary architectural practice the exigencies of individual building problems, or the demands of aesthetic effect frequently render complete following out of the engineering theory impractical, and in one important class of architectural trusses, the hammerbeam (*q v.*) trusses, considerable side thrust is exerted upon the supporting walls or piers Although the basic principle of truss design, that of the rigidity of a triangle, is so simple, the scientific design of trusses is a matter of comparatively recent development, and in the greater number of classic, Roman-esque and Gothic trusses, despite the ingenuity of their construc-tion and, especially in late Gothic work, the beauty of their design and execution, it is only rarely, and as it were by accident, that a perfect triangulation of the members is achieved

A truss diagram is a graphic method of discovering the stresses in the component members of a truss, based upon the mechanical theory of the resolution of two angular forces into the diagonal of the parallelogram constructed upon them. (*See* BRIDGES; MECHANICS; ROOFS)

TRUST, INVESTMENT: *see* INVESTMENT TRUST

TRUST and **TRUSTEES.** *Use in Early English Law*—The use or trust is said to have been the invention of ecclesiastics well acquainted with Roman law, the object being to escape the provisions of the laws against mortmain by obtaining the conveyance of an estate to a friend on the understanding that they should retain the use, *i e*, the actual profit and enjoyment of the estate. Uses were soon extended to other purposes. They were found valuable for the defeat of creditors, avoid-ing of attainder and charging of portions. A use had also the advantage of being free from the incidents of feudal ten-ure; it could be alienated *inter vivos* by secret conveyance, and could be devised by will. In 1535 the famous Statute of Uses (27 Hen VIII. *c.* 10) was passed, forming the basis of con-veyancing until it was repealed in 1925 by the Law of Property Act. The statute does not, however, apply indiscriminately to all cases, as only certain uses are executed by it. It does not apply to leaseholds or copyholds, or to cases where the grantee to uses is anything more than a mere passive instrument, *e.g.*, where there is any direction to him to sell the property. The

publicity of transfer, which it was the special object of the Statute of Uses to effect, was almost at once defeated.

Trusts.—A trust in English law is defined in Lewin's *Law of Trusts*, adopting Coke's definition of a use, as "a confidence reposed in some other, not issuing out of the land, but as a thing collateral, annexed in privity to the estate of the land, and to the person touching the land, for which *cestui que trust* has no remedy but by *subpoena* in Chancery." The term *trust* or *trust estate* is also used to denote the beneficial interest of the cestui que trust. A trust has some features in common with contract (*q.v*); but the great difference between them is that a contract can only be enforced by a party or one in the position of a party to it, while a trust can be, and generally is, enforced by one not a party to its creation. A division often adopted in modern textbooks and recognized by parliament in the Trustee Act 1850, is into *express, implied* and *constructive* An express trust is determined by the person creating it. It may be either *executed* or *executory,* the former where the limitations of the equitable interest are complete and final, the latter where such limitations are intended to serve merely as minutes for perfecting the settlement at some future period, as in the case of marriage articles drawn up as a basis of a marriage settlement to be in conformity with them An implied trust is founded upon the intention of the person creating it, examples of it are a resulting trust, a precatory trust, and the trust held by the vendor on behalf of the purchaser of an estate after contract and before conveyance. A constructive trust is judicially created from a consideration of a person's conduct in order to satisfy the demands of justice, without reference to intention The law was consolidated by the Trustee Act 1893 and some subsequent amending statutes as the Law of Property Act, 1925

Who May Be a Trustee or *Cestui que Trust*—The Crown and corporations aggregate can be trustees Provision is made by the Municipal Corporations Act 1882, for the administration of charitable and special trusts by municipal corporations There are certain persons who for obvious reasons, even if not legally disqualified, ought not to be appointed trustees Such are infants, lunatics, persons domiciled abroad, felons, bankrupts and *cestuis que trustent* Any one may be a cestui que trust except a corporation aggregate, which cannot be a cestui que trust of real estate without a licence from the Crown For the Public Trustee, *see* below The disabilities affecting some Roman Catholic charities were abolished by the Roman Catholic Relief Act 1926

Creation and Extinction of the Trust—A trust may be created either by act of a party or by operation of law The Statute of Frauds altered the common law by enacting that all declarations or creations of trusts or confidences of any lands, tenements or hereditaments shall be manifested and proved by some writing, signed by the party who is by law enabled to declare such trust, or by his last will in writing, or else they shall be utterly void and of none effect For the purpose of conveying or creating a legal estate they must be made by deed (Law of Property Act, 1925, s 52). Interests created by parol are by will only (s 54) Trusts arising or resulting by implication or construction of law are excepted, and it has been held that the statute applies only to real estate and chattels real, so that a trust of personal chattels may still be declared by parol The declaration of a trust by the Crown must be by letters patent. Trusts created by will must conform to the requirements of the Will Act. (*See* WILL) Except in the case of charitable trusts, the cestui que trust must be a definite person. A trust, for instance, merely for keeping up family tombs is void. By s. 10 of the Trustee Act 1893 (superseding Lord St Leonards's Act of 1860 and the Conveyancing Act 1881), the surviving or continuing trustee or trustees, or the personal representative of the last surviving or continuing trustee, may nominate in writing a new trustee or new trustees. On such appointment the number of trustees may be increased. Existing trustees may by deed consent to the discharge of a trustee wishing to retire. Trust property may be vested in new or continuing trustees by a simple declaration to that effect. Also a separate set of trustees may be appointed for any part of the property held on distinct trusts. Trusts created by operation of law are those which are the effect of the application of rules of equity. They include resulting and constructive trusts. A resulting trust is a species of implied trust, and consists of so much of the equitable interest as is undisposed of by the instrument creating the trust, which is said to result to the creator and his representatives. An example is the purchase of an estate in the name of the purchaser and others, or of others only. Here the beneficial interest is the purchaser's. An example of a constructive trust is a renewal of a lease by a trustee in his own name, where the trustee is held to be constructively a trustee for those interested in the beneficial term. Besides being duly created, it is necessary for the validity of the trust that it should be a lawful one An unlawful trust is one which contravenes the policy of the law in any respect Examples of such trusts are trusts for a corporation without licence, for a perpetuity, and for purposes subversive of morality, such as trusts for illegitimate children to be hereafter born Superstitious uses also fall under this head There are also certain trusts which are avoided by statute under particular circumstances, such as settlements in fraud of creditors (*See* BANKRUPTCY) The law cannot be evaded by attempting to constitute a secret trust for an unlawful purpose If an estate be devised by words prima facie carrying the beneficial interest, with an understanding that the devisee will hold the estate in trust for such a purpose, he may be compelled to answer as to the secret trust, and on acknowledgment or proof of it there will be a resulting trust to the heir-at-law In the case of an advowson suspected to be held for the benefit of a Roman Catholic patron, there is a special enactment to the same effect. (*See* QUARE IMPEDIT) The rules of equity in charitable trusts are less strict than those adopted in private trusts Charitable trusts must be lawful, *e g*, they must not contravene the Statutes of Mortmain, but a wider latitude of construction is allowed in order to carry out the intentions of the founder, and they will not be allowed to fail for want or uncertainty of objects to be benefited The court, applying the doctrine of *cy près* (*q v.*), will, on failure of the original ground of the charity, apply the funds as nearly as possible in the same manner. On this principle gifts originally made for purely charitable purposes have been extended to educational purposes. Further, trustees of a charity may act by a majority, but ordinary trustees cannot by the act of a majority (unless specially empowered so to do) bind a dissenting minority or the trust property A trust estate is subject as far as possible to the rules of law applicable to a legal estate of a corresponding nature, in pursuance of the maxim, "Equity follows the law." Thus trust property as assets for payment of debts, may be taken in execution, passes to creditors in bankruptcy, and is subject to dower and curtesy, to the rules against perpetuities, and to the Statutes of Limitation A trust is extinguished, as it is created, either by act of a party or by operation of law. An example of the former mode of extinction is a release by deed, the general means of discharge of a trustee when the purposes of the trust have been accomplished Extinction by operation of law takes place when there is a failure of the objects of the trust. *e g*, if the cestui que trust die intestate without heirs or next of kin. Equitable interests in real estate in other countries are as a rule subject to the *lex loci rei sitae,* and an English court has no jurisdiction to enforce a trust or settle a scheme for the administration of a charity in a foreign country An English court has, however, jurisdiction to administer the trusts of a will as to the whole real and personal estate of a testator, even though only a very small part of the estate, and that wholly personal, is in England (See *Ewing* v *Orr-Ewing*, L R 9, A C 34)

Rights and Duties of the Trustee.—The principal general properties of the office of trustee are these: (1) A trustee having once accepted the trust cannot afterwards renounce. (2) He cannot delegate it, but an inconvenience which formerly attached to dealings with trustees and trust property, in consequence partly of this rule, and partly of the liability of persons dealing with trustees to see that money paid to them was properly applied, was largely obviated by s 17 of the Trustee Act 1893 (replacing s. 2 of the Trustee Act 1888), which in effect provides that a trustee may appoint a solicitor to be his agent to receive and give a discharge

for any money or valuable consideration or property receivable by the trustee under the trust, by permitting the solicitor to have the custody of and to produce a deed having in the body thereof or endorsed thereon a receipt for the consideration money or other consideration, the deed being executed or the endorsed receipt being signed by the trustee, and a trustee is not chargeable with breach of trust by reason only of his having made or concurred in making any such appointment, and the producing of any such deed by the solicitor is a sufficient authority to the person liable to pay for his paying to the solicitor without the solicitor producing any separate or other direction or authority in that behalf from the trustee (3) In the case of co-trustees the office must be exercised by all the trustees jointly (4) On the death of one trustee there is survivorship that is, the trust will pass to the survivors or survivor. (5) One trustee shall not be liable for the acts of his co-trustee. (6) A trustee shall derive no personal benefit from the trusteeship The office cannot be renounced or delegated, because it is one of personal confidence It can, however, be resigned, and legislation has given a retiring trustee large powers of appointing a successor The liability of one trustee for the acts or defaults of another often raises very difficult questions A difference is made between trustees and executors An executor is liable for joining in a receipt *pro forma*, as it is not necessary for him to do so, one executor having authority to act without his co-executor, a trustee can show that he only joined for conformity, and that another received the money The rule of equity by which a beneficiary who consented to a breach of trust was liable to indemnify the trustees to the extent of his interest has taken definite statutory shape in s 45 of the Trustee Act 1893 (replacing s 6 of the Trustee Act 1888), which enacts that when a trustee commits a breach of trust at the instigation or request, or with the consent in writing of a beneficiary, the High Court may, if it thinks fit, and notwithstanding that the beneficiary is a married woman entitled for her separate use and restrained from anticipation, make such order as to the court seems just for impounding all or any part of the interest of the beneficiary in the trust estate by way of indemnity to the trustee The rule that a trustee is not to benefit by his office is subject to some exceptions He may do so if the instrument creating him trustee specially allows him remuneration, as is usually the case where a solicitor is appointed The main duties of trustees are to place the trust property in a proper state of security, to keep it (if personalty) in safe custody, and properly to invest and distribute it A trustee must be careful not to place himself in a position where his interest might clash with his duty As a rule he cannot safely purchase from his cestui que trust while the fiduciary relation exists between them Investments by trustees demand special notice The Trustee Act, 1925, has consolidated the law on this point, and provides, as it were, a code or charter of investment authorizing trustees, unless expressly forbidden by the instrument (if any) creating the trust, to invest trust funds in various modes, of which the more important are as follows In any of the parliamentary stocks or public funds or government securities of the United Kingdom; in real or heritable securities in Great Britain, in stock of the Bank of England or the Bank of Ireland, in India 7, 5½, 4½, 3½, 3 and 2½ stock, in any securities, the interest of which is for the time being guaranteed by parliament; in consolidated stock created by the Metropolitan Board of Works, the London County Council, debenture stock created by the Receiver for the Metropolitan Police District, Metropolitan Water stock, in the debenture or rent-charge or guaranteed or preference stock of any railway company in the United Kingdom incorporated by special act of parliament, and having during each of the ten years last past before the date of investment paid a dividend at the rate of not less than 3% on its ordinary stock and in certain other railway or canal stocks; in the debenture stock of any railway company in India, the interest on which is paid or guaranteed by the secretary of state in council of India; in the "B" annuities of the Eastern Bengal, the East Indian and the Sindh, Punjaub and Delhi Great Indian Peninsula and Madras Railways, etc.; and also in deferred annuities—comprised in the register of holders of annuity Class D, and annuities comprised in the register of annuitants Class C of the East Indian Railway Company; in the stock of any railway company in India upon which a fixed or minimum dividend in sterling is paid or guaranteed by the secretary of state in council of India, or upon the capital of which the interest is so guaranteed; in the debenture or guaranteed or preference stock of any company in Great Britain or Ireland established for the supply of water for profit, and incorporated by special act of parliament or by royal charter, and having during each of the ten years last past before the date of investment paid a dividend of not less than 5% per annum on its ordinary stock, in nominal or inscribed stock issued, or to be issued under any Act of Parliament or provisional order by the corporation of any municipal borough in the United Kingdom having, according to the returns of the last census prior to the date of investment, a population exceeding 50,000; or by any county council in the United Kingdom in certain water stocks; in securities authorized under the Colonial Stock Act, 1900, etc ; the Housing (Additional Powers) Act, 1919, loan securities issued by the Government of Northern Ireland, in any of the stocks, funds or securities for the time being authorized for the investment of cash under the control or subject to the order of the High Court Trustees may from time to time vary any such investments for others of an authorized nature The statutory power to invest on real securities does not, of course, authorize the purchase of realty, but by s 5 of the Trustee Act 1893 a power to invest in real securities (in the absence of express provision to the contrary) authorizes investment on mortgage of leasehold property held for an unexpired term of not less than 200 years and not subject to a greater rent than one shilling a year, or to any right of redemption or condition of re-entry except for non-payment of rent The Trustee Act 1925 must be consulted for full information

The position of trustees in respect of what was frequently an undue personal responsibility for the administration of their trust has been much improved by s 8 of the Trustee Act 1888 which enables an honest trustee to plead the Statutes of Limitation It has been decided that in the case of a breach of trust consisting of an improper investment of the trust funds, time begins to run in favour of the trustee from the date of the investment Sub-section (3) of the Judicial Trustees Act 1896 gives power to the Court further to relieve honest trustees for breaches of trust

Under the old law trustees could not safely advance on mortgage more than two-thirds of the actual value of agricultural land or one-half of the value of houses This "two-thirds rule" is now made statutory by s 8 of the Trustee Act 1893 The same section protects trustees for not investigating the lessor's title when lending on the leasehold security, and for taking a shorter title than they might be otherwise entitled to on the purchase or mortgage of any property, if they act with prudence and caution. By s. 9 (replacing s 5 of the Trustee Act 1888) trustees who commit a breach of trust by lending more than the proper amount on any property are excused from making good any more than the excess of the actual loan over the sum which they might have properly lent in the first instance. (*See* generally the Trustee Act, 1925, for full information)

Rights and Duties of the Cestui que Trust.—The cestui que trust has a general right to the due management of the trust property, to proper accounts and to enjoyment of the profits. He can as a rule only act with the concurrence of the trustee, unless he seeks a remedy against the trustee himself.

Judicial Trustees—The Judicial Trustees Act 1896, inaugurated a semi-official system of trusteeship which was new in England, but had been known in Scotland for upwards of 150 years

Public Trustee—A step further was taken by the Public Trustee Act 1906, which established the office of public trustee. By the act he is a corporation sole, with perpetual succession and an official seal and may sue and be sued under his official title. He may, if he thinks fit, act in the administration of estates of small value; as custodian trustee, or as an ordinary trustee; he may be appointed a judicial trustee, or administrator of a con-

vict's property. The law of trusts generally is applicable to him Full information as to the machinery and procedure of the office and the requirements necessary to obtain the services of the public trustee are obtainable on application to the Public Trustee Office, Kingsway, London

Scotland—The history of the law differs considerably from that of England, though perhaps the position of the Scottish trustee is now not very different from that of the trustee in England The Statute of Uses did not apply to Scotland, since neither that nor any similar legislation was necessary in a system in which law and equity were administered by the same tribunals Trusts seem to have existed from time immemorial, and have been frequently regulated by statute. The policy of the English Statute of Frauds was no doubt intentionally imitated in the Act 1696, c. 25, enacting that no action of declarator of trust should be sustained as to any deed of trust made for thereafter, except upon a declaration or back-bond of trust lawfully subscribed by the person alleged to be trustee and against whom or his heirs or assignees the declarator should be intended, or unless the same were referred to the oath of the party *simpliciter*. The act does not apply to all cases, but only to those in which by the act of parties documents of title are in the name of a trustee, but the beneficial interest in another The person creating the trust is called the *truster*, a term unknown in England On the other hand the term *cestui que trust* is unknown in Scotland The office of trustee is prima facie gratuitous, as in England, it being considered to fall under the contract of mandate Some of the main differences between English and Scottish law are these There is no presumption in Scotland of a resulting trust in favour of a purchaser A trust which lapses by the failure of a beneficiary goes to the Crown as *ultimus heres* The office of trustee is not a joint office, therefore there is no right of survivorship, and on the death of a trustee the survivors are incompetent to act, unless a certain number be declared or presumed to be a *quorum*, or the office be conferred on trustees and the accedors and survivors of them Sometimes the concurrence of one trustee is rendered absolutely necessary by his being named *sine qua non* The Court of Session may appoint new trustees, but generally appoints a judicial factor There has been a considerable amount of legislation, chiefly in the direction of extending the powers of trustees and of the court in trust matters. The powers of investment given to trustees are much the same as those allowed in England

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United States.—It is generally true that the institutions of the English law were adopted bodily by the American colonists and became part of their jurisprudence modified only in such details as the exigencies of the new country demanded That this was true of trusts is, however, somewhat remarkable in view of American hostility during the 18th and early 19th centuries to the English system of equity jurisprudence Indeed, several colonies possessed no chancery courts and not until the late 19th century had full equity powers been vested in State courts such as Massachusetts and Pennsylvania Despite this, however, the trust as developed in England was well-known in America. Remedies were administered in the absence of equity powers by law courts through their own legal forms. The institution consequently followed the English law in its major outlines and only the more important differences need here be considered

Passive trusts, in which the trustee performs no active duties but is simply a receptacle of the legal title. have under various theories ceased to exist for practical purposes, such a grant being deemed to vest the beneficiary with legal title This result, reached in the American States through a judicial extension of the Statute of Uses or by local legislation, has in substance done away with all passive trusts except such resulting or constructive trusts as are created by operation of the law Consequently for the effective creation of a trust it is necessary to impose affirmative duties of administration upon the trustee Furthermore legislation in the several States similar to the provisions of the English Statute of Frauds requires trusts of real property to be in writing, though trusts of personal property unless created by will may be established by oral evidence

Notable American legal doctrines concern the purposes for which trusts may be created. The spendthrift trust, a distinct American institution, seeks to secure the beneficiary against his own improvidence or incapacity by providing against alienation by anticipation of the trust income by the beneficiary either by his own voluntary act or *in invitum* by his creditors. The beneficiary cannot assign his right to receive future income nor can such income be subjected to the payment of his debts. In England such trusts have been held invalid on the ground that it is against public policy to permit the ownership of property without permitting its alienation nor burdening it with liability for its owner's debts The majority of the American States have upheld the validity of such trusts, following the views enunciated by the Massachusetts court in *Broadway Nat Bank* v *Adams,* 133 Mass 170 and the Supreme Court of the United States in *Nichols* v *Eaton,* 91 U S 716 American legal doctrines surrounding the creation of charitable trusts have had a curious development After intimating that their validity depended solely upon statute, the Supreme Court of the United States in the famous *Girard Will Case* (2 How 127) concluded that the English Statute of Charitable Uses of 1601, 43 Eliz c. 4, was but declaratory of the common law and that such trusts were valid in the absence of legislation Several State courts had theretofore repudiated the Statute, and the early legislation of these States failed to recognize the existence of charitable trusts The failure of the famous Tilden trust devising several millions for charitable purposes to the city of New York under a decision of the Court of Appeals of New York led in 1893 to legislation in that State and similarly situated States restoring the old English system of charitable trusts Indeed, since then the American courts have generally been more liberal than the English courts in their interpretation of what uses may be regarded as charitable The policy involved in the English mortmain statutes finds its counterpart in different types of American statutes. Some restrict the amount of property a charitable corporation may hold; others prohibit a testator from giving more than a certain portion of his fortune to charity; and still others invalidate all gifts to a charity made within a brief period before the death of the donor.

There are numerous distinctions between English and American law concerning the rights of the trustee, of which the more important may be noted Unlike the English rule, the trustee even in the absence of a provision in the trust deed for remuneration, is entitled either by statute or under equity rules to a reasonable compensation for his services Such remuneration is commonly calculated on a commission basis, and the trustee possesses a lien upon the trust property for his services. Two or more trustees are entitled to one commission only Strict rules, however, prevent a trustee from deriving any personal benefit from his trusteeship by action antagonistic to the best interests of the beneficiary The various States have many different rules governing the manner in which the trustee shall invest the trust property. The subject is largely controlled by legislation setting forth the specific types of securities which the trustee may purchase. Corporate bonds of approved railroads and public utility companies are generally considered legal investments and a few of the States permit investments in the common stock of reputable corporations Though mortgages upon real property are permissible investments, real estate as such is commonly considered too speculative and too unconvertible for purchase by the trustee. Two different rules prevail in America concerning the distribution of income of trust estates as between life tenants and remaindermen. When such income is represented by dividends, the rule of some States requires the payment of cash dividends to the beneficiary, whereas

stock dividends are to be held as capital Other States, however, regard the source of the dividend as the test, holding that all dividends whether in stock or cash accruing from profits earned subsequent to the creation of the trust are payable to the beneficiary

Of interest also is the development in America of the institution of the trust as a means for aggregations of capital to carry on business. This development should be distinguished from the monopolistic illegal "trust" The legal trust contemplates contributions by a number of persons of capital to trustees who, under a declaration of trust executed to them, carry on the business for the benefit of such persons as are beneficiaries. Transferable certificates are issued to the contributors and income from the conduct of the trust is paid to them in the manner of dividends. Since the organization is simply an adaptation of the common law trust no legislative authorization is a condition precedent to the right to carry on business in this manner. The declaration of trust also provides that only the trust property and neither the trustees nor the shareholders are to be individually liable to creditors. The chief distinction between such an organization and a partnership is that the shareholders as beneficiaries cannot control the management of the business by the trustees, and if power to manage the business is vested in the shareholders or if they are permitted to appoint and remove trustees at will, the courts treat the organization as a partnership Though this application of the trust is not unknown in England (see *Smith* v. *Anderson*, 15 Ch. D 247), conditions peculiar to America have made for its extraordinary growth in the latter country The device originated in Massachusetts, hence the term "Massachusetts trusts," due to the fact that the laws of that State did not allow corporations to deal in real estate Experience refined the forms of organization to permit their application to other enterprises, but until late years the device was not generally employed in other States. But when legislation during the beginning of this century sought to impose onerous burdens upon the doing of business in the corporate form, especially upon corporations of other States, the trust device was generally resorted to in order to avoid these burdens The business trust thus became a familiar type of organization It was expressly recognized by legislation in Oklahoma in 1919, and since then by a few other States Some State courts, however, have as yet failed to recognize the possibility of adapting the trust as a form of business organization

Another adaptation of the trust for business purposes is the voting trust, a device whereby the stock of shareholders is deposited with a trustee for the purpose of controlling the policy of a corporation. The interests of the shareholders are commonly represented by transferable certificates Though in some States such trusts cannot be employed to control certain types of business, their legality is recognized provided that all shareholders shall be permitted to avail themselves of the trust agreement and provided that its purpose is to benefit all shares alike

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(J. M. LA.)

TRUST COMPANY, is a financial institution organized to perform duties and functions for corporations and private individuals and to assume the general responsibilities imposed upon individuals and corporations under the law of trusts While the principal business of these companies in their formative period early in the last century was the supervision of personal estates and the negotiation of insurance, the insurance function has disappeared, and the trust companies have become a major factor in commercial banking for both domestic and foreign business, in addition to being corporate fiduciaries The broad financial powers that the trust companies enjoy have earned for them the name of department store banks, and their growth in the United States has been rapid since the opening of the 20th century.

As organized to-day, trust companies in the United States perform in many instances a complete commercial banking service and many also maintain complete savings departments, but their trust functions are distinct from their general banking services and cover two separate fields, namely, personal trusts and corporate trusts

Personal Trust Department.—In its personal trust department, the trust company, either as executor or administrator, settles estates of individuals As trustee, it manages property under the laws pertaining to trusts, distributing income and principal to beneficiaries designated in the wills or trust deeds under which it operates. A trust company may be designated as trustee either by the terms of a will, or by the terms of an agreement entered into during the life of an individual. The latter form of trust is usually known as a living trust or a voluntary trust, and when made to cover policies of life insurance it is designated as a life insurance trust In its personal trust department, the trust company also acts as a guardian of property for minors, and as committee of property of incompetent persons.

The fundamental duty of a trust company is sound management of property placed under its care and application of income and distribution of principal in strict accordance with the terms of the instrument under which it acts An additional service to individuals which a trust company performs is caring for securities in safekeeping or custody Through this service, the trust company attending to the collection of income and maturing principal, the details of routine care and watching for changes in the status of holdings, such as redemptions, conversion privileges, etc—the securities, however, are always under the control of the owner and may be withdrawn or added to.

Corporate Trust Department.—In its corporate trust department, the trust company plays a vital part in the issuance of bonds, the registration and transfer of stocks, the handling of property under escrows, the exchange of securities under capital readjustments and changes, as fiscal agent for governments and corporations, and in other capacities It renders important service in corporate reorganizations, under bondholders' or stockholders' protective agreements; consolidations, dissolutions and reorganizations; voting trust agreements; creditors' agreements, receipt of subscriptions to securities offered in the form of rights and disbursements of liquidating dividends As paying agent for corporations it pays interest on bonds, also the principal of matured or called bonds; it also handles the disbursement of dividends for corporations. The trust company also holds securities for corporations in safekeeping, affording the same service as that to individuals described previously An important feature of trust company service, as it is organized by the larger trust companies, includes special service to municipal, county, State and Government officials, as trustee and paying agent under bond issues, registrar of bond issues, and in other fiduciary capacities

Early History.—Early in the 19th century the first trust companies made their appearance in the United States and carried on a business of insurance and trusteeship for estates and individuals. As the corporate form of commercial organization became a dominating factor of American business toward the close of the century, there were created many opportunities for the trust company to enter new fields and to undertake duties hitherto unattempted Also, it was not until the latter half of the 19th century that the large private capital aggregations had been amassed. The combination of this accumulation of large personal fortunes and the increasing tendency toward the corporation type of business organization provided the extensive field in which the trust companies were privileged to operate

Since the Civil War, which caused the enactment of the National Banking Act in 1863, there have existed side by side two systems of banking in the United States, namely national and State. The expansion of the trust company in the '80s and '90s, however, soon attracted considerable attention. It was not long before the banking community of the country realized that this new form of financial organization was destined to become one of the important systems in the country's banking machinery.

Under the general trust company law of New York State enacted in 1887, trust companies were empowered to accept de-

posits and pay interest upon balances. This feature of trust company activity was the root of the national bank-trust company controversy that subsequently developed. Shortly after 1900, however, trust companies began to maintain a cash reserve against deposits. During 1903, the New York clearing house adopted a resolution in regard to the reserve requirements of trust companies. Starting at 5% of their deposits, it was later advanced to 15% Trust companies in New York city later withdrew from membership in the New York clearing house, but subsequent legislation fixed the reserve against deposits at 15%, which was divided into three classifications, namely, 5% in cash, 5% with approved banking institutions, and 5% in certain types of bonds, preferably government or municipal issues With the enactment of the Federal Reserve law, important changes were made in the financial machinery of the country; seasonal and periodic demands for funds in different parts of the country could not easily be met. Under the Federal Reserve System, with the country divided into 12 sections, the flow of credit from one section to the other was greatly stimulated, and the primary cause of financial panics practically eliminated

Recent Expansion.—Since 1900 the history of the American trust company has been one of phenomenal expansion and development. The report of the controller of the currency of the United States for the fiscal year ended June 30, 1900, which summarizes the condition of all reporting financial institutions in that country, stated that 290 trust companies possessed a total capital of $126,930,840, while their deposits amounted to $1,028,232,400. During the next 27 years, the number of companies reporting to the controller of currency had increased to 2,731, and their aggregate capital during this interval rose even more rapidly The report of the condition of these institutions on June 30, 1927, stated that total capital amounted to $1,161,305,900, and that deposits were $16,824,822,700 The developments in the trust company field during the last ten years are still further emphasized by the fact that in 1917, 2,009 trust companies had total resources less than half the amount possessed by the companies in existence at the close of 1927 A growth of 127% in trust company resources occurred in this period, in comparison with the advance of only about 25% in the number in operation

A statistical review of trust company growth is presented in the accompanying table.

Trust Companies in the United States			
June 30	Number	Capital	Deposits
1927	2,731	$1,161,305,900	$16,824,822,700
1926	2,684	1,087,415,500	15,982,226,300
1925	2,701	1,021,167,900	15,007,778,400
1920	2,241	716,720,000	9,764,751,300
1915	1,777	503,382,683	5,010,051,200
1910	1,527	446,168,100	3,308,287,200
1900	290	126,930,840	1,028,232,400
1897	251	106,968,300	566,922,200
1891	171	79,292,900	355,330,000
Trust Companies in New York City			
1927	131	$264,275,000	$5,083,581,700
Per cent. of U.S	4 8	22 7	30 2

Regional Distribution.—Although the development of trust companies in the eastern section of the country has been greater than in the central or western sections, this is almost entirely due to the fact that the States bordering on or adjacent to the Atlantic ocean were the first to be settled, and hence the first in which wealth was created With the expansion of business and the increase in population in the central, western and southern sections of the country, the introduction of the trust company idea has gone along at a rapid pace. With New York as the present financial centre of the country, however, the greater aggregate in trust companies' resources is destined to be in and near this section. The inauguration of the Federal Reserve System did not in any way reflect upon or change the method of State supervision of financial institutions within the borders of the States, but rather co-ordinated all financial resources to meet unusual or excessive demands when and where needed.

A constantly growing realization of the superiority of the fiduciary service rendered by a corporate trustee over an individual, with its fixed responsibility, legal continuity and trained staff, is stimulating the growth of these institutions rapidly Observing the growth of this form of banking service the national banks secured an amendment to the National Banking Act in 1918 by which they were permitted to perform fiduciary services and many of the larger national banks now maintain trust departments organized for such purposes. (F. H Si)

TRUSTS. The term "trust" is a convenient though mostly inaccurate label popularly applied to any large business concern, or amalgamation or association of business concerns, which exercises some degree of monopolistic power over output and prices in the industry with which it is connected. The "trust," as it first appeared in America in the '80s, was a form of organization in which the shareholders of a number of enterprises agreed to assign the whole of their stock to a small board of trustees, receiving in exchange trust certificates representing the valuation of their properties. This particular way of bringing a number of rival businesses under one direction has no particular significance nowadays, and it is but by historical accident that it has given its name to something much wider than itself; but the term has become established, and when a British official committee was appointed in 1918 to enquire into all forms of trade organization and combination it was officially designated "The Committee on Trusts." The subject of this article, then, is not "trusts" in the derivational sense, but the whole movement of which the "trust" proper was and still is one example. That movement has two main aspects. It entails, in the first place, a change in the size of the business unit, a change from a multitude of small separately-controlled businesses to a few big businesses; and in the second place a change in the basic principle upon which industry is conducted, a change from competition as the ruling factor in the fixing of output and prices to deliberate control, fortified by monopoly, on the part of the manufacturing or commercial interests concerned

From Competition to Combination.—The system under which goods are produced, distributed and bought is still commonly referred to as the "competitive system," but for the last half century and longer the economic order has been changing and the assumptions upon which it was formerly held that supplies, prices, profits and wages were best left to the free play of competition are becoming ever less valid For an account of the competitive system and the nature of the change from competition to combination the reader should see the article COMPETITION IN INDUSTRY, where the virtues and triumphs of competition are extolled but it is shown that there comes a stage in industrial development at which the continuance of competition along the old lines is actually detrimental to industrial efficiency and obstructive to further progress, and that when that stage is reached, or when industrialists wake up to the fact that there is an easier way than competition to the ends they pursue, competition gives place to combination

FORMS OF COMBINATION

(1) **Gentlemen's Agreements.**—Industrial combination in the dual sense of the replacement of many small firms by a few large firms and the substitution of concerted control for competition takes a wide variety of shapes. At its simplest and most elusive there is no outward sign of change but a few business rivals meet from time to time and reach an "understanding" in regard to prices, output, division of business, etc In effect, the competitors agree not to compete· that is all Nothing is put on paper; a gentleman's word is as good as his bond Such understandings are fairly common among local coal dealers, carriers, shopkeepers etc., and are no less a figure in industrial diplomacy on the largest scale. The reader should see the article GENTLEMEN'S AGREEMENTS.

(2) **The Trade Association.**—A more advanced kind of combination is that in which a large proportion of the manufacturers or traders in a particular line of business form an association for

the purpose of regulating the trade. Here, as in the "Gentlemen's Agreement," is exemplified one only of the two aspects of combination: there is no change in the size of the business unit, but something has happened to the competitive principle by which the relations of the various firms are supposed to be governed Associations for the regulation of trade are associations for the "rationalization" of competition This can be effected in a variety of ways; by fixing uniform prices, by apportioning and controlling output, by supervising tenders, by dividing up the market For an account of these bodies, which are to be found in almost every branch of industry in Great Britain and America and indeed in all industrial countries, the reader should see the article ASSOCIATIONS, INDUSTRIAL. The economic effects of the limitations of competition effected by these associations, and the social and political problems to which the possibilities of abuse of their powers give rise, will be discussed at greater length in the present article as part of the comprehensive phenomenon and problem of the "Trust" movement.

(3) **The Consolidation.**—The most concrete type of combination is the mammoth business of such size and power that it represents within itself the greater part, locally, nationally, or maybe internationally, of the particular line of business in which it is engaged and is able within limits to control the output of the industry and dictate the prices at which its particular type of goods shall be sold. In local trade its rudiments may be seen in the case of the cobbler or farrier who has "no opposition" and whose customers must pay his prices or incur the expense of going far afield for the satisfaction of their needs but these do not make the modern problem; improving facilities of transport and the ease of establishing rival concerns provide sooner or later an effective remedy The phenomenon and the problem are only formidable where the consolidation is on at least a national scale In these cases it almost always occurs where two or more previously independent business concerns are permanently amalgamated into one large concern under more or less completely centralized direction and control It may be a coalition of equals, or it may be the result of a powerful concern buying up one or more smaller rivals it may have been engineered by outstanding personalities within the industry, or it may be the result of operations promoted by outside financiers: the previously independent businesses may continue to operate to all outward appearance as though they were still independent, or some of them may disappear as separate entities, their goodwill and business passing to more efficient establishments within the amalgamation According to their origin, scope and manner of operation, distinguishing names have been given to these conglomerate bodies The term "combine" is frequently used in Great Britain, generally to designate a merging of firms in the same line of business at the instance of some dominant concern or group among their number. The term "merger" is more usually used in the United States in much the same sense The term "*Kartell*" is widely used to denote the specifically German type of joint selling organization (*See* CARTEL) Trust, as already mentioned, has particular application to the former American plan of assigning the stock of the associated enterprises to a body of trustees There is no need for present purposes to examine more closely these differences in financial structure and control The terminology is largely arbitrary, and the distinctions often without real significance. It is, however, useful to recognize another broad distinction in the composition and industrial range of the greater consolidations which cuts right across those mentioned above, that between the "vertical" and the "horizontal" type; for the relative beneficence and success of the one and the other is a matter of some moment. The "vertical" consolidation results from a merging of firms engaged in the production of a commodity at successive stages of manufacture, *e.g*, coal and iron mining, pig iron, iron and steel and ships The "horizontal" consolidation, on the other hand, results from the merging of firms engaged in the same line of business at the same stage of production, *e g.*, the firms engaged in the bleaching and dyeing industry or those engaged in the manufacture of cement

Multiple Directorships; Banking and Accountancy Control.—Among a miscellany of forms taken by the movement under discussion, other than those already named, three of far greater import than might at first sight appear call for specific mention. The first of these is the increasing practice of one person holding directorships in a number of ostensibly competing firms or in firms engaged in mutual trade. Cases of persons holding a dozen directorships are common, and it is on record that as many as thirty-two directorships, including thirteen chairmanships and three positions of managing director, in businesses of the first order of magnitude concerned not only with manufacture but also with banking, shipping, railways and telegraphs, have been simultaneously held by one person. The same phenomenon appears in more systematic guise where arrangements for the collaboration of erstwhile competing firms take the form known as "interlocking directorates" in which an interchange of shares is accompanied by arrangements whereby the directors of one concern sit upon the board of another. Where these conditions obtain it is evident that the idea of competition in its old crude sense must be modified The second is the control exercised over a large part of the industrial field by the great banks It is not suggested that the details of prices, output and marketing are matters with which the banks concern themselves, but their influence over the industrial and commercial policy of their clients is hardly in dispute, and that influence has its reflex upon the policy of its clients towards each other (*See* BANKING) The third is the increasing part played in the financial administration and structural reshaping of great industrial concerns by firms of accountants who have come to combine with ordinary accountancy work the functions of the financing house and the entrepreneur Throughout any survey of tangible consolidations and trade associations these less tangible influences must be kept in mind if a comprehensive idea of the extent of trade combination is to be obtained

National Characteristics.—The combination movement has accommodated itself in each country to national conditions and characteristics In the United States the size of the national market, the natural protection accorded to home manufacturers by the distance of that market from European manufacturing centres, and the singular uniformity in the goods required by American consumers, were all favourable to centralized large-scale production The greater importance of rail transport costs as an element in total selling costs and the highly monopolistic position of the main railroads gave added cause for collaboration among manufacturers with a view to collective bargaining with the railroad interests These circumstances, together with a national zest for power and masterdom, conduced when time was ripe to a rapid growth of great industrial consolidations In the United Kingdom great consolidations wielding monopolistic and political power have not in general been so formidable as in America, nor have British associations of independent manufacturers developed so fully the range of activities displayed by such organizations in Germany The movement toward industrial combination in the United Kingdom has been relatively more cautious and less spectacular than elsewhere. The reasons for this would appear to be partly the deep-rooted individualism of the British manufacturer and partly the greater difficulty of establishing monopolistic consolidations in a country where many of the principal industries are widely dispersed, where the raw materials of most of the great industries are drawn from world-wide sources and where such shelter as monopoly might obtain from protective import duties has not been available None the less, combination has replaced or minimized competition over a great part of the industrial activity of the United Kingdom. In Germany the local concentration of the coal and iron industries, the moderate protective policy, the state-ownership of the Prussian railways, and the inter-relations of industry with government, all contributed to the emergence of a special type of trade combination in the form of a joint selling organization between independent concerns in the same line of business empowered to fix and maintain prices and to allot the participation of each independent producer in the aggregate output. For this German type of combination the reader should see the article CARTEL.

Industrial Occurrence.—It would be difficult to lay down any rule as to the industries which are most susceptible to combination or have travelled farthest along that road; but a few generalisations can be made. Industries engaged in supplying the need for a standard unvarying product—*e g.,* steel bars and rails, sewing cotton, cement, salt, sugar, tobacco—invite combination more than do industries engaged in miscellaneous and varying production, such as general engineering and shipbuilding Manufacturers requiring much capital for their establishment, or capable of being carried on much more economically with expensive plants are in general more easily collected into large aggregates by the instrumentality of high finance and are more secure against sporadic competition than are industries which require little capital Local proximity has been a factor of some importance in certain cases as facilitating centralized control; but improvements in transport and communication are minimizing this factor Patents have formed the bed-rock of combinations in some industries *e g*, electrical, chemical and shoe-machinery; and national monopoly has supported others Manufacture in general lends itself to consolidation much more than agriculture; but combination plays an important part in the marketing of agricultural products For many years retail distribution lagged behind manufacture as a subject for combination; but the last twenty years has seen an immense increase in the multiple shop or chain store. Indeed, no array of purely economic factors will explain why combination has developed much farther in some industries than in others; why, for example soap, cocoa and sewing cotton should be represented in Great Britain by vast establishments; why shipbuilding and coal-mining should have stood so much aloof from the general tendency The present industrial spread of the movement would appear to have depended, as much as on anything else, on the chance emergence in certain industries, at the critical moment, of dominant personalities who have conceived great plans and carried them through Where the right man with the necessary powers has been lacking at the propitious moment combination has had to wait

The growth and present existence of trusts in the United States has been very largely conditioned by legislation The passing of the Sherman Act of 1890 necessitated the abandonment of the trust proper and led to the adoption of the method of complete amalgamation either by outright purchase or by the formation of holding companies This process of consolidation has proceeded very rapidly, with the result that a wide range of American industrial production has come to be under the dominion of giant concerns exercising a large degree of monopoly power Most prominent among these are the United States Steel Corporation, the International Harvester Company, the American Tobacco Company, the American Sugar Refining Company, the United States Rubber Company and the Central Leather Company; but in the Electrical, Chemical, Cement, Oil Seed, Meat, Shoe Machinery, Constructional, and Non-ferrous Metal industries, to name but a few, great consolidations play a dominant part In the United Kingdom consolidations of such a size as to be capable of exercising some degree of monopolistic power also exist in the main branches of manufacture In the cotton branch of the textile industry Messrs. J. & P. Coats and The Fine Cotton Spinners' and Doublers' Association are of long standing; and two great post-war amalgamations are The Amalgamated Cotton Mills Trust and Crosses and Winkworths In the woollen and worsted industries combination has taken the form rather of association than consolidation; but Woolcombers Ltd is an amalgamation dating back some years, while since the World War large amalgamations have been formed in the worsted spinning and knitting wool spinning sections of the industry Outstanding in the bleaching, dyeing, printing and finishing industries are the Bradford Dyers' Association, the Bleachers' Association, the Calico Printers' Association, the British Cotton and Wool Dyers' Association and the English Velvet and Cord Dyers' Association In the chemical industry Brunner Mond and Company, the United Alkali Company, Nobel Industries and British Dyestuffs were amalgamated in 1926 into one great undertaking; Lever Brothers, the Salt Union and Borax Consolidated, are each dominant in their respective branches of industry. In the coal industry amalgamation has not proceeded far, except in South Wales, where there are two large groups of anthracite collieries, merged under Amalgamated Anthracite Collieries Ltd and United Anthracite Collieries Limited In the iron and steel industry combination by terminable association has been accompanied by great concentrations of capital, such as Dorman Long and Co, Bolckow, Vaughan & Co., Baldwin's Ltd, The Ebbw Vale Co. and Guest, Keen and Nettlefolds. The engineering and shipbuilding industries, again, present a network of terminable associations studded by large consolidations Foremost among these are Vickers Ltd, Armstrong Whitworth & Co, Cammell Laird & Co and John Brown & Co, but a score more could be quoted within almost the same range of importance In other industries examples of dominant consolidations may be found, notably in matches, glass, bottles, electric lamps, machinery and tobacco

International Combinations.—From combines of national range and consolidations of national magnitude it is a natural step to agreements and amalgamations on the international scale It has been estimated that there were in existence before the war 114 international associations, chiefly in the coal, ores, metal, transport, chemical, textile, pottery, paper and electrical industries The object of the majority of these organizations was the regulation of competition, and especially the exclusion of foreign competition from the respective home markets of the participants and the division and demarcation of sales territories; but some of them regulated prices, credit terms and selling practices generally among their members and in a few cases there were arrangements for the exchange of patents or knowledge of technical processes The outbreak of war in 1914 broke up most of these international groups, but since the war some have been re-formed and others are in process of formation or re-formation Among these the International Rail Makers' Association is one of the earliest, having been first formed in 1884 by British, German and Belgian steel manufacturers for the purpose of dividing up export orders and securing the home market to the home manufacture The association was re-constituted under the name European Railmakers' Association in 1926 The pool formed by the French, German, Belgian and Luxembourg steel makers in 1926 provides for the allocation of output quotas among its members with penalties for exceeding the quota and compensations for keeping below it Associations existed before the war to regulate the international relations of manufacturers engaged in the production of galvanized steel, tubes, pipes, rods, wire nails and enamel ware, and many of these have been or are being re-formed A copper syndicate comprising producers responsible, it is said, for some 90% of the world output and intended to control prices and reduce the number of middlemen was formed at the end of 1926 Potash, electric lamps, explosives, glass bottles and gas mantles are the subject of other agreements among the principal manufacturers in the various countries In addition to these international associations, agreements, cartels or combines there were built up before the war a number of giant consolidations of world wide extension In petroleum the world trade is largely dominated by two enormous groups, the Standard Oil Group and the Royal Dutch Shell Group These in collaboration control something less than half the world's production but a far greater proportion of international trade. In tobacco the export trade of America and Great Britain is largely in the hands of the British-American Tobacco Company, and the match industry is largely dominated by a trust headed by the Swedish Match Company.

Relative Extent and Trend of Combination.—The degree to which combination has supplanted competition as the ruling factor of business operations must not be exaggerated Even in the most powerfully organized industries competition plays its part with fitfully recurring intensity; while there are still industries (*e.g.,* coal, shipbuilding, textile, manufacturing, as well as a host of minor industries) in which the concerted control of output or prices or the concerted direction of industrial policy has made relatively little headway But the steady trend is toward increased combination. Under the influence of war conditions not

only were numbers of listless associations galvanized into great activity and enterprise, but many new associations were formed. Also, one effect of the excess profits tax was to encourage the buying up of unprofitable businesses by prosperous concerns, for such purchases were in effect paid for by moneys which would otherwise have gone in excess profits duty to the revenue. For this and other reasons the war period was one of unusual increase in the number of amalgamations Since the war the movement has shown no signs of slackening but the impetus has been towards amalgamation rather than association; indeed trade associations have been through a difficult time and several have dissolved Despite the misfortunes that have come upon certain of the greater consolidations as the Nemesis of prosperity and inflation during the war and the post-armistice boom, the tendency is still toward large-scale amalgamation, and our economic and financial system appears to provide thus far no machinery whereby a great consolidation may dissolve into its constituent elements It is an old American aphorism that "you cannot unscramble eggs"

The Advantages of Combination.—Great possibilities of industrial and commercial improvement lie beyond the confines of free competition, and are only to be realized by combination in one or other of its several forms; by informal consultation and co-operation, by formal association, or by actual amalgamation. Only from the latter proceeds in full measure the advantage that may follow from extending over a wide area the intelligence and control of technicians and administrators of outstanding ability such as only a large undertaking can afford to retain; and only the consolidation can order with plenary powers the policy of the industrial block over which it exercises authority and can acquire control of the sources of raw material and an influential interest in the means of transport; but associations as well as consolidations can effect many improvements and economies along the whole line of manufacture and sale. By the consolidation purchases of material and components can be made in gross instead of in detail, with the advantages of better selection, better terms and lower transport charges; middlemen can be side-stepped and, as already stated, the control over the sources of material can be acquired. The association is not entirely powerless in these matters, for it can assist members to better buying by collecting and distributing information on the point As regards manufacture, it is possible under combination to arrange for a standardizing of parts and sizes throughout the industry, whereby production can be greatly cheapened and the parts of one maker made interchangeable with those of another Again it is possible to arrange that instead of every firm trying to cover the whole ground, each shall devote itself to some particular section, and install specialized equipment for its own section and for that only, in which case wasteful duplication can be avoided and specialized skill developed; or, where other conditions prevail, it is possible to bring equipment and inside organization throughout the industry to a uniformly high level Further, whereas under free competition the firms in one district may be working overtime while those in another district are on short time, it is possible with combination to maintain something like an equal distribution of work and to control orders so that the volume of work does not fluctuate so greatly from one period to another

The economies in the matter of distribution to be achieved by associations and combines need little demonstration Critics of the competitive system have often pointed out the wastefulness of the "five milkmen in one street" The economic waste of numbers of rival travellers, each seeking to frustrate the efforts of the rest, and of competitive advertisements which cancel each other out, has long been a subject of comment But only by some form of understanding or concerted arrangement of monopoly can such wastes of competition be put an end to Moreover, for a country carrying on a large export trade, representation in foreign markets is a matter of primary importance, and it has become increasingly apparent that independent manufacturers, if they combine for nothing else, must combine for the purpose of pushing their wares abroad if they wish to keep and extend their foreign connections

With these advantages that combination alone holds out goes another—the freer exchange of knowledge. Under competition every one of a host of small manufacturers works out his own problems, evolves his own methods and processes, and "keeps what he knows to himself" When a combine or a consolidation is formed this secrecy is ended and anything worth imitating at one branch is available for all the others. Associations do not always adopt the policy of "open doors" as between the members, but many of them go a long way in that direction, and the regular meetings conduce to a friendly atmosphere in which ideas are exchanged The two essentials of the healthy rivalry which advances, as distinct from the jealous competition which obstructs, are a common basis of comparison and the pooling of data With combination it is possible to arrange for a uniform system of costing throughout an industry and for the circulation of cost-sheets showing what has been achieved by the most efficient firms With such a sheet before him the less efficient member can see precisely where his methods are faulty and can set to work to improve them.

Possible Losses from Combination.—Against these possible gains on the score of productive and distributive efficiency must be set some possible losses. Where an industrial unit grows beyond the compass of one man's personal detailed direction, "system" must be introduced and system can degenerate into bureaucracy and red tape. What is gained in power and knowledge at the centre may be lost in freedom and strength at the circumference, and the over-grown unit is in constant danger of becoming inefficient and reactionary Again, under the shelter of monopoly a comfortable somnolence may descend upon the giant concern, the fear of change is a well-known characteristic of large administrations, and the large business unit may become stagnant and even reactionary, especially if its control falls increasingly into aged hands

Rationalization.—Since the World War, a term not previously familiar has come into general use to signify the process of reordering industry so as to achieve the advantages just mentioned. It is "the rationalization of industry." The implications of the term cannot, however, be properly understood except with reference to the indispensable condition of "rationalization"—centralized control wielded with monopolistic powers Whatever be in practice the net balance of the advantages and disadvantages set out above, whether they result in greater or in less productive efficiency, "rationalization" brings in its train the danger of monopoly power being used to exact monopoly prices and conditions from the public. The problem for all industrial communities is therefore one of how to leave business concerns free to achieve the economies and other advantages of combination in so far as they are consistent with the general interest, and at the same time to provide means of curbing any tendency to use monopoly power detrimentally to the public and of penalising those who do so use it. (*See* RATIONALIZATION)

Monopolistic Power.—Size is an important element in combination, but mere bigness is not disconcerting so long as competition remains effective as a curb upon the operations of the mammoth organization The problems with which industrial communities are faced arise when the proportion of an entire industry covered by a great amalgamation is so large as to give it some degree of monopolistic power It has sometimes been laid down as a rough working rule that any consolidation or association which covers 80% of the output of an industry can dictate the prices at which the other 20% shall sell its competing products and so may be described as having an effective monopoly; but that formula cannot be applied indiscriminately, inasmuch as the limiting conditions of control vary greatly from industry to industry and in some industries very effective monopolies of merely local range may exist. Confidence that the fear of competition can be relied upon to restrain tendencies to extortion on the part of even the most complete monopolies rests upon the belief that no association, combine, or consolidation, even though it has a monopoly, can for long put up prices above what is fair and reasonable, because, if it does, it will only "invite competition": new people will come into the industry, competition will start afresh, and prices will fall. But a powerful monopolistic firm or group can make it

extremely difficult for any new entrant to get a footing. It can monopolize raw materials, put pressure on merchants and retailers, or scare investors by hints of an under-selling campaign. It can tie the distributing trade to it with deferred rebates and conditional commissions. It can make it so that no one will enter the field against it except as a perilous speculation It can in fact, if so inclined, build a stockade round its industrial territory. These are the instruments and devices by which a monopoly which is not complete and which is always in peril of a recrudescence of competition can maintain its dominance. For a fuller statement of the history, nature and significance of monopoly the reader should consult the article MONOPOLY The practical outcome of the principles there expounded, as evinced in the case of the great consolidations and powerful associations, are dealt with in this article.

Effects of Combinations: General.—It is in the nature of things not possible to prove conclusively the effect of combination upon the well being and prosperity of an industry or upon the volume of its output or the prices charged to customers It is possible to trace, in very many cases, the course of prices and profits before and after the forming of a particular consolidation or association, but from such surveys there is always lacking a knowledge of what prices and profits would have been had no combination been formed Further, it does not follow that an increased level of prices and profits, if proved, is of necessity an evil There have undoubtedly been, and will yet be, cases of industries working for long periods at less than their proper remuneration, and it may well be a gain, considered corporately, that an industry so placed should improve its position even at the expense of the rest The idea that the state of an industry under competitive conditions is an ideal standard from which to measure departures is not tenable

Effect upon Prices.—One of the most important trade associations in Great Britain, the National Light Castings Association, declared in its original rules "The object the Association has in view is that of raising and keeping up the price of the buyer . ." Most associations, however, would repudiate the suggestion that they aimed at raising prices; and would describe their policy as being directed towards "preventing price-cutting," "securing fair and reasonable prices," "providing a fair return on capital and energy," or, most probably, "stabilizing prices " This latter phrase puts the case for price-control at its strongest. Stabilization, regularity of output, continuity of returns is a desirable condition for any industry, a condition much preferable to one of violent alternations of good times and bad; and steady prices are an important element in steadiness of prosperity. Associations have done much to prevent prices falling, at times of slack demand, to ruinous levels and there can be no doubt that during the war scarcity and post-war boom periods the prices of goods controlled by associations were not in general allowed to rise to the heights reached by goods not so controlled This greater steadiness of prices has certain advantages for the consumer Contractors and buyers of semi-manufactures and components find it satisfactory to be able to depend, in sending out estimates or in planning ahead their own developments, on a reasonable stability in the price they will have to pay for their wares

Again, so far as the stabilization of prices is accompanied by the standardization by prices. *i.e.*, the charging of uniform prices or prices regulated in accordance with a known scale to all purchasers, there is some advantage in each contractor or retailer knowing that his rival is buying on the same terms as himself. These advantages, first to the industry itself and second to the manufacturers and traders who use its products are to be set off against the natural tendency of associations to steady prices in an upward direction; and it must be kept in mind as at least a possibility that the proceeds of steadier prosperity will be devoted to improvements so that in the long run the public may gain the advantage of cheaper goods.

The effect of actual amalgamations of business concerns upon the prices at which their products are sold depends upon a multitude of factors—the circumstances of the businesses before the amalgamation, the thoroughness with which the economies of combination are carried out, the extent of the monopoly power possessed by the amalgamation. There is, however, one factor which may and often does over-rule all these, that of capital inflation accompanying amalgamation. If the purchase price paid to the stock-holders of the several businesses is higher than the capital value of their earning capacities prior to amalgamation, or if the expenses of flotation and the rewards taken by promoters are considerable, the very increase in the capital on which dividends are payable may prevent any reduction in prices even though economies are effected in working costs; the increased capital may, indeed, be regarded as a future charge upon the industry arising from and equal to the economies the combination is expected to achieve

Effect upon Output.—The output of an industry depends upon the demand for its products and that demand is largely conditioned by the price at which they are sold. In general, and with very many qualifications and exceptions, the effect of combination upon output is a reflex of its effect upon price. So much are price and output recognized as interdependent that trade associations have a choice of two ways of "stabilizing" the industry, one being the fixing of prices and the other the regulating of output. In the article ASSOCIATIONS, INDUSTRIAL, an account is given of the system under which certain associations regulate the output of the whole of their members by allotting to each a fixed percentage of the total production, whatever that total may be, with penalties for exceeding the quota and compensations for falling short of it. It is held by the promoters of such "pooling" associations that the effect of the system is not to diminish output It is explained that under the system the total output is neither fixed nor even regulated: but is free to expand or contract in accordance with the total demand It is difficult, however, to accept this view without some reservations Since those who increase their output beyond the average are penalized, and those who fall below the average are rewarded, it would appear that the aggregate output must tend to be less than it would have been in the absence of any "pool." Yet such statements as "there has never been a time when we have failed to supply the utmost demand of the market" are doubtless made in good faith and have a certain truth What happens is that under the influence of the penalties and rewards prices rise, and though the whole demand at the increased price may be met, it is a demand depressed to some extent by the greater costliness of the article. This appears in every way likely to be the immediate effect of the pool system, but against it may be set the consideration that in the long run the gains of steady and equalized production in the various works composing the industry and the greater efficiency due to the removal of obstacles to the interchange of knowledge may accrue to the public in the shape of lower prices, whereupon demand may recover and output increase.

Effect upon Quality.—It has been contended and with some truth, that the fixing of a uniform price at which all establishments in a given branch of industry shall sell their products does not mean an end of competition but rather a change-over from competition in price to competition in quality. Differences in price are more evident than differences in quality and are apt to affect the judgment more. The difference between £1 and 19/- in the price of an article is a plain matter of five per cent. the difference of five per cent in quality is less easily discernible. The immediate effect of the standard uniform price for various makes of the same article is undoubtedly to turn attention at once to differences other than price, and it may be accepted as usually the case that the establishment of uniform prices is followed by a tendency to improvement in designs and quality and hence in value.

Effect upon Evolution of Industry.—According to the competitive principle industrial evolution proceeds in part by the ill-endowed and ill-placed firm being "unable to compete" and after a struggle more or less prolonged going out of business. The ease and certainty with which this process of the "elimination of the unfit" accomplished itself in practice under the competitive system may easily be over-rated, but it certainly did occur The risk of failure, of the total loss of all the capital sunk in the undertaking, was one of the accepted risks of industrial enterprise. Under combination other provisions are made for the flow of business from

the less efficient to the more efficient units In the case of trade associations working a quota system the less efficient members of the group are the more ready to let their business go to the more efficient in that they receive, from the pool, monetary compensation. The least efficient may find it worth while to close down altogether and draw the compensation in perpetuity, and the firms best equipped for efficient production may find it well worth their while to do more than their quota and pay the penalty.

This transference of work from the less to the more efficient firms does in fact take place to a considerable extent, and it cannot be doubted that as a result production is carried on to greater advantage, but it is not so clear that much of the advantage accrues to the general public, since the greater part of the gains of increased efficiency go in the form of compensation to the less competent producers Similarly with amalgamations It may be essential to the attainment of an effective monopoly that all the firms in a line of industry, inefficient and unprofitable, shall be brought within the amalgamation But the inefficient concern will not sell out at a knock-down price, the fact that its non-existence is needed by the amalgamation gives it a new value Many a trust and combine, therefore, has had to acquire properties already overdue for dissolution and has had to choose whether to keep them in being or close them down It will be observed that in both types of combination the cost of providing for the elimination of the units that have shown themselves least fit in the industrial struggle falls not upon the owners of the derelict business but upon the more efficient survivors Questions as to what shall happen to the least profitable concerns in an industry whose capacity exceeds foreseeable demand are among the most difficult of all that confront attempts to "rationalize" such industries and were the main obstacle in 1927 and 1928 to rationalization in the coal and cotton industries of Great Britain

Industrial States.—It must be accepted that the tendency is powerfully and probably irresistibly towards the formation of great consolidations representing whole branches of industry and that these consolidations have it in their power to effect great improvements in the lay-out and organization of the industry and to cut out much of the friction, waste and overlapping which is often due to competition.

It has at the same time to be borne in mind that as these consolidations come into being the old accepted basis and operating principle of industry undergoes a radical change, is completely revolutionized The wheel comes once again full circle and industries are corporate bodies with monopolistic powers, in which a central intelligence directs policy and ordains what supplies and prices shall be A consolidation representing the greater part of an industry, with command or influence over the sources of material and the channels of the distributing trade will be a close corporation from which would-be intruders can be excluded The prospect opening out is thus one of a series of industrial monarchies or republics, enjoying an economic sovereignty within the political realm

Limitations of Powers.—What are the limiting conditions within which these organizations can wield their monopoly powers. It will be evident that in the first place a combination representing an entire branch of industry and charged with the best present and future interests of that industry will not fix prices at a level which will cause the volume of trade to shrink, plant to be idle, and gross earnings to fall How far it could go, if it cared to, in the direction of extorting monopoly prices depends on the elasticity of the demand for the goods it handles and in particular upon whether there is some other article, not very inferior, upon which the consumer can fall back in the event of prices being raised against him In so far as its goods are sold to manufacturers in other industries the undue exercise of monopoly power is likely to produce a corresponding degree of combination among its customers, resulting in prices being a matter of negotiation, bargaining, and agreement between parties of the same order of strength Where the combination is of no more than national range, foreign competition or the fear of such competition may act, in the absence of high import duties, as a check upon any tendency to abuse of monopoly power in some branches of manufacture, but the safeguard of foreign competition is apt to be rendered inoperative by international agreement or consolidation just when its influence is making itself most felt.

LEGAL POSITION OF MONOPOLISTIC COMBINATIONS

Great Britain.—The position is set out in a report furnished in 1927 by the Board of Trade to the League of Nations. In brief, combination of manufacturers or traders is not governed by any special statute, but is subject to the common law doctrine that restraints on trade are bad Contracts or agreements in restraint of trade are in principle unenforceable, though they are not actually illegal unless they involve an illegal act Nevertheless a contract which is technically in restraint of trade has long been regarded by the courts as valid and enforceable when it involves a particular restraint which is not larger than the protection of the party with whom the contract was made reasonably requires. The doctrine of the unenforceability of contracts in constraint of trade is part of the larger legal doctrine of "public policy," which is interpreted in economic matters as equivalent to freedom of trade, or disapproval of measures in restraint of trade In recent years however, the courts have shown a perception of the fact that free competition is not necessarily in the interests of the community, and that, on the contrary, competition may be accompanied or followed by serious disadvantages There has consequently been a tendency for the law relating to combinations to be stated with modifications It may be noted also that in a number of cases the courts have upheld the legality of trade boycotts and other devices by which trade associations seek to strengthen their positions against outside competitors Such devices are regarded as methods of competition and it is held that no action will lie in the absence of a specific illegal act It remains true, however, that the interpretation which the courts give to the common law doctrine relating to contracts in restraint of trade is a limiting factor upon the formation of powerful cartels, in that it is difficult for the latter to secure the enforcement of agreements as against disloyal or recalcitrant members Under the Profiteering Act of 1919–21 investigations were made into the operations of trusts and combines in a number of industries and reports were published, but the acts lapsed in 1921 since when there has been no legal authority to require information to be furnished regarding the operations of trusts or combinations

Canada.—Section 408 of the Canadian Criminal Code deals with conspiracies in restraint of trade The following are defined as offences under this section. to limit transportation facilities, to restrain commerce, to lessen manufacture, and to lessen competition The Combines Investigation Act, 1910, was totally repealed by Statute of 1919 and this latter measure was in turn repealed by the Statute of June 13, 1923. This Statute is entitled "An Act to provide for the Investigation of Combines, Monopolies, Trusts and Mergers" It is the only definite combines act existing in the British empire It provides for the appointment of a registrar, whose duty it is, on receipt of a properly executed application, to cause an enquiry to be made into all matters concerning the alleged combine Upon the report of this preliminary enquiry the minister responsible for the administration of the act decides whether further enquiry is called for, in which case it is undertaken with powers to require evidence on oath, and entry to all premises and documents At the conclusion of every such investigation a report must be presented in writing and within 15 days after its receipt by the minister it must be made public, unless for reasons of public interest. The law has thereupon to take such action as is necessary, and this may take the form of reduction of import duties on foreign competing goods, revocation of patents, or prosecution in the courts on the charge of being a party to or knowingly assisting in the formation or operation of an illegal combine.

United States.—Under the common law of the United States as under English common law agreements in restraint of trade are not enforceable. In 1890 there was passed the Sherman Anti-Trust Act which prohibited under severe penalties "every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several

States, or with foreign nations" and declares it to be an offence to "establish or attempt to establish a monopoly, or to combine or conspire . . . to establish a monopoly of commerce between the several States or in the foreign nations" Much difficulty arose over the interpretation of the act, in particular as to whether it applied to all contracts in restraint of trade or merely to those in unreasonable restraint of trade Successive Supreme Court decisions made the position increasingly clear, but in general in the direction of a more liberal interpretation of the statute From the 1912 decision in the case of the United States Steel Corporation it appeared that the legality of a combination depended on the proportion of the industry it represented, and a 1911 decision made contracts not illegal unless in unreasonable restraint of trade. As a result of these decisions it was felt that the Sherman Act needed strengthening and, on the other hand, it had become evident that some power of dispensation was required to modify the cruder effects of the act Consequently, in 1914, two further acts were passed, the Clayton Act, and the Federal Trade Commission Act. The Clayton Act legalizes certain activities of trade association which were declared illegal under the Sherman Act. It makes it illegal for a company to acquire shares in another company if this leads to "a real diminution of the competition between companies" or "tends to establish a monopoly", it prohibits price discrimination between different purchasers which aims at lessening competition or creating monopoly; and the giving of discounts or rebates on condition that the buyer shall not use or deal in the goods of competitors, and it contains provisions against the holding of posts simultaneously in different companies by directors and employees

The Federal Trade Commission Act established a commission of five members to be appointed by the president to which was assigned two main tasks to investigate and report upon the organization and conduct of corporations alleged to be infringing the anti-trust laws, and to prevent unfair competition. In pursuance of the latter function the commission could, after oral hearing, issue an order requiring the cessation of any practice which it judged to be in contravention of the acts If the order failed to be carried out the commission might apply to the circuit court for enforcement With the exception of the 1918 Webb-Pomerene Act, which permits associations for the purpose of foreign trade which would be illegal in internal trade, the legal position of trusts and associations remains as laid down in the 1890 and 1914 Acts interpreted by successive Supreme Court decisions

British Attitude to Anti-Trust Laws.—As seen by British eyes legislation of the Sherman and Clayton kind is not easily made effective without the doing of more harm than good. The Committee on Trusts, appointed in Feb. 1918, turned its attention rather to what might be called "policing" action than to repression. It sought for ways in which combinations might be controlled or supervised to safeguard the public interest from the abuse of monopoly power while being otherwise left free to achieve all those economies and improvements which combination alone can furnish.

Public ownership, public control, public competition, profit limitation and profit taxation were passed under review. In all these suggested schemes three main difficulties were encountered at the outset; first, that of defining a monopolistic concern; second, that of distinguishing rightful rewards of enterprise and efficiency from the exactions of monopoly; and, third, that of determining the datum on which rate of profit can be calculated. These suggestions were one by one rejected as limited in scope, difficult of application, or hazardous in reaction, and the committee turned its attention in other directions. It was thought that if fuller publicity in regard to the conduct and earnings of business concerns generally, and of the working and effects of combinations in particular, could be secured, the desired object would be in great measure achieved. It was also thought that some machinery should be provided whereby suspected or alleged abuses could be penalised.

Accordingly, the conclusion was reached that there should be established a department of state charged with the duty of informing itself as to the nature, extent and development of combinations of all kinds in so far as they tend to the restraint of trade and the creation of monopolies, and of making preliminary inquiry into complaints made in regard to them, also that a tribunal should be set up to which the department could apply for powers to obtain particular information, and would refer for full investigation cases in which combinations appeared to act injuriously to the public interest The requisite publicity would thereby be secured in two ways the relevant facts as to offences proved before the tribunal would be made public, and the department would present annually to parliament a report upon the nature, extent and development of combinations. Publicity thus secured would not only be in itself a considerable safeguard against the abuse of monopolistic power, but it would serve to reveal actions and developments for which publicity alone was not a sufficient safeguard, and against which further action should be taken, whether in the form of nationalization, public competition or the control of prices and profits. These conclusions formed in substance the recommendations of the committee, but down to the end of 1928 they had not been made the subject of legislation

Until the appointment of the Committee on Trusts no official investigation of the problem presented by the growth of combination in British industry generally had been made The report of that committee, with its appendices, afforded for the first time to parliament and the public authoritative information as to the position Subsequently committees appointed under the Profiteering Acts of 1919 and 1920 issued reports upon particular industries in which much detailed information was embodied. These reports constitute a mine of information for the student of industrial combination in the United Kingdom

The standing of trusts and other combinations before the law, the government and public opinion of the United Kingdom presents curious anomalies. In July 1927 Justice Eve refused a petition to permit the twelve constituent members of the amalgamation "British Ropes, Ltd" to charge their assets, through the medium of a holding company, for the purpose of buying other businesses, and denounced the scheme as a most villainous and mischievous form of finance He declared the combination to be inspired by gain only, its object being to reduce competition to its smallest possible limits and then to impose on the public a price in excess of what the public would be called upon to pay if competition had been left to find its own level On appeal, the Master of the Rolls reversed the decision on the ground that there was reason as well as legal right, in the grouping of the companies concerned, and in this reversal Justice Lawrence concurred, but on the ground that the court was not concerned, under the Companies Acts, to see how the alteration would affect persons outside the company; the variety of these legal pronouncements reflects the indefiniteness of the bearing of the common law upon the modern monopolistic activities The attitude of parliament as reflected in acts concerned in part with sectional questions of monopoly is perhaps most significant in its inconsistency Amalgamations among the great banks have been prohibited; amalgamations among the railways have been enforced, and under the Mining Industry Act of 1926 compulsory powers can be given in certain cases to the promoters of colliery amalgamations for the bringing in of any recalcitrant undertaking whose adherence is essential to the success of the scheme; and in the case of rubber the state has participated in an international output-restriction scheme

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TRUTH. The concept of truth belongs to the fundamental philosophical problems—in fact, one may describe it as the central question of all theoretical philosophy The first step in philosophic reflection consists in asking the question concerning the nature and criteria of truth The world of being is no longer accepted as a simple datum, but a "reason" for it is required; a "principle" is sought which will enable human cognition to distinguish "genuine" being from "non-genuine" being, "reality" from "appearance," truth from error. The same change of attitude occurs also in regard to *values.* Here, too, cognition is not satisfied with the values accepted on the testimony of tradition, custom or authority, but inquires into the *meaning* of the difference between "good" and "evil," and seeks universally valid, "objective" norms to justify this distinction. In this two-fold significance, the problem of truth was first raised in Greek philosophy. From it evolved the various fields of philosophy within Greek thought Logic as also ethics and physics have their common root in the problem of truth For they are all founded on the presupposition that both the *immediate* view of reality, as presented to us in perception, and the immediate purposes pursued by instinctive impulse and desire, are not finally valid. This immediacy is transcended in the theoretical as well as in the practical sense. it is "questioned" and "called to account." This account implies that from now on, in the sphere of thinking, as in that of willing, individual contents are distinguished as having positive or negative value, the latter being rejected as "invalid," the former retained as "valid" This fundamental distinction forms the pervading theme of Greek philosophy.

The individual systems differ only in the means by which they try to solve it, by which they try to obtain a clear definition of the difference between "True" and "False."

In theoretical respects, the first step is made when the certainty of immediate sense perception is shaken and is opposed by another, "critical" authority It is not the senses which decide about truth and falsehood, about being and non-being, the decision rests with reason, pure thought. The beginnings of this view can be traced to the older Ionian philosophy of nature, but it reached its proper development only in the classical systems of the great pre-Socratics Parmenides and Heraclitus, Pythagoreanism and Atomism reject unanimously the view of the world as perceived through the senses and oppose to it another view which is based on thought—the power of the "Logos." According to Heraclitus, the senses alone are "bad witnesses": they can be used for a knowledge of reality only when they are judged by the soul as to their value and truth The senses individualize and separate; as long as we follow them exclusively, each perceiving mind has its own world in which it remains enclosed. Thought, however, is "common to all": by means of it, alone, we reach a universally valid, "objective" view of the cosmos. "It is a duty to follow that which is common, but although the Logos is common to all, the majority live as though they had an insight of their own" (Heraclitus, *Fragment* 2 [Diels]; cf *Fragments* 72, 89, 112–114). "Wisdom resides in One, in the recognition of the reason which pervades all and everything" (*fr.* 41). According to Parmenides, the road to truth consists in not allowing oneself to be misled by well-worn habit into trusting sense perception: "no, by reason decide the controversial test, the question of Being and Non-Being" (Parmenides, *Fragment* 1, *cf.* 33 *sqq.*). The true power of conviction (πίστις ἀληθής) does not reside in the senses but in pure thought. "for thinking and being are the same." Similarly, the Pythagoreans see the true *essence* of reality in number, because number is to them the principle of all truth. "For nothing of delusion (ψεῦδος) does the nature of number admit; but delusion occurs only in the realm of the unlimited, the unreasonable, and of that which is not determined by the Logos" (Philolaos, *Fragment* 11). Democritus distinguishes two forms of cognition. the genuine and the spurious one The spurious one comprises sight, hearing, taste, smell and touch—in short, the whole world of sense qualities, which exist only "according to custom",—the genuine one gives us an insight into the veritable, the "true" reality, which belongs only to the atoms and empty space (Democritus, *Fragment* 11)

The completion of this trend of thought is reached in Plato. According to the platonic doctrine of ideas the sensible world, as a world of becoming, can possess no veritable being or truth. It is a world of mere "opinion" (δόξα), a world of "appearance," whereas truth and knowledge refer only to objects of pure thought which are not subject to change This "rational" conception of truth, however, was not without its countercurrents in Greek philosophy The *Sophists* deny the possibility of a universal truth valid for all thinking subjects According to the proposition of Protagoras that "man is the measure of all things," truth is relative and subjective. "for each, his perception is true" (*cf.* Plato's *Theaetus*) Out of this opposition, there develops in later Greek philosophy the controversy between the "dogmatic" and the "sceptical" schools For the former, there is a universally valid "criterion" of truth, which gives to certain concepts and principles absolute certainty

According to the *Stoics* this criterion consists in "cataleptic presentation" (φαντασία καταληπτική). It forms a spontaneous achievement of thought, a type of assent (συγκατάθεσις), which must be added to the sensible impression in order to make it *known* A doubt with reference to the "cataleptic presentation" is not possible we possess full evidence that the object is reproduced in it as it is in itself. In opposition to this the Greek Sceptics deny that there is any such criterion of "evidence" All supposed "truth" is mere probability For the absolute objects, the "things in themselves," are entirely unknown to us (ἄδηλα); accessible to our judgment are merely the appearances of things, which, however, take entirely different shapes according to the differences of the perceiving subjects and the conditions of the perception itself. The definiteness of reason, of the "Logos," is thus abandoned concerning any subject there are innumerable assertions each of which may claim to be equally valid (*See* Herbertz, *Das Wahrheitsproblem in der griechischen Philosophie*, 1913.)

Mediaeval scholasticism, in its definition of the concept of truth, refers throughout to Greek philosophy, especially to Aristotle. According to it, truth consists essentially in the agreement of thinking and being, in the *adaequatio intellectus et rei* (Thomas Aquinas, *De veritate* 1, 2) But this definition bears now a new content For the problem of truth belongs no longer exclusively to the realm of logic, to the sphere of pure *cognition*, but refers essentially to the question of *religious certainty.* The opposition between "sensibility" and "thought" is now replaced by the opposition between "faith" and "knowledge." Religious faith seeks support in the intellect (*fides quarens intellectum*), although it cannot find in it a sufficient foundation but stands in need of another, superior source of certainty. Thus the problem arises as to how both principles of certainty, how "natural intellect" and "revelation" stand to one another Scholasticism, at times, supposes a relation of mere *subordination;* at times, it asserts a complete separation between them In the later nominalism this idea of separation is predominant. There arises the doctrine of "twofold truth," according to which a definite sentence may be true from the standpoint of knowledge and false from the standpoint of faith. The problem of truth and of logical and religious certainty

had been conceived most profoundly by Augustine. "Do not turn outward; go back into yourself; in the inner life of man resides the truth." The inner life gives us, as a first indubitable starting point, the certainty of the thinking, feeling and willing subject: the certainty of our own Being and Knowing and Willing This certainty cannot be attacked by doubt because doubt itself is an act of thought and must, therefore, presuppose the latter. "Whoever knows himself as doubting, knows something true and is certain of that which he knows; he is thus certain of truth. Therefore, whoever doubts whether there is a truth, has thus in himself a truth about which no doubt is possible. Therefore, he who doubts at all, cannot doubt truth as such." (Augustinus, *De vera religione*, cap. 39.) However, this *immanent* truth as exhibited in the thinking consciousness, is not the only one, nor a sufficient one for the foundation of religious cognition. For the Being to which religious cognition refers, lies, as an *infinite* Being, beyond the limits of human consciousness For a knowledge of the Divine mere *ratio* must be "transcended" by another power of the mind. Entering into the inner life of the subject and going beyond this inner life are thus the two phases which disclose the realm of truth as a whole. If there were only a truth of finite and contingent things, we could stop with the finite, empirical consciousness as the bearer of this truth However, since there is a region of eternal truths (*veritates aeternae*)—Augustine cites the truths of religion and of pure mathematics—there must be an infinite intellect which thinks them and in which they subsist Human thought does not create these truths; it is only able to receive them in so far as it is enlightened by a higher power In every cognition of a necessary and eternal truth, our reason is only seemingly self-active and autonomous In order to apprehend such a truth, it must be enlightened by the divine intellect The divine Logos is the "hidden sun" which alone makes truth visible for us

The intimate connection of the problem of truth with the problem of God, which is characteristic of mediaeval epistemology, continues for a long time also in *modern philosophy* The after-effects of the Augustinian doctrine are obvious in Nicolaus Cusanus and Marsilius Ficinus. (*See* under FICINUS) (*Cf.* Ernst Cassirer, *Individuum und Kosmos in der Philosophie der Renaissance*, 1927) But also Descartes and Malebranche, Cudworth and the Cambridge Platonists show clearly traces of this On the other hand, however, there develops a more and more pronounced tendency to emancipate the problem of truth from all entanglements with theological questions and to give it logical independence. Modern rationalism, as represented especially by Herbert of Cherbury's *De veritate* (1624), maintains the pure self-determination, the unconditioned autonomy of thought Human reason decides according to its own, universally valid, innate principles about truth and error. Its fundamental concepts and axioms are absolutely binding. There can be no conflict between faith and knowledge because any truth of faith needs the test of reason to attain to and be determined in its certainty. In Descartes, Spinoza and Leibniz, the clear and distinct cognition (*clara et distincta perceptio*) is set forth as the criterion of truth Those judgments alone may claim universal assent which are founded on clear and distinct ideas and which allow us to recognize the connection of these ideas with the same certainty that obtains in the propositions of mathematics (*See* RATIONALISM)

Accordingly, the characteristic trait of truth, the *norma veritatis*, is no longer placed in the agreement of a presentation or cognition in us with an external "transcendent" object, but in the agreement with definite principles of reason itself. Every idea is called true which can be derived from them in a strictly deductive manner, by the method of purely logical or mathematical inference. When this proof has been given for a certain idea, there can be no doubt that the objective reality must conform with the idea; for this agreement forms, itself, a necessary axiom of reason. Thus, Spinoza, for instance, expounds in his *Treatise on the improvement of the understanding* that that which makes a thought a true thought, must lie entirely within it; that the real cause of truth is to be sought, therefore, not in an external object, but exclusively in the intellect itself The mathematical idea of the sphere, for instance, is "true" even if there is no entity to be found in intuition and empirical perception which corresponds to the definition of the sphere in all respects and with perfect accuracy; and after this ideal conception of the sphere, we determine the reality of "nature" as it is grasped and "clearly and distinctly" recognized through geometry and mechanics With particular clarity this conception of truth appears in Leibniz's *Meditationes de cognitione, veritate et ideis* (1684). Against the nominalistic view of Hobbes, that truth consists only in the correct connection of certain linguistic signs (*veritas non in re, sed in dicto consistit*), Leibniz emphasises that the correctness of the connection between the signs must be based on a relation between the ideas themselves. Truth, therefore, always depends on the relations which subsist between the pure ideas

The process in which the assumption of one idea necessarily implies another, gives birth to the systematic coherence of knowledge—and this *nexus* according to the principle of sufficient reason makes up the fundamental character of all truth. Even the truth of phenomena consists only in the fact that they obey certain laws which correspond to the ideal truths of pure logic and pure mathematics. A different form is given to the problem of truth in the English philosophy of the 17th and 18th centuries. In Locke the "intuitive" truth of mathematical ideas is contrasted with the empirical certainty of the existence of things, which can never be inferred by pure logic, but rests on the testimony of sense perception Empirical truth, in this sense, belongs only to the simple ideas which are given to us immediately through sensation or reflection. What we can predicate, on the other hand, about the connection of these simple ideas, about their coexistence, their regular recurrence, etc, has no truth in the strict sense of the word, no demonstrative certainty, but rests on mere probability. With Berkeley and Hume, this view is developed further and stated more radically with reference to the empirical knowledge of nature. The order of nature is not founded on principles which can be understood in themselves as necessary and unconditionally valid, but it represents a purely empirical regularity with which we become acquainted through *habit* and *custom;* the knowledge of this order can, therefore, never claim to be more than probable

With Kant, the battle between the rationalistic and the empirical conceptions of truth is decided in such a way that the laws of pure understanding are recognized as necessary and universal, as valid *a priori*, but that, on the other hand, these laws themselves can retain their validity only within the bounds of experience The traditional definition of truth—namely, that it is the "agreement of knowledge with its object"—involves, as Kant expounds in the *Critique of Pure Reason* (p. 82), a logical circle. For the problem of knowledge consists in determining just what the "relation of a presentation to its object" means, and how we can ascertain this relation The concept of an "object of knowledge" is only the concept of a "Something in general = X," "because, apart from our knowledge, we have nothing which we could set over against it as corresponding to it" "It is clear, however, that because we have only to do with the manifold of our presentations and because that X which corresponds to them, in so far as it is to be something distinct from our presentations, is for us nothing, the unity made necessary by the object can be nothing other than the formal unity of consciousness in the synthesis of the manifold of presentations. Then we say we know the object, when we have effected synthetical unity in the manifold of intuition." (*Kritik der reinen Vernunft*, 1st ed, p 104 *seq.*) The "transcendental" truth, the truth of the object, rests thus on the "formal" truth; for only the forms of pure intuition and understanding make a connection of the phenomena possible; this connection, however, and nothing else, is meant when we attribute to a phenomenon objective significance, objective validity However, since, on the other hand, the concepts of the synthesis *a priori*, although not originating in experience, all refer, nevertheless, to experience as the condition of its possibility, one may say that the possibility of experience is that which alone gives objective reality to all our cognitions. Cognition *a priori* has, therefore, *truth* (agreement with the object) only because it contains nothing further than what is necessary for the synthetic unity

of experience. (*Kritik der reinen Vernunft,* 2nd ed. p 195 ff.) In this sense, Kant declares that with regard to theoretical cognition of nature, experience supplies the rule, and that it is the "source of truth" (*Krit d r. Vern.* p. 375), but in contradistinction to the empiricism of Locke and Hume, experience is here to be understood not as a "mere rhapsody of perceptions," but a synthetical unity according to laws In this point, Kant sees the decisive contrast between his "formal" idealism and the speculative idealism represented, for instance, by Berkeley "The thesis of all true idealists, from the Eleatic school down to Bishop Berkeley, is contained in this formula 'All cognition through sense and experience is sheer illusion, and only in the ideas of pure understanding and reason is truth' The principle which governs and determines my idealism throughout, is, on the contrary. 'All cognition of things merely out of pure understanding or pure reason, is sheer illusion, and only in experience is truth' " (*Prolegomena,* Appendix)

Also in the epistemology of the 19th and the beginning of the 20th century, the problem of truth is the central problem It is especially the battle between pure "formalism" or "logicism" on the one hand, and "pragmatism" on the other, which gives to this epistemology its stamp. In the sense of "logicism," the concept of truth is determined especially by Bernhard Bolzano (1781–1848) Bolzano demands that the logical definition of truth must be set forth without any regard for the individual minds for whom the truth is valid, and without any intermingling of psychological determinations Truth is entirely independent of the thought of an individual mind This view is expressed in Bolzano's concept of a "truth in itself" "I understand by a truth in itself any proposition which predicates something as it is, whereby I leave undetermined whether this proposition has really been thought and expressed by anybody or not Be it the one or the other, the proposition shall always receive from me the name of a truth in itself if only . . . the object with which it deals, really possesses what it attributes to it Thus, the quantity of flowers, for instance, which a certain tree standing in a definite place had last spring, is an indicable number even if nobody knows it; a proposition, therefore, which indicates this number, has for me the name of an objective truth even if nobody is cognizant of it"

This formal determination of truth, which abstracts from any reference to actual thinking, is opposed by pragmatism (*q v*) For pragmatism, the concept of truth can be understood only if it is referred to the *activity* of thought, and if this activity is not considered merely in the abstract but is treated as a vital expression of a living individual "True" is the term applied to those representations which hold good in the course of one's experience, *i e*, which prove practically useful. This "power to work" is the real characteristic and criterion of truth It is, accordingly, not so much an abstract-logical, but rather a *biological* conception. the truth of a judgment is decided not by the agreement with a reality existing in itself, but by its practical efficiency As a consequence, there results that *relativity* of truth which had already been urged by the Greek Sophists, especially by Protagoras Truth is never absolute and universally valid. it is always true only for a definite biological species, inasmuch as the advantage of certain beliefs depends upon what is conducive to the species (For a *criticism* of pragmatism, *see* CASSIRER: *Substance and Function*) In an entirely different manner and with a different tendency Rickert tries to base the conception of truth not so much upon theoretical as upon "practical reason" According to Rickert's doctrine, we must start our quest for this concept not from the idea of what *is*, but from the idea of what *ought to be*, not from "ontology," but from the *theory of values* The concept of reality finally presents itself as a concept of values; for we apply the name "real" to that which, in demanding recognition from every thinking mind, is valid as a *norm* for all thought Only by regression to a superindividual command, to a "transcendent ought," can the meaning of truth be clarified and understood All cognition, inasmuch as it proceeds by judgments, *i.e*, by assent and dissent, implies an act of taking sides. Such an attitude, however, is possible only towards a value Insight into this "primacy of the ought" is necessary for a satisfactory solution of the problem of truth. (Rickert, *Der Gegenstand der Erkenntnis,* 1904.) In general, the treatment of the problem of truth in the epistemology of the 19th and 20th centuries, as compared with that of the 18th century, shows a change in point of view The opposition of "experience" and "thought," of "empiricism" and "rationalism," has been replaced by the opposition of the "theoretical" and the "practical," "intellectualism" and "voluntarism"

(E. CR.)

TRUTNOV, a town of Bohemia, Czechoslovakia, is situated at the foot of the Riesengebirge, on the right bank of the Upa, a tributary of the Elbe Founded by German colonists in the 13th century it developed a flourishing linen industry which was helped by the bleaching suitabilities of the mountain streams and meadows. Pop (1921) 14,584, of whom 11,412 were Germans

TRUXTUN, THOMAS (1755–1822), American naval officer, born at Jamaica, Long Island, N Y, Feb. 17, 1755. While still young he went to sea During the Revolutionary War he was first persuaded to serve in a royal ship But having been wounded in an action with a privateer manned by his countrymen, it is said that he declared he would never fight them again Henceforth he commanded a succession of privateers sent out to cruise against British trade He had the reputation of being uniformly successful in all engagements with British vessels When the independence of the United States was recognized he returned to trade with a high reputation as a seaman When the U.S navy was reconstituted in 1798 he was one of the original corps of six captains American commerce was then subject to much intolerable interference on the part of the French as well as of the British naval officers It was against the first that Truxtun rendered the services which have made him a prominent personage in the history of the U S navy In Feb 1799, he was captain of the United States "Constellation" and on the 19th of that month he captured the French "L'Insurgente" In the following year, and while still in command of the "Constellation," he fought the French "Vengeance," and drove her into Curaçao After 1802 he was not further employed by the navy department He died at Philadelphia on May 5, 1822

TRYON, DWIGHT WILLIAM (1849–1925), American artist, was born at Hartford, Conn, Aug 13, 1849 At the age of 25 he left his position as a clerk in a Hartford publishing house to devote himself entirely to art, and two years afterwards went to Paris, where he became a pupil of the École des Beaux Arts, under J de la Chevreuse, Charles Daubigny and A Guillemet. He first exhibited at the Salon in 1881 In 1882–86 he was director of the Hartford School of Art, and in 1886 became professor of art at Smith college He became a National Academician (1891), and won numerous medals and prizes at important exhibitions, among his pictures being "Daybreak," "Moonlight" and "Early Spring, New England" He died at South Dartmouth, Mass, July 1, 1925

TRYON, SIR GEORGE (1832–1893), British admiral, a younger son of Thomas Tryon, of Bulwick Park, Northamptonshire, was born on Jan 4, 1832 He entered the navy in 1848, and served on various stations and in the Abyssinian expedition of 1867 In 1889 Tryon was promoted vice-admiral, and in August 1891 was appointed to command the Mediterranean fleet, which under him—following the example of his old chief, Sir Geoffrey Hornby—became an evolutionary and, in that sense, experimental squadron On June 22, 1893, the fleet being off Tripoli on the coast of Syria, in two columns, Tryon made the signal to invert the course, the ships turning inwards in succession By a fatal error, the psychological cause of which has never been explained, he ignored the patent fact that the two columns were so near each other that the manoeuvre, as ordered, must entail the most serious risk, if not certainty, of collision. And, in fact, the two leading ships did come into collision, with the result that the "Victoria," Tryon's flagship, was cut open and sank in a few minutes. Tryon and 358 officers and men were drowned.

See the *Life,* by Rear-Admiral C C. Penrose-FitzGerald.

TRYON, WILLIAM (1729–1788), American colonial governor, was born at Norbury Park, Surrey, England, in 1729. In 1764 he succeeded Arthur Dobbs as governor of North Caro-

lina. By refusing to allow meetings of the Colonial Assembly he prevented North Carolina from sending representatives to the Stamp Act Congress in 1765 With the support of the law-abiding element he suppressed with severity the Regulator uprising of 1768–71, caused partly by excessive taxation In July, 1771, he was transferred to New York, where he acted as governor, nominally at least, until 1780 On his return from a trip to England in 1775 he found the colony in rebellion and was compelled to take refuge on the sloop-of-war "Halifax" in New York harbour He was restored to power when the British took possession of New York city in September, 1776, though his actual authority did not extend beyond the British lines. In 1777 he became commander of a corps of Loyalists, and in 1779 invaded Connecticut and burned Danbury, Fairfield, and Norwalk In 1780 he returned to England, and on Jan 27, 1788 died at his London home

See M. D Haywood, *Governor William Tryon and his Administration in the Province of North Carolina* (1903).

TRYPANOSOMES, single-celled parasitic animals belonging to the class *flagellata,* chiefly found in the blood of vertebrates, some cause dangerous maladies, *e g* , sleeping sickness in man, and nagana, or tsetse disease in ruminants, in Africa. For further particulars *see* PROTOZOA

TSAI-DAM (ZAIDAM), a basin area in Central Asia, between the eastern Kuenlun mountains on the south and the Altyntagh and Nan-shan mountains on the north, in the north part of the Chinese province of Kuku-Nor Its altitude is about 8,200 ft above sea, and it has many brackish pools and swamps with bare hills around them, there being little vegetation, save on the mountain slopes around The name Tsai-dam is widely applied to dry lake bottoms in the Mongolian region

See E Trinkler, *Tibet* (Mitteilungen Geogr Ges Munchen, bd 50, 1921–22)

TSANA: *see* TANA

TSANKOFF, ALEXANDRE (1879–), Bulgarian statesman, was born in 1879 in the town of Oriatovo, on the Danube He got his secondary education at Roussé and studied law at Sofia university After specializing in political economy in Germany where he was sent by the university he became professor of economics at Sofia university A social-democrat in his student years, Tsankoff long remained outside active politics In 1922 he became leader of a small group called the National Concord (Naroden Sgovor), drawn from the intelligentzia of the various political parties and the mass of ex-officers, which aimed at combining the dispersed national forces for a struggle against the semi-dictatorship of Stamboliski. To him fell the premiership of the coalition Government, representing all the political parties, except the communists, that took power on June 9th, 1923, after a military *coup d'état,* in the preparation of which Tsankoff's National Concord had its share Prof. Tsankoff remained prime minister till the end of 1925 when he was replaced by Andrea Liaptcheff (*q v*) another leader of the Democratic Union His tenure of office coincided with one of the most tragic periods in modern Bulgaria's history The disturbance that broke out after the overthrow of Stamboliski's régime took thousands of human lives The principal moments in it are the communist rising of Sept. 1923 and the communist outrage at Sveta Nedelia in April 1925

TSARITSYN: *see* STALINGRAD

TSARSKOYE SELO: *see* DYETSKOYE SELO

TSCHAIKOVSKY, NIKOLAI VASSILIEVICH (1850–1926), Russian revolutionary and politician, born at Viatka, studied chemistry at the university of St Petersburg under Mendeleev and Butlerov, and published in the *Bulletin of the Academy of Sciences,* an original work on chemistry. But pure science did not satisfy the ardent youth, who strove for practical activity. Herbert Spencer and Auguste Comte were Tschaikovsky's spiritual guides. The 19 year old student became the soul of the "circle," which soon took his name "The circle of Tschaikovsky" laid the foundation of the Russian Narodniki (populist) movement and for many years directed its channels Persecutions by the authorities changed the character of the movement; from purely cultural it became political, and from the original circle it soon created the revolutionary-terroristic "Narodovolzy."

Tschaikovsky fought desperately against the new tendencies, and after a strong moral crisis left Russia with a few followers for America, where he founded in the wild steppes of Kansas a colony of people "seeking God in themselves." He organised this commune of "Godmen" in the belief that only people enlightened from within could conquer social evils and form a perfect society Nikolai Vassilievich remained true to this conviction and his Christian faith to the end of his days. The Kansas experiment did not succeed and after two years Tschaikovsky returned to Europe "to fight for his ideals among men."

He could not return to his country; long years of exile began He worked in the "Red Cross of the Narodnaya Volia," in the "Fund of the Free Russian Press" and went to the United States to collect funds and to make propaganda for the Russian movement for freedom In 1909 during a secret voyage to Russia he was arrested, but set free after trial He devoted himself to the organisation of the co-operative movement in Russia. The war and revolution found the "first Russian Narodnik" at work in relieving the sufferings of the Russian people: he helped with the food supply of the Northern front, and fed the populations of Lettonia, Poland and Latvia ruined by the war In the revolution of 1917 he fought to the last the Bolshevist currents in the councils of workers and soldiers deputies, finally resigned and gave himself entirely to the White fight against the Bolshevist government He was elected a member of an All-Russian directory in Ufa, and later became president of the Northern Government on the Archangel front Afterwards he was a member of the "political consultation" in Paris, and of the South-Russia government in Ekaterinodar and the Crimea Exile again; once more emigration The White front was broken, the White fight lost After the fall of the Crimean front Tschaikovsky organised in Paris a secret "centre of action," for a fight against the Bolsheviks inside Russia. Until 1923 efforts were made to organise in Russia "a new revolution" but for lack of funds the "centre of action" ceased its existence

TSCHAIKOVSKY, PETER ILICH (1840–1893), Russian composer, born at Votkinsk, in the province of Viatka, on May 7, 1840, was the son of a mining engineer, who shortly after the boy's birth removed to St Petersburg (Leningrad) to become director of the Technological institute there While studying in the school of jurisprudence, and later, while holding office in the ministry of justice, Tschaikovsky picked up a smattering of musical knowledge, but he was never suspected at first of possessing any special musical talent, of which there had been no previous traces in his family Nevertheless, the seriousness of his musical aspirations revealed itself in due course and led him to enter the newly founded Conservatorium of St Petersburg under Zaremba, where he was induced by Anton Rubinstein, its principal, to take up music as a profession

With the former he fared better than the latter who, though worshipped by Tschaikovsky, seems never to have appreciated the gifts and promise of his young pupil who was destined none the less completely to eclipse his own fame Very different was the attitude of Nicholas Rubinstein (Anton's brother) who showed his belief in the young musician in the most practical manner by inviting him to become, in 1866, practically the first chief of the recently founded Moscow Conservatorium, since Serov, whom he succeeded, never took up his appointment

In Moscow, while engaged at the Conservatorium, Tschaikovsky wrote among other things his first opera *The Vojevode,* which was, however, a failure when produced in 1869 In the meantime he had met in St Petersburg Balakirev, Stassov, Rimsky-Korsakov and other representatives of the then "advanced" school in Russian music, who exercised a stimulating influence on him, although neither then nor later was he ever wholly in sympathy with their ideals

Also at this period he fell desperately in love for a time with the opera singer Désirée Artôt who, however, shattered his hopes by marrying someone else He found consolation in his art, and his third opera *The Oprischnik,* was one of many works composed at this time, others including the pianoforte concerto in B flat

minor, the third symphony and another opera *Vakoula the Smith.* The *Opritschnik* was produced at St. Petersburg in 1874 and *Vakoula the Smith* in 1876, but neither had any success

A happier fate attended the B flat minor piano concerto, which though severely condemned in the first instance by Nicholas Rubinstein (to whom it was originally dedicated) as clumsy and unplayable, as a mere duel between the piano and orchestra, and so on, was afterwards taken up with enthusiasm by Hans von Bülow (to whom the composer transferred the dedication) and performed by him everywhere with the greatest success At the same time it is only fair to add that Tschaikovsky, though much hurt by Nicholas Rubinstein's strictures, considerably modified the work on the strength of his criticisms and that Rubinstein in turn ultimately recognized the merits of the concerto and played it constantly To the period of the late '70s belong the E flat quartet, the ballet *The Swan Lake*, and the "Francesca da Rimini" fantasia among other compositions, while during this period also, namely in 1877, Tschaikovsky first began to work on the opera of *Eugen Onegin*, destined to become the most popular of all his stage works and first heard at the Moscow Conservatorium in March 1879

Meanwhile the more personal side of the composer's career had been given a romantic touch by his acquaintance with his lifelong benefactress Nadezhda Filaretovna von Meck (1831–1894) and his deplorable fiasco of a marriage. In 1876 he had aroused the interest of Mme von Meck, the widow of a wealthy railway engineer and contractor. She had a large fortune and she began by helping the composer financially in the shape of commissions for work, but in 1877 this took the more substantial shape of an annual allowance of £600. The strangest feature of their association consisted in the fact that, by agreement, they never met, though they corresponded with one another continually. In 1890 Mme. von Meck, imagining herself—apparently a pure delusion—to be ruined, discontinued the allowance; and though Tschaikovsky was then no longer really in need of it, he was deeply wounded by the manner in which she had made the announcement, and to the end of his days never entirely recovered from the shock which his abnormally sensitive nature had received from the termination of their relations.

Not less distressing was the episode of his marriage Tschaikovsky married Antonina Ivanovna Milyukova on July 6, 1877, but the union proved an impossible one through no fault of hers but simply through his own abnormality of temperament, and it resulted in separation in October

Tschaikovsky, who was deeply affected, went abroad with his brother to recover and was restored in due course to a more satisfactory state, but such happiness as he was to enjoy throughout the remainder of his career was qualified in an ever increasing degree by the tendency to melancholy and morbid introspection which, from the first, had been a conspicuous characteristic of his disposition.

Nor can it be said that he did not have many causes for discomfort and disillusionment in the ill luck and indifferent appreciation which attended in so many instances the performances of his works But he continued to produce none the less with unchecked ardour and the fourth symphony may be named among the other works which he composed during his period of recuperation abroad

Later, after his return to Russia, came the Italian Capriccio and the "1812" overture among other things. In 1879 he wrote his *Maid of Orleans* (produced in 1880) and his first suite for orchestra. In 1881 died Nicholas Rubinstein, to whose memory he dedicated the pianoforte trio in A minor. To the next five years belong the *Manfred* symphonic poem and the *Hamlet* overture fantasia, the operas *Mazeppa* and *Charodaika*, the "Mozartiana" suite and the big fifth symphony, of which even the last-named, though reckoned nowadays among his finest achievements, failed to elicit any great enthusiasm at first Nor were the opera *The Queen of Spades* (which later vied with *Eugen Onegin* in popularity) or the delightful ballet *The Lake of Swans, The Sleeping Beauty* and *Casse-noisette* any more favourably received when first produced, so far at least as the critics were concerned. Better fortune, however, attended the *Casse-noisette* music in suite form which soon found unlimited favour and quickly established itself as one of the most popular pieces of its class ever written. (Incidentally, it may be noted that Tschaikovsky himself had the poorest opinion of this music when he was actually writing it.)

But though, after the time honoured experience of genius, Tschaikovsky gained full appreciation so tardily in his own country, in foreign countries his claims were much more readily recognized. In 1887 the first of several concert tours took him to Leipzig, Berlin, Prague, Hamburg, Paris and London, and won many warm friends for his music in every instance, not least so in London where he conducted the Serenade for strings and the Variations from the third suite at a Philharmonic concert.

Later, in 1891, he paid a visit to America, where he conducted six concerts—four in New York, one in Baltimore and one in Philadelphia—and again he was everywhere received with unbounded enthusiasm, the works performed being the Coronation March, the third suite, two sacred choruses, the B flat minor piano concerto and the Serenade for strings.

In 1893 Tschaikovsky sketched his sixth symphony, becoming more and more absorbed in his task as the work proceeded and more and more firmly convinced that it was the greatest thing he had ever done, a judgment subsequently confirmed in full measure by the world at large; for this was the symphony afterwards known as the "Pathetic," and under that title destined to enjoy such world-wide fame and popularity as perhaps no similar work had ever known before Yet even this symphony had a cold and indifferent reception on the occasion of its actual first performance (on Oct. 28, 1893) at St. Petersburg, though in this instance the verdict was speedily reversed, both in Russia and elsewhere

But the composer was not fated to witness and enjoy its triumphs. For within ten days of its production the world was shocked by the news of his wholly unexpected death—from an attack of cholera, caused by the drinking of unfiltered water—on Nov 6, 1893.

As to the precise value of Tschaikovsky's music and the place which it is likely ultimately to take critical opinion has been sharply divided, but with a prevailing tendency to accord far less importance to his work than some consider its due Almost inevitably the enormous popularity enjoyed by so many of his works at the hands of the general public has strengthened this tendency and the impartial student may well wonder if, even when the worst has been allowed, the process of critical belittlement which has been witnessed during recent years in the case of Tschaikovsky, has not gone far beyond the requirements of the case

While his work as a whole may be unequal, there is in the finest of his orchestral compositions, which represent him at his best, a breadth and scope, a wealth of inspiration and imagination, and a command of his materials which may well secure for them a far greater measure of favour at the hands of posterity than is anticipated by some of his critics How, indeed, the title of a great master can be denied to the composer of such things as the fifth and sixth symphonies, the "Francesca da Rimini" fantasia, the B flat minor piano concerto, and the pianoforte trio, it is indeed hard to understand Tschaikovsky's operas are admittedly on a lower plane than the best of his orchestral writing, though containing many delightful pages, and much the same applies to the songs, albeit these also include many examples—he wrote over 100 in all—of rare beauty and charm.

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(H. A. Sc.)

TSCHAKSTE, JAN (1859–1927), first president of the republic of Latvia, was born in Courland, Sept. 14, 1859. He was educated at the Mitau gymnasium, studied law at the University of Moscow, and was for some years in the public prosecutor's depart-

ment of the Courland Government. Leaving the public service in 1888, he started practice as a barrister in Mitau and began to edit the paper *Tēvija* (Fatherland). In 1902 he served on a committee appointed by the local administration to enquire into agricultural conditions in Courland, and from time to time was employed on various Imperial Government committees In 1906 he was elected a member of the first Russian Duma. The German invasion of Courland, July 1915, obliged him to leave Mitau He went to Petrograd (Leningrad) where he founded a central relief committee for war refugees. In 1916 he went to Stockholm to promote the cause of Lettish independence and published there in German his book, *Die Letten und ihre Latvija*.

In 1918 Tschakste was elected chairman of the People's Council and was later head of the delegation sent to Paris and London to secure the recognition of the republic of Latvia. He was president of the Latvian National Council and in 1920 he was president of the Latvian Constituent Assembly, and also became professor of international law at the University of Riga On Nov 14, 1922, he was unanimously elected president of Latvia by the first Latvian Saemia (parliament), and on Nov. 6, 1925, was re-elected for a further period of three years, but he died on March 14, 1927, before the completion of his term of office, after a long and painful illness His activities as a statesman have been dealt with in special publications and, since his death, a memorial fund has been started.

TSCHUDI, GILES or **AEGIDIUS** (1505–1572), Swiss historian, a zealous Catholic, who became the chief magistrate or *landammann* of Glarus in 1558, and in 1559 was ennobled by the emperor Ferdinand, to whom he had been sent as ambassador. He is, however, best known as the historian of the Swiss Confederation His great work is the *Chronicon helveticum*, or *Eidgenossche Kronik*, dealing with the period from 1000 to 1470 In spite of its many inaccuracies, falsifications and acceptance of baseless legends (comp, *e g.*, the article, TELL) this work is one of great interest and merit, and was long considered the leading authority on its subject It enshrines the text of many ancient documents that would otherwise have been lost

Tschudi's chief works were not published until long after his death The *Beschreibung Galliae Comatae* appeared under Gallati's editorship in 1758, and is mainly devoted to a topographical, historical and antiquarian description of ancient Helvetia and Rhaetia, the latter part being an early work on Rhaetia revised and greatly enlarged This book was designed practically as an introduction to his magnum opus, the *Chronicon helveticum* above mentioned, which was published by J R. Iselin in two stately folios (1734–1736) *See* Lives by I. Fuchs (1805) and C. Vogel (1856)

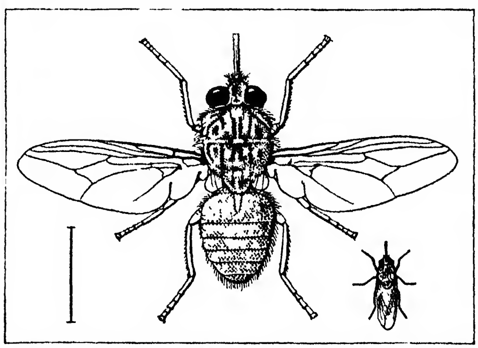
TSÊNG KUO-FAN (1811–1872), Chinese statesman and general, was born in 1811 in the province of Hunan, where he took in succession the three degrees of Chinese scholarship In 1843 he was appointed chief literary examiner in the province of Szechuen, and six years later was made junior vice-president of the board of rites. The Taiping rebels were overrunning Hunan, and Tsêng was ordered to assist the governor of the province in raising a volunteer force, and on his own initiative he built a fleet of war junks, with which he attacked the rebels His lieutenants recovered the capital, Chang-sha, and destroyed the rebel fleet. Following up these victories of his subordinates, Tsêng recaptured Wuchang and Hanyang, near Hankow, and was rewarded for his success by being appointed vice-president of the board of war. The rebels retook Wuchang and burnt the protecting fleet. Tsêng, however, succeeded in clearing the country round the Poyang lake, and subsequently in ridding the province of Kiangsu of the enemy In 1857 he took supreme command in Cheh-kiang. Subsequently the rebels were driven westwards and Tsêng then cleared the province of Ngan-hui of rebel bands.

In 1860 he was appointed viceroy of the two Kiang provinces and Imperial war commissioner. At this time, and for some time previously, he had been fortunate in having the active support of Tso Tsung-t'ang, who at a later period recovered Kashgar for the emperor, and of Li Hung-Chang. In 1862 he became assistant grand secretary of State. At this time the Imperial forces, assisted by the "Ever-victorious Army," had checked the progress of the rebellion, and Tsêng was able to carry out a scheme which he had long formulated of besieging Nanking, the rebel headquarters. While Gordon, with the help of Li Hung-Chang, was clearing the cities on the lower waters of the Yangtse-kiang, Tsêng drew closer his besieging lines around the doomed city In July 1864 the city fell into his hands, and he was rewarded with the rank and title of marquis

After the suppression of the Taipings the Nienfei rebellion, closely related to the former movement, broke out in Shantung, and Tsêng was sent to quell it He failed, and was relieved of his command by Li Hung-Chang, who succeeded him in the vice-royalty of Chihli Tsêng died in 1872

Tsêng was a voluminous writer. His papers addressed to the throne and his literary disquisitions are held in high esteem by the scholars of China, who treasure as a memorial of a great and uncorrupt statesman the edition of his collected works in 156 books, which was edited by Li Hung-Chang in 1876 (R K. D)

TSETSE-FLY, the name given to any one of the twenty species of *Glossina*, a genus of African blood-sucking flies of the family Muscidae, order Diptera (*q v*) In appearance they are brownish insects banded or mottled with darker markings they are somewhat larger than the house-fly and have a prominent proboscis projecting horizontally in front of the head Their habit of resting with the wings closed flat, one over the other, on the back enables them to be distinguished from other blood-sucking flies The female insect does not lay eggs but brings forth at intervals a single fully-grown larva which is deposited on the ground, where it speedily conceals itself in some shady place and turns to a pupa. The flies abound where there is bush or forest, often frequenting the margins of rivers, lakes and islands; they are not found continuously but are restricted to areas known as fly belts Both sexes are active blood suckers and are most troublesome during the hotter parts of the day, attacking both man and domestic animals They are of great economic significance because they act as carriers of the pathogenic organisms (trypanosomes) which are responsible for fatal diseases in man and animals When a tsetse-fly alights on an infected subject and sucks its blood, numbers of the trypanosomes may be taken in at the same time. These tiny organisms require to undergo a developmental phase within the fly and when it is completed, are



TSETSE-FLY (GLOSSINA PALPALIS), FOUND IN WEST AND CENTRAL AFRICA THE SMALLER FIGURE SHOWS THE INSECT WITH ITS WINGS CLOSED FLAT IN A RESTING POSITION, AND THE LINE ON THE LEFT INDICATES THE NATURAL SIZE

ready to pass into the blood of any man or animal upon which the fly happens to feed. In this manner the tsetse-fly *Glossina palpalis* transmits *Trypanosoma gambiense*, the causal agent of sleeping sickness from man to man by means of its piercing mouth-parts, and in a similar fashion *Glossina morsitans* transmits *Trypanosoma rhodesiense*, which is responsible for the more local or Rhodesian form of that disease This same species of tsetse-fly is also the principal carrier of *Trypanosoma brucei*, which causes nagana disease among domestic animals. Five other

kinds of tsetse-fly have been proved experimentally to be capable of transmitting trypanosomes, and it is probable that a number of species are natural carriers of the diseases mentioned.

The development of communications has probably been responsible for the spread of sleeping sickness from West Africa to eastern Central Africa where the population had acquired no immunity. In the five years 1901–06 it is stated that over 200,000 natives died of the complaint in Uganda, where it was previously unknown, and the local tsetse-flies up till then were believed to have been uninfected with the trypanosome The island population of Lake Victoria Nyanza suffered most seriously from this outbreak Among the various methods which have been tried to control the fly, the clearing of vegetation around villages, so as to make such localities unsuitable for the insect, is now receiving attention No feasible methods of luring or poisoning the insect are known, while the destruction of the concealed pupae presents great difficulties if carried out on a sufficiently extensive scale. The utilization of natural parasites has received some attention but at present offers little prospects of success It has been proved experimentally that monkeys can be infected with the sleeping sickness trypanosome, and certain wild game, including antelopes, are regarded as functioning as "natural reservoirs" for trypanosomes although they themselves apparently suffer little ill effects

For a discussion of this subject and all matters connected with the tsetse, *see* E E Austen and E Hegh, *Tsetse Flies* (1922); also R Newstead, *Guide to the Study of the Tsetse Flies* (1924) An account of the ravages of sleeping sickness is given by G D H. Carpenter in *A Naturalist on Lake Victoria* (1920). (A D. I)

TSHI, a group of Negro peoples of the Gold Coast (*q v*) The chief of these are the Ashanti and Fanti

TSIMSHIAN, an American Indian linguistic stock on Nass and Skeena rivers and Milbank sound, British Columbia They are typical North Pacific Coast tribes, forming, with the Tlingit, the Haida and certain Athabascans of the adjacent interior, a matrilineal sub-culture group The four Tsimshian phratries, Raven, Wolf, Eagle and Grizzly Bear, are distributed through the three tribes composing the stock, namely Tsimshian proper, Niska and Gitksan Population, originally estimated, 7,000, 1906, 3,700

TSINAN, TSI-NAN-FU: *see* CHINAN

TSINGTAO, a port on a large inlet named Kiaochow bay, on the south side of the base of the Shantung peninsula, China The bay was occupied by Germany after the murder of two missionaries in Shantung in 1897, and negotiations followed, resulting in a lease of land to Germany for 99 years The area leased was about 117 sq m, and all points within 32 m of any point on the bay were held not to be affected by Chinese ordinances without German consent A free port was created in 1899, and a branch of the Imperial Maritime Customs was established there for collection of duties on shipments to and from the interior, in accordance with the general tariff. Tsingtao, on the bay, became the port and chief centre, and the German Government created educational and agricultural institutions in the leased territory, and fortified the port Japanese forces took the place in 1914, and held it till 1922, when it was returned to China under the Washington Agreement The port is connected with Chinan, the capital of the province of Shantung, by rail, and here the railway joins that from Peking and Tientsin to Pukow on the Lower Yangtze

The Siege of Tsingtao.—The first part which Japan took upon herself to play in the World War was the reduction of the German stronghold of Tsingtao, on the bay of Kiachow This fortress served at the outset of the war as the only base of operations in Eastern Asia for the German marauders menacing the Allied trade routes It was imperative to make von Spee's raiders homeless, and the military and naval operations against the redoubtable base, which was under the command of Capt Meyer-Waldeck and garrisoned by some 13,000 men, of whom 5,599 were German regulars, were started with the utmost despatch On Aug. 27, 1914, the blockade of Kiachow bay was declared by the Japanese navy, and Lungkow, 150m N of Tsingtao, was chosen as the point for landing troops

On Sept 2, 1914, the Japanese division, under the orders of Lieut.-Gen Kamio, commenced landing at Lungkow. Despite the terrible weather conditions, the vanguards arrived on the 12th at the small town of Tsimo, where they encountered the enemy for the first time. The second Japanese contingent began to land at Laoshan bay, within the leased zone, on Sept. 18 and soon established touch with the first army. The Japanese forces under Gen. Kamio thus amounted to about 22,980 officers and men, and they succeeded in some 10 days in wresting from the Germans several of their advanced positions. On Sept. 24 there arrived at the arena of campaign the British force, commanded by Gen. Barnardiston, consisting of 910 officers and men of the 2nd South Wales Borderers and 450 of the 36th Sikhs. After the non-combatants had been permitted to leave the fortress, the general attack of the position was commenced on Oct 31, the Japanese blockading fleet off the harbour assisting by a continuous bombardment On the morning of Nov 7 white flags were descried on the forts of Moltke, Bismarck and Iltis, to the pleasant surprise of the attacking army, which had expected a protracted siege After the fall of the stronghold it was ascertained that all enemy ships, including the Austrian cruiser "Kaiserin Elisabeth," had been sunk in the port of Tsingtao. The Japanese army lost during the campaign 1,968 killed or wounded, and the Japanese navy, a cruiser, a destroyer and a torpedo boat. The port of Kiaochow was reopened for trade by the Japanese on Dec 28, 1914. (*See* WORLD WAR. *Bibliography*.)

TSINLINGSHAN, a range of mountains which forms the southern wall of the Wei-ho valley and extends eastwards into the plain of north China (Honan). It forms a boundary in geology, climate and human relations between the region of loess in the north and the basin of the Yangtze to the south The Tapaling or Tapashan is a range diverging from it south-eastwards, with the valley of the Han between them These mountains are often held to be structurally a continuation of the Kuenlun system and, like the Kuenlun, show folding of rocks up to the Upper Carboniferous age, with granites and gneiss in many places, especially in the north. The reduction in height from the great mountains of the Kuenlun system on the west to the Tsinlingshan on the east is very marked, though the latter reach 10,983 ft and its average height is surprisingly great The break between the Kuenlun system and these mountains is a part of the great break seen all along the east side of the Tibetan plateau The north face is very steep, and loess reaches up to some 3,300 ft above sea-level at places along it The top of the range is broad, with sharp heights The south face has rounded heights and wild, deep-cut valleys. In spite of its size and height the range is essentially one mass, and not a complex of chains such as we find, for example, in the Alps The Chinese were interested in and occupied the Han valley in distant antiquity, but until a way was worked out across the Tsinlingshan, these had to pass south-eastwards up the Tankiang, a long detour if the ultimate goal were Han-chung-fu, or, perhaps, Chengtu in Szechwan The date of the first making of a road across the range is in doubt as between 200 B C. and A D. 200.

TSU-SHIMA, an island belonging to Japan, situated about midway between Korea and the island of Iki, so that the two islands were used as places of call in former times by vessels plying between Japan and Korea Tsu-shima lies about 34° 20′ N., 129° 20′ E The nearest point of the Korean coast is 48 m. distant It has an area of 262 sq m and a population of *c.* 42,000 It is divided at the waist by a deep sound (Asaji-ura), and the southern section has two hills, Yatachi-yama and Shira-dake, 2,130 ft. and 1,680 ft high respectively, while the northern section has Ibeshi-yama and Mi-take, whose heights are 1,128 ft. and 1,598 ft The chief town is Izu-hara The Mongol armada visited the island in the 13th century and committed great depredations. In 1861 an attempt was made by Russia to obtain a footing on the island. The name of the battle of Tsu-shima is given to the great naval engagement of the 27th and 28th of May 1905, in which the Russian fleet under Admiral Rozhdestvensky was defeated by the Japanese under Admiral Togo.

TUAM, a market town and episcopal city of Co. Galway, Ireland, 20 m. N N.E. of Galway on the Great Southern railway. Pop. (1926) 3,288 It is the seat of a Roman Catholic archbishopric, and of a Protestant bishopric. The cross of Tuam, re-erected in modern times, bears inscriptions in memory of Tur-

logh O'Conor, king of Ireland, and O'Hoisin, successively (1128) abbot of St. Jarlath's Abbey and archbishop (1152) of Tuam, when the see was raised. St Jarlath's Roman Catholic college is a seminary founded in 1814 for the education of priests. To the west are the archbishop's palace and a convent of Presentation nuns. The town received its first charter from James I.

TUAN CHI-JUI, Chinese politician, was born in Anhwei He succeeded Yuan Shih-kai as viceroy of the Hukuang Province, and was one of the military leaders who signed the memorial of Jan. 1911, urging the Emperor to abdicate. He was acting Premier from May to July 1913, Minister of War in 1914, and Premier in April 1916. In Oct. 1918 he resigned, and, after an ill-advised coup on behalf of the Anfui Club, played no great part in national affairs till Nov. 24, 1924, when he succeeded Tsao Kun as President.

TUAPSE, a town on the Black Sea in the North Caucasian Area in 44° 10′ N., 38° 59′ E., linked by a branch line with Armavir on the Rostov-Baku railway It has oil refineries working on oil from the Grosniy district, to which a pipe line is being constructed (1928). Its population has grown from about 1,000 in 1897 to 12,142 in 1926

TUAREG, also **TAWAREK** (sing. *Tarqi*), the name given by Arabs to the western and central Saharan Berber peoples in the desert from Tuat to Timbuktu and from Fezzan to Zinder, an area of about 1,500,000 sq m. The Tuareg resort to the centres from which the trade routes radiate, Timbuktu, Ghat, Ghadames, Murzuk and Tuat Their general colour is the reddish yellow of southern Europeans, the uncovered parts of the body being, however, darker through exposure Their hair is long, black and silky, beards black and thin, eyes black; blue eyes are recorded, light brown and grey eyes are commoner, noses small, hands delicate, and bodies muscular They are tall and graceful

The aristocratic section is called *Tmajagh;* Arabs call them *muleth themin* (veiled people) The men wear the veil day and night, the women never The Tuareg, at any rate the noble class, are among the purest of the Berber stocks but have become largely Arabised, though the nomad Tuareg preserve in singular purity the Temajegh language of the Berber family The script is known as T'ifinagh, consists of 40 to 50 symbols, some of which have Punic or Phoenician parallels It may be written in various ways They dress generally in a black tunic (some wear white), trousers of white cotton, and wear a cloth called *litham* or *tagilmus,* the end of which is drawn over the face, leaving visible only the eyes and the tip of the nose. These cloths are dark blue or white In the north the former is worn most by nobles, the latter by the common people To this difference of colour is due the terms "black" and "white" Tuaregs The veil has, or had, some social significance Social status is marked first by assuming the trousers, at 16, then the sword is worn, 18, the stone ring put on, 18 to 21, and last the veil 22–25; marriage takes place late and Tuareg girls enjoy freedom.

Socially the Tuareg are divided into six classes, viz : *Imajeghan* or nobles; *Marabout* or priests; *Imghad* or serfs; *Irejanaten* or mixed people, issue of noble and Imghad; *Ikelan* negro slaves and *Buzu* outdoor slaves. The nobles are all pure blooded and provide the tribal chiefs They do no manual work but live either in convoying those caravans which pay for safe passage, or by making raids on trade routes or even outlying Arab settlements Among the Imghad serfdom is hereditary, and they are bound collectively to a noble tribe or group of tribes They cannot be sold or freed like slaves though they may be inherited. Most of them have practical independence and act as "squires" to the nobles on their pillaging expeditions. The Tuareg weapons are a straight two-edged sword about 4 ft. long, a dagger bound to the left forearm by a leather ring, and spears of two types and leathern shields In hunting, wooden missiles like boomerangs are used.

See Heinrich Barth, *Travels in Central Africa* (1858); W. J. Harding King, *A Search for the Masked Tuaregs* (London, 1903); M. Benhazera, *Six Mois chez les Touareg du Ahaggar* (Algiers, 1908); Lieut. C. Jean, *Les Touareg du sud-est* (Paris, 1909); E. Doutté, *Magie et religion dans l'Afrique du nord* (Algiers, 1909), E. F. Gautier, *Le Sahara* (1923); F. R Rodd, *People of the Veil* (1926).

TUAT, a word sometimes applied generally to all the oases in the western part of the Algerian Sahara, *i e*, between 2° W. and 2½° E. 26° and 30° N., sometimes restricted to a particular group which borders the east side of Wad Messaud between 26⅓° and 27½° N. According to the first usage Tuat includes the oases of Gurara in the north and Tidikelt in the south with the important centre of Insalah. The three groups are spoken of collectively by the French as the Tuat archipelago. The district is comparatively fertile, and produces dates and some cereals and vegetables The wadi Saura (known in its lower course as the Messaud), formed by the junction of the wadis Zusfana and Ghir, marks the north-western boundary of the oases After the winter rains in the Atlas it carries a considerable body of water in its upper course, but lower down its channel is choked by sand At Gurara water is obtained from springs brought to the surface by the outcrop of impervious Devonian rocks There is an extensive *sebkha* or salt lake at Gurara The inhabitants live in *ksurs* or fortified villages, grouped in districts. The Tuat group forms part of the Southern Territories of Algeria; Gurara and Tuat are attached to the territory of Ain Sefra and to the native commune of Timimun Tidikelt to the Oasis territory and to the native commune of Wargla. The total population is 48,914, of which Gurara has 21,338, Tuat 17,493 and Tidikelt 10,329 The principal ksurs are in Gurara, Timimun (pop. 4,828), Deldoul (4 527) at Tuat, Timmi (3,037), Zaouiet-Kounta (2,948), at Tidikelt, In Salah (1,047), In Ghar (1,871) The district is of importance as commanding the routes southwards to Timbuktu and the Sudan.

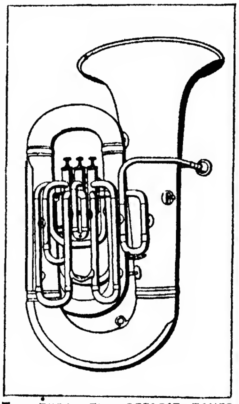
The oases appear to have been inhabited from a very early period According to tradition numbers of Jews migrated thither in the 2nd century A D They were the predominant element in the oases when the conquests of Sidi Okba drove the Zenat south (7th century) These Berbers occupied Tuat and, to a large extent, absorbed the Jewish population The Arabs took possession of the oases in the 10th century and imposed Islam upon the people Thereafter the region was governed by Zenata Berbers or by Arab chieftains The treaty of 1845 between Morocco and France left the question of the possession of Tuat, Gurara and Tidikelt unsettled In 1899 a French scientific mission, under Flamand, was despatched to the oasis of Tidikelt The French were attacked by the natives (Dec. 28, 1899), whom they defeated, and the next day Insalah was occupied. This was the beginning of a campaign which ended in March 1901 in the complete occupation of the oases and of the Zusfana-Saura line of communication, linking the oasis with the region of South Oran. The French were not, however, left in peaceable possession of their newly acquired territory. Attacks by the nomad tribes, Moroccan and others, were made on the line of communications, and during 1903 the French troops suffered serious losses To punish the tribes the town of Figig was bombarded by the French (June 8, 1903) On the 2nd of September, following, a band of nomads attacked, at a place called El Mungar, the escort of a convoy going to Taghit. From 1904, the methods of governor Jonnart and of General Lyautey brought about rapid pacification In 1905, the extension of the railway from South Oran to Colomb Bechar, which had been occupied in Nov. 1903, definitely stabilised French domination in that region

Major A G Laing visited the Tuat territory in 1825 on his way to Timbuktu, but his papers were lost The next European to visit Tuat was Gerhard Rohlfs, who described his explorations and investigations in *Tagebuch seiner Reise durch Marokko nach Tuat, 1864* (Gotha, 1865) and *Reise durch Marokko Exploration der Oasen von Tafilet, Tuat und Tidikelt* (Bremen, 1868) E F Gautier, *Sahara algérien* (Paris, 1908). Id *La conquête du Sahara*, Paris, 1910; Id. *Le Sahara*, Paris, 1923, G. B M Flamand, *Recherches géologiques et géographiques sur le haut-pays de l'Oranie et sur le Sahara*, Lyon, 1911; Augustin Bernard and N Lacroix, *La pénétration saharienne*, Alger, 1906; *Les territoires du Sud de l'Algérie* (publication du gouvernement général avec bibliographie et cartes) 3 vol., Alger, 1922.

TUATARA, the common name of the aberrant lizard-like reptile *Sphenodon* (*q v*) of New Zealand

TUBA, in music, the tubas—bombardon, helicon, euphonium —are a family of valved instruments of powerful tone forming the tenor and bass of the brass wind In the orchestra these instruments are called tubas; in military bands euphonium (tenor), bombardon and helicon (bass)

The modern tubas owe their existence to the invention of valves or pistons by two Prussians, Stolzel and Blümel, in 1815 The tubas are often confounded with the baritone and bass of the saxhorns, being like them the outcome of the application of valves to the bugle family There is, however, a radical difference in construction between the two types. Given the same length of tubing, the fundamental octave of the tubas is an octave lower than that of the saxhorns, the quality of tone being besides immeasurably superior This difference is entirely due to the proportions of the truncated cone of the bore and consequently of the column of air within By increasing the calibre of the bore in proportion to the length of the tube it was found that the fundamental note or first sound of the harmonic series was easily obtained in a full rich quality, and by means of the valves, with this one note as a basis, a valuable pedal octave, absent in the saxhorns, is obtained The instruments termed Wagner tubas are not included among the foregoing, these being really horns designed for Wagner in order to provide for the *Nibelungen Ring* a complete quartet having the horn timbre.



THE TUBA, THE DEEPEST TONED INSTRUMENT OF THE BRASS WIND FAMILY

The modern tuba finds its prototype as well as the origin of the name in the Roman tuba (the Greek *salpinx)* Compared with the other military service instruments of the Romans, the buccina and cornu, the tuba was straight and was used to sound the charge and retreat, and to encourage and lead the soldiers during action, it was sounded at the changing of the guard, as the signal to begin and leave off work, etc It is represented, together with the buccina and cornu, on Trajan's column

TUBE. This term generally refers to a hollow cylinder or pipe for conveying liquids or gases In botany it denotes the narrow basal portion of a gamopetalous corolla or a gamosepalous calyx For a discussion of the manufacture of metal tubing, both seamed and seamless, *see* the articles on IRON AND STEEL; CHEMICAL APPARATUS

The manufacture and application of glass tubing is discussed under GLASS MANUFACTURE Tubes for boilers (*i e*, fire tubing and water tubing), are treated under BOILERS and STEAM GENERATION The term as used in the textile industry (*i e*, tube yarns), is found in articles related to textiles

The application of the term to sub-surface transit is found in the article RAILWAYS, TUBE The article PNEUMATIC CONVEYING treats the use of tubes in postal and similar services Under TYRE various types of inner tubes for vehicles are described The Coolidge Tube and tubes used for X-ray treatment and Radiotherapy are discussed under articles related to these subjects The tubes used in lighting are discussed under LIGHTING AND ARTIFICIAL ILLUMINATION. For Estuary Tubes *see* AQUEDUCTS

Perhaps the most common use of the word in recent years has been in connection with vacuum tubes used in the radio These are discussed under THERMIONICS and THERMIONIC VALVES.

Many special tubes applying to different fields of science and industry are found under various headings in their related fields. One device, however, which deserves mention here is the Knowles Grid-Glow Tube or relay This is a device for controlling electrical power which is so sensitive that it can be operated by the mere approach of the human hand. Superficially the Knowles Grid-Glow Tube resembles the radio tube for it has the anode, the cathode, and Grid However, it has no filament; the connection of the anode and cathode are the reverse of the radio tube; the grid is merely a piece of heavy wire and the tube is filled with neon, argon, or some other gas. The ordinary relay is a device which is operated by a small current which controls a much larger one. The relays commonly used in electrical engineering have an amplifying power of about 10,000, which means that they can control a current 10,000 times greater than the current controlling them A Knowles Grid-Glow Tube has an amplifying power of the order of 100,000,000 and it is probably the most sensitive thing of the kind ever devised. The energy required to operate it is about one one-thousand-millionth ($\frac{1}{1,000,000,000}$) of a watt. This small amount of energy is sufficient to start a current of as high as 25 milli-amperes flowing through the tube This current is sufficient to close or open a switch of 25 amperes and this in turn is ample for controlling almost any operation. It is quite possible by the use of this relay to turn on the lights of the city, start or stop a railway train, or manoeuvre a battleship. The tube is the invention of D. D. Knowles of the research staff of the Westinghouse Electric and Manufacturing company.

TUBE RAILWAYS: *see* RAILWAYS, TUBE.

TUBERCULIN: *see* TUBERCULOSIS.

TUBERCULOSIS. Tuberculosis is a disease of man and animals caused by the tubercle bacillus, which belongs to the "acid-fast" group of bacteria, some of which are pathogenic and others quite harmless. The most important pathogenic varieties are the "human," the "bovine" and the "avian" Whether these are to be regarded as distinct organisms or merely as mutations is not yet settled but they are easily distinguished by their selective effects on test animals.

Fundamentally, tuberculosis consists in an inflammatory reaction of any particular tissue to the invading bacilli, and since tubercle bacilli are relatively little virulent, this tissue reaction is subacute in character It consists in the formation round the bacilli of a microscopic agglomeration of cells constituting the so-called "tubercle." In a typical tubercle there is usually a very large or "giant" multi-nucleated cell in the centre, surrounded by smaller epithelioid cells, and outside these again a zone of lymphocytes Blood vessels are completely absent, and the bacilli may be contained within the giant cell or scattered among the cells. Though in the earliest stage the tubercle is microscopic, when several are formed close together they become visible to the naked eye, and constitute the condition known as miliary tubercle from their supposed resemblance to millet seeds Almost as soon as formed the tubercle undergoes central degeneration (caseation), believed to be directly caused by a toxin produced by the bacilli, aided by the avascular character of the tubercle itself The further progress of the disease varies greatly according to the resisting power of the individual and the presence or absence of secondary, usually pyogenic, infection of the tuberculous focus If resistance be low, and especially if pyogenic micrococci gain access, the focus becomes merely a specialized variety of abscess and behaves like other abscesses, even, at times, to the extent of invading the blood stream and leading to a generalized tuberculosis If, on the contrary, resistance be high the inflammatory reaction terminates in a reparative formation of fibrous (scar) tissue, often with local deposition of calcium salts. Between these extremes are innumerable varieties according as one or other condition predominates

Tuberculosis, when it has reached the stage at which it is clinically recognizable, may be regarded as the end-result of a slow progressive and long unrecognized bacterial invasion. It should never be forgotten that, in the majority of infected persons in civilized communities, this clinically recognizable end-stage is never reached; in other words, only a relatively small proportion of the number of infected persons actually becomes clinically tuberculous

Distribution Throughout the World.—A world-survey shows that tuberculosis tends to be widespread in densely populated areas linked by commercial and social ties with the outside world, and is rare or absent in sparsely populated and culturally isolated communities. Climatic, geological and racial factors appear to play a secondary part. Density of population, with the opportunities for frequent and close contact with infective persons which it involves, appears to be all-important in the dissemination of the germ, while wages, occupation, housing, diet, climatic

conditions and racial customs constitute ancillary factors of varying significance in so far as they bear upon the capacity of the individual to resist the infective dose or doses to which he has been subjected.

With human tuberculosis, it is where men are herded together in the centres of industry that the infection becomes so common as to be almost universal. That this statement is true is proved by the post-mortem findings of reliable pathologists in Europe and America who have investigated long series of cadavers of persons dying from all diseases. In the words of M Fishberg "no matter what the cause of death may have been, whether the persons knew they had tuberculosis or not, between 50 and 100% of people living in large cities show active, quiescent or healed tuberculous lesions in some organ of their bodies."

These findings bring into sharp relief the importance of the distinction between infection and disease. The results of tuberculin tests applied to healthy persons (Pollak, Vienna, 1911; Mantoux, Paris, 1909 and 1910; Fishberg, New York, 1914; Calmette, Lille, 1911 and others) show that, by the age of 15 years, nearly every individual living under urban conditions has already become infected with the tubercle bacillus.

It is clear, therefore, that, in densely populated countries, tuberculous infection is far more widespread than tuberculous disease In sparsely populated and isolated countries, on the other hand, neither tuberculous infection nor tuberculous disease is common Borrel, for instance, found that only 3% of the Senegalese soldiers summoned to Europe for the World War gave a positive response to the tuberculin skin-test on arrival in France, while numerous investigations carried out in the African and Asiatic colonies and dependencies of the European Powers show that primitive tribes living under their natural conditions are almost free from tuberculosis.

It has frequently been shown, however, that the members of these primitive communities, on quitting their native surroundings and coming into contact with the "tuberculized" populations of Europe, tend to show a marked susceptibility to tuberculosis; the clinical course, in these cases, being of a rapidly progressive and usually fatal type

It would seem, in fact, that, where there has been little or no previous exposure to infection, the individual remains completely unprotected against tuberculous disease, while, on the other hand, there is manifest in the members of communities in which tuberculous infection is widespread, a considerable power of resisting the development of the tubercle bacillus and of rendering latent the active foci of infection

Clinical Manifestations.—The primary clinical manifestations of tuberculosis tend to vary with the portal of entry of the bacillus In uninfected subjects, the germs can pass through the mucous membranes of the respiratory and alimentary tracts, without causing, at the moment, any marked local disturbance, and their transit thence is easy along lymphatic channels to the nearest lymphatic glands In these glandular filters, the tubercle bacilli tend to be arrested and there they pullulate and set up the first foci of disease

The formation of secondary foci of infection depends upon the spread of tubercle bacilli from their primary foci in the lymphatic glands to other tissues and organs The presence of secondary foci thus implies a generalization of the infection chiefly by way of the blood stream This generalization can take place much more easily in susceptible persons than in those who are more resistant, and in the young than the old Thus the tendency to widely disseminated tuberculosis is much more marked amongst those groups of individuals in which the "tuberculin test" shows the highest proportion of negative results

In the infants and young children of European and American communities, the proportion of bone and joint tuberculosis and of tuberculous meningitis is far higher than in adults; while, in the adults of "primitive" communities, brought for the first time into contact with infection, the same tendency to wide dissemination of lesions is always found.

The *reactive intolerance* implied in a positive response to the tuberculin test which is only acquired as the result of a preceding infection, constitutes a factor of supreme importance in limiting the spread of tubercle bacilli within the body, by causing local inflammation, cell-proliferation and finally fibrosis, with arrest of the wandering germs and their confinement within a fibrous or calcified area. And this reactive intolerance is manifested, not only toward endogenous re-infection from pre-existing foci but to exogenous re-infection from outside the body

Pulmonary Disease.—With this conception in mind, it is not difficult to understand why the tuberculosis of adult life in civilized and "tuberculized" communities usually takes the form of pulmonary disease In the generalization of infection through the blood stream from the primary lymph-gland foci, the bacillary emboli must travel along the veins from the glands and since all the venous blood must necessarily pass through the capillary bed of the lungs before being re-distributed throughout the body, the lung tissue presents the first filter to be encountered by the blood-borne bacilli It is into the lungs, too, that all contaminations are drawn in respiration While both blood-borne and air-borne tubercle bacilli may pass unchecked through the "virgin" lung-tissue of children and non-infected adults, they tend, where "reactive intolerance" exists, to be arrested in the pulmonary tissue and to set up the inflammatory and ulcerative phenomena of phthisis.

I. IN GREAT BRITAIN

Changes in Clinical Type.—The statement is frequently made that the cases of pulmonary tuberculosis encountered 30 or so years ago were much more acute than those seen to-day, and a general impression exists amongst clinicians that phthisis is more acute even now in parts of Ireland, Scotland and Wales than in London and the big industrial centres This clinical impression receives strong support from the statistical enquiries of J Brownlee (M.R C. Special Report Series No 18, 1918), who has shown that, in males especially and to a less extent in females, the age-period of maximum death-rate has steadily receded from the "young adult" group to the "middle age" group in the succeeding decennia from 1851–60 to the present time

This diminution of the "young adult" type of death-rate has, however, been less marked in certain counties of Ireland, Scotland and Wales, and indeed, in agricultural communities everywhere, than in the larger centres of population Brownlee, in the report quoted, suggested that these differences might be due to the existence of para-tubercle bacilli of unequal virulence, but later researches by Tulloch have failed to discover any antigenic variants in a large series of "human" tubercle bacilli investigated by him. It may be assumed, therefore, that the recession of the age-period of maximum mortality from early adult to later life implies a more protracted clinical type of pulmonary tuberculosis now than formerly and in the larger centres of population as compared with the more sparsely populated agricultural districts

Fall in Tuberculosis Mortality.—As will be seen from the appended table (extracted from the registrar general's *Statistical Review of England and Wales for the Year 1921*, Table 6, page 35) there has been, from 1838 onwards, a steady fall in the tuberculosis death-rate affecting both the pulmonary and all other forms of the disease This fall, which has been observable in other civilized countries, though often claimed as evidence of the value of modern methods of prevention, was just as marked before the recognition of the infective nature of tuberculosis as after the discoveries of Villemin and R. Koch had given a definite direction to sanitary effort. Clearly therefore, some factor of natural adaptation must have been present to supplement the efforts of preventive medicine

Those who favour the theory of an "hereditary disposition" to tuberculous infection see in this diminution of mortality the result of the dying off of susceptible stock and the survival of the more resistant Others consider that, with the wide dissemination of infection resulting from the agglomeration of large numbers of persons into urban communities, there has been at work a factor of natural auto-immunization, individuals acquiring various degrees of resistance as the result of mild and repeated infections.

TABLE I *Annual Mortality at All Ages per Million Persons Living*

Period	Tuberculosis (all forms)	Tuberculosis (of respiratory system)
1838-42 (5 years)	4,419	3,782
1847-50 (4 years)	3,714	2,889
1851-55	3,638	2,805
1856-60	3,323	2,572
1861-65	3,313	2,527
1866-70	3,201	2,447
1871-75	2,942	2,217
1876-80	2,817	2,038
1881-85	2,543	1,830
1886-90	2,324	1,635
1891-95	2,122	1,461
1896-1900	1,906	1,323
1901-05	1,743	1,218
1906-10	1,566	1,106
1911-15*	1,414	1,047
1916-20*	1,441	1,107
1921	1,126	884
1922	1,121	889
1923	1,062	836
1924	1,058	841
1925	1,038	833
1926	961	771

*The mortality for the years 1915-20 relates to civilians only.

In favour of the latter theory, it may be said that "acquired immunity" plays a part in limiting the spread of other bacterial diseases, that even the most susceptible animals may be made relatively resistant to tuberculosis through mild laboratory infections and that a high degree of resistance in any given community, as evidenced by a relatively low death-rate and a relatively chronic clinical type, goes hand in hand with a wide diffusion of infection as proved by tuberculin tests.

Prevention.—Man is liable to infection from two main sources, the first and infinitely the more important being infected persons and the second, milk from infected cows.

Not all infected persons are equally infective Those suffering from the chronic type of pulmonary disease with cavities are, perhaps, the most dangerous of all, such cases producing, as a rule, copious expectoration of a sputum heavily charged with bacilli while, being relatively resistant, they often survive for years and are well enough to remain at home. There exist, too, cases whose symptoms are more suggestive of chronic bronchitis or asthma than of tuberculosis and who consequently remain undiagnosed, no precautions being taken Not only the sputum of such persons but the droplets emitted in coughing and talking are sources of danger to others, while the excreted bacilli may accumulate on the clothing and bedding used by them and in the apartments which they occupy

Such persons establish the greatest concentration of infective matter within the home, and the smaller, the worse ventilated and the more crowded the home, the more massive the infection and the more serious the danger to others. In the home contact with susceptible persons is most likely—for the home is the nest for infants and young children It is upon the homes and the families of infected persons that preventive measures must be focussed

Adequate provision of hospital and sanatorium accommodation is also a prime necessity so that infected persons may be removed from amongst their still healthy relatives The use of sputum flasks, the ventilation of rooms, provision of good food for dependants—all these will help. In France, promising results are being attained on the Grancher System by which the young children of tuberculous parents are placed with selected foster parents in country districts.

Another interesting line of prophylactic effort now under trial in France is the protection of the infants born to tuberculous parents by "vaccination" with living but attenuated tubercle bacilli. A. Calmette and C Guerin have succeeded, by special cultural methods, in so reducing the virulence of a selected bacillary strain that it no longer produces tuberculosis but merely a transitory and benign infective process accompanied, however, by the development, in experimental animals, of a high degree of resistance against re-infection by virulent strains. This vaccine of Calmette (B.C.G.) is now being administered not only to calves but to the infants of tuberculous parents shortly after birth. So favourable have been the results of experiments on laboratory animals that there are grounds for hope as to prevention of human and bovine tuberculosis. Results published by Calmette and his co-workers have, however, been criticized on statistical grounds (notably by A Wallgren in *Acta Pediatrica* 1927, vii., 120) and it will take years to evaluate the success or failure of these experiments. In the interval, the want of any specific preventive measure throws us back upon general measures of hygiene, attempts to diminish the pool of infective persons by improved methods of treatment and the supervision, control and, where possible, isolation of infected persons through the machinery of the tuberculosis schemes of local authorities and by precautions against the sale or the use of milk containing living tubercle bacilli

General measures of hygiene find their most important application in arrangements for the conscientious notification of diagnosed cases, the inspection of "contacts," the medical inspection of school children, the provision of "clean milk," the betterment of housing, the adequate disinfection of contaminated articles and places and tactful and efficient "health visiting"

Recent Methods of Treatment.—Symptomatic treatment, while often affording relief, cannot cure Even "specific" treatment aiming at the production of immunity, while helpful in certain patients, has proved disappointing Tuberculin, in its various forms, is no longer regarded as "a cure in the strict sense of the term" and is not entirely free from risk. The natural power of the human body to amplify its powers of resistance is very great and many cases do well if placed under favourable conditions of life. In this lies the secret of "sanatorium treatment" in which the mode of life of the patient is carefully adjusted to the limits imposed by his disease. Within these limits he can exercise and work with benefit to himself and an increase in the amplitude of his resistance For the more favourable types of pulmonary cases, sanatorium treatment offers a very definite prospect of restoration to average health and working capacity Although so much stress is laid on controlled exercise and work, the basis of the treatment is *rest* In the case of "surgical tuberculosis," too, where the bones and joints of the body are affected, we find in rest the greatest of all adjuvants to recovery A study of the results attained at such English centres as the Treloar Hospital for Cripples at Alton, the Shropshire Orthopaedic hospital, the North Wales sanatorium and the Metropolitan Asylums' Board hospital at Carshalton will suffice to prove the curability of surgical tuberculosis in children by judicious immobilization and rest. Fresh air (*see* PUBLIC HEALTH), sunlight (*see* HELIOTHERAPY) and also the artificial sunlight produced by arc lamps are being used, more and more, to help on the results of treatment by surgical rest, and wonderfully favourable results are already claimed for these methods

In pulmonary tuberculosis, too, the method of "surgical rest" for the affected part is applicable where the disease is confined or almost confined to one lung, and new vistas are being opened up through the use of artificial pneumothorax, apecolysis and thoracoplasty. Nothing is more certain than that the surgical treatment of pulmonary tuberculosis is destined to play an increasingly beneficent part in the future. But, while all these methods are of proven value in appropriate cases, none of them can be claimed as a cure, and it is to Chemiotherapy that we turn in our hope for the future.

Robert Koch found that salts of certain metals, and especially gold, had a lethal effect on the tubercle bacillus but only in concentrations which were also deleterious to the tissues. Research however, has continued on these lines, and Prof. Möllgaard, of Copenhagen, has succeeded in producing a gold compound, sodium aurothiosulphate or Sanocrysin, which, while still under test, appears to have a definitely lethal effect on tubercle bacilli in the

human or animal body, in concentrations which are non-toxic for the patient. Here, again, we appear to be upon the threshold of a great advance in the treatment of tuberculosis. The method, however, is not without danger. (*See* THERAPEUTICS.)

Tuberculosis Schemes.—Up to the end of 1910, the work of fighting tuberculosis in Great Britain was left, for the most part, to the initiative of the more progressive local authorities, supplemented by private enterprise and the work of voluntary organizations Much knowledge was accumulated through the work of the Royal Commissions of 1890 and 1901 and through the activities of the Local Government Board, but there was no coordinated national effort to deal with the disease.

In Nov. 1911, it was made incumbent on every medical practitioner attending on or called to visit any person suffering from pulmonary tuberculosis to notify the case immediately to the medical officer of health concerned. These regulations, the outgrowth of orders by the Local Government Board of Dec. 1908, were made applicable to *all forms* of tuberculosis in Dec. 1912.

In 1911, too, the National Insurance Act made provision for sanatorium benefit for insured persons, the Local Government Board being empowered to authorize county councils to provide, maintain and manage institutions for the treatment of tuberculosis Under the Finance Act, 1911, and the Insurance Act, a sum of £1,500,000 became available for provision of or grants in aid toward sanatoria and other tuberculosis institutions while the Government undertook to pay 50% of the annual cost of the anti-tuberculosis work carried out by local authorities. The Public Health (Tuberculosis) Act of 1921 placed a statutory obligation on each county and county borough council to make arrangements for the treatment of all persons suffering from tuberculosis, whether insured or not.

Finally, in 1911, a departmental committee, presided over by Major (now Lord) Astor, was appointed to report on the general policy in regard to tuberculosis in its preventive, curative and other aspects The tuberculosis schemes now operative everywhere throughout England, Scotland and Wales are based, chiefly, on the report of the Departmental Committee

The units in a complete scheme are as follows:

1 *The Tuberculosis Dispensary or Institute*—The functions of this unit are to be "a receiving and clearing-house and a centre for diagnosis, consultation and observation, where persons can avail themselves of the services of specially qualified medical men" On the dispensary or institute is based, too, the work of the tuberculosis nurses and visitors "who advise and instruct patients in a hygienic mode of life" and help the tuberculosis officer to keep in touch with the homes of tuberculous cases.

2. *Residential Institutions.*—These consist of sanatoria for the more favourable cases and hospitals for those patients unable, at the moment, to benefit by sanatorium treatment. The schemes include arrangements for home nursing, dental treatment, provision of extra nourishment, training in new occupations and "after-care"

For a full account of this subject a pamphlet on "Anti-Tuberculosis Measures in England," by Dr. F. J. H. Coutts, C B., senior medical officer, Ministry of Health, may be consulted.

The growth of anti-tuberculosis work in England since the passing of the Insurance Act may be gathered from the steady increase in expenditure shown in the table in next column which is quoted from Dr Coutts' pamphlet.

Large as these figures may seem, there is still a vast field to cover if tuberculosis is to be dealt with adequately on the present lines The actual notifications, amounting for England and Wales to 57,737 persons in 1924, or 1 47 per 1,000 of population, are admittedly an under-estimate of the known cases, while the undiagnosed carriers of infection must be more numerous still. If the isolation of infective persons is to become effective—and the Public Health Act, 1925, contains clauses providing for the compulsory hospitalization of infective cases—it will be necessary to face the public maintenance of their dependants while patients remain in residential institutions. And there is an urgent need for further expenditure to provide accommodation and treatment for cases of surgical tuberculosis. The best chance of ultimate economy would seem to lie in the endowment of research directed towards preventive measures and curative treatment

(S. L C)

TABLE II. *Tuberculosis Expenditure (England)*

Period (1)	Gross expenditure of local authorities (2)	Income from insurance committees (3)	Payments from the Exchequer in aid of expenditure incurred during the period mentioned in col 1 (4)
July 15, 1912, to March 31, 1913	£ 96,000	£ 34,000	£ 30,000
Year ended March 31, 1914	373,000	189,000	87,000
Year ended March 31, 1915	505,000	227,000	176,000
Year ended March 31, 1916	700,000	211,000	237,000
Year ended March 31, 1917	894,000	251,000	300,000
Year ended March 31, 1918	1,087,000	266,000	384,000
Year ended March 31, 1919 . .	1,285,000	314,000	450,000
Year ended March 31, 1920	1,954,000	621,000	635,000
Year ended March 31, 1921	2,950,000	828,000	1,011,000
Year ended March 31, 1922	3,074,000	200,000	1,717,000
Year ended March 31, 1926 . .	2,849,815	315,358 (fixed annual payment)	2,345,016
Year ended March 31, 1927	2,972,357	315,358	2,696,112

United States.—During the present century tuberculosis has been a declining disease in all industrialized nations. A moderate though rather steady fall in its death-rate was interrupted by the World War, when all countries involved experienced increases of mortality that were roughly proportionate to the stresses and deprivations (as of food and shelter) incident to the conflict After 1918 the decline in mortality reappeared at an accelerated pace and to an unprecedented degree.

This universal recession of the age-long principal cause of death was most pronounced in the United States Here its outstanding features may be summarized as follows: (1) a drop in the tuberculosis death-rate from 202 per 100,000 population in 1900 to 80·7 in 1927. (2) An estimated total of 102,000 deaths among a population of approximately 117,000,000 in 1927 as compared with upward of 154,000 deaths among only 76,000,000 people in 1900. (3) Almost a million and a half fewer deaths from tuberculosis during 1900–25 than if the old high rate of 1900 had continued throughout the period. (4) The retreat of tuberculosis from first to fifth place as a cause of death Until 1912 it had always been the most mortal of all diseases, in 1914 it yielded up this position permanently; and since 1924 it has been outranked by the classifications Diseases of the Heart, Pneumonia (all forms), Cancer and either Cerebral Haemorrhage or Nephritis.

This unexampled diminution of a formerly entrenched principal disease has attended a development and perfection of sanatoria for its treatment that have far outstripped similar efforts in any other country. Thirty-four of these institutions, with 4,485 beds, in 1900, had by 1910 grown to 145 with 20,195 beds and by 1925 to over 600, with facilities for 73,715 patients (including 13,401 under the auspices of the Federal Government) At present about 150,000 new patients with tuberculosis are being admitted to sanatoria annually, and Drolet has estimated that, up to 1926, a total of 1,234,000 individual patients had received treatment in the tuberculosis sanatoria of the United States.

As between the several States the disease varies widely in both

mortality and morbidity. Colorado, to which sufferers resort for climatic treatment, has long had the highest death-rate, while Utah, adjoining it, has reported the lowest rate (39 for 1924). In general, tuberculosis mortality is normally highest in the Southern States as a group, particularly those with relatively larger urban population (Kentucky, Maryland, Tennessee, Louisiana, Virginia) The high rates of these States are the direct result of the exaggerated toll of tuberculosis among their city negroes, for whom the disease is two to three times as deadly as for the whites. Nevertheless, encouragement is to be found in the fact that the tuberculosis mortality of the negro is also declining markedly.

The recent radical restriction of immigration has not been in effect long enough to disclose its influence on the nation's tuberculosis In former times of unrestrained immigration, the pouring of new thousands of young and vigorous members of European stocks into the great Atlantic ports probably operated toward a reduction of local mortality by dilution of population. In general, the Russian Jews appeared to weather American urban life best, so far as tuberculosis was concerned, and in New York city would consistently show death-rates for the disease below those of the general community. Next usually came Italians, French (many from Canada), Germans and English, with rates not much higher than those for native American stock The Irish have been notably prey to tuberculosis on American soil, while the Finns, whose numbers are small, have had rates almost as high as the negroes in New York city Any attempts to explain these national (rather than racial) differences must no doubt take into consideration such a prime factor as relative adaptability to American life

The diminution of mortality has been most pronounced in the large cities For instance, in 1900 the tuberculosis death-rate for New York city was 39% in excess of that for the general population of the country (death registration area) By 1925 this disparity had fallen to 7% and exhaustive analysis will show that it represents a general phenomenon. There is no longer any doubt that tuberculosis is declining more rapidly in the cities than in the country districts of the United States

It is also declining most at the earlier ages of life, that is, more among infants under two years of age than among children, and more among the latter than among the general population In New York city the death-rate for infants in 1923 was only one-sixth that of 1898 (94 in 1923 and 609 in 1898), while for children under 15 the decline was from 136 to 33; meanwhile the rate for the general population was cut in three

The forces that are combining to bring tuberculosis under control in the United States are by no means clear. They are, no doubt, numerous and complex That the sanatoria are playing their part can hardly be questioned These institutions annually remove tens of thousands of the ill from active life and thus interrupt innumerable infectious contacts between the sick and the healthy They, meanwhile, train the patients in habits of better health and return them to the community as living object-lessons of the benefits of a hygienic regimen. That the American people have accepted the sanatorium movement is evidenced by the tens of millions of dollars that they are providing out of public funds for the founding and maintenance of sanatoria.

The sanatorium movement in the United States is the outgrowth of organized propaganda set in motion by the National Tuberculosis Association established in 1904. The efforts of this organization, working through its affiliated local societies, entered into every hamlet For 25 years it has exhorted the people continuously on practices designed to avoid and treat tuberculosis, maintaining services and agencies to be applied to every phase of the disease Its funds are recruited through the unique manner of selling, every year at Christmas-time, the so-called "Christmas Seals," stamps to be affixed to postal matter but not for postage. Their sale has become so enormous as to bring an annual gross return of over $5,000,000 though they cost but a cent each.

Working toward the reduction of tuberculosis must also be regarded the amelioration of existence and the rise of the standards of living that have characterized our era and which have, in turn, flowed from the extraordinary multiplication of national and personal wealth in the United States. These resultants of the industrial age have served to cut down tuberculosis; organized endeavour has been alive to their influence and for its own purposes has moulded them to greater effectiveness.

In the United States sanatorium regimen is synonymous with treatment of the disease to a degree that is unmatched elsewhere in the world. The attitude of the medical profession toward newer and more special modes of therapy has been, in general, more conservative than that of their European *confrères.* However, artificial pneumothorax and the more radical surgical measures (thoracoplasty, phrenicotomy, pneumolysis, etc.) have become standard procedures in selected cases of pulmonary tuberculosis and are in general usage. Heliotherapy and other forms of light treatment are universally employed in non-pulmonary disease; their utility in phthisis has not won the same general approval and at present the weight of opinion advises awaiting more tangible results before expressing final judgment. Specific treatment (tuberculin), valuable only in expert hands, holds its own, its most settled field embraces certain forms of ocular tuberculosis. Chemotherapy has made no headway

The X-ray is universally recognized as indispensable in diagnosis, but each succeeding year strengthens the conviction that rontgenography cannot supplant tried and standard methods of physical examination, but, on the contrary, gains in utility only as it is brought into co-ordination with the latter Of the many specific and laboratory tests only the long-recognized demonstration of tubercle bacilli in tissue products is regarded as decisive in diagnosis

The spirit of study and research of the disease has developed enormously It was given great impetus by *The American Review of Tuberculosis,* a monthly scientific periodical, founded in 1917 by the National Tuberculosis Association Among the more prominent centres of research in tuberculosis are the Trudeau Foundation at Saranac Lake, the Henry Phipps institute at Philadelphia, the Kenneth Dows laboratories of the Johns Hopkins university at Baltimore, the National Jewish hospital at Denver, the municipal sanatorium at Chicago, the Lymanhurst School for Children at Minneapolis and the Colorado foundation at Colorado Springs, all of which were established since 1910 (A K. K.)

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TUBEROSE. The cultivated tuberose (*Polianthes tuberosa*) of the family Amaryllidaceae is a plant allied to the Mexican agaves, and is a native of the same country. The tuberous rootstock sends up a stem 3 ft in height, with numerous lanceolate leaves and terminal racemes of waxy white, funnel-shaped, very fragrant flowers. Each flower is about 1½ in. long, with a long tube and a six-parted limb The ovary is three-celled, and the ovoid fruit is crowned by the persistent flower. The plant is largely grown in the United States and at the Cape of Good Hope for export to England, as it is found that imported bulbs succeed better than those grown in the United Kingdom. The double-flowered form is that principally grown.

TUBILIDENTATA, an order of mammals, including only the African aard-varks (*q.v.*), and formerly united with the Xenarthra and Pholidota (*qq.v.*) as the order Edentata, under which heading these groups are treated.

TÜBINGEN, a town of Germany, in the republic of Württemberg, on the banks of the Neckar, at its junction with the Ammer and Steinlach, 22 m. S. of Stuttgart by road. Pop. (1925) 20,266. Tübingen is mentioned as a strong fortress in 1078, and was ruled from 1148 by counts palatine. In 1342 it was pur-

chased by the count of Württemberg, whose descendants afterward acquired the title of duke. The town was captured by the Swabian League in 1519, by Turenne in 1647, and again in 1688 by the French, who destroyed the walls.

The most conspicuous building is the old ducal castle of Hohentübingen, built in 1507–35 on a hill overlooking the town, and now containing the university library and the observatory. The quaint old *Stiftskirche* (1469–83) is a Gothic building containing the tombs of the rulers of Württemberg; the town-hall dates from 1435 and was restored in 1872. Tübingen's chief claim to attention lies in its famous university, founded in 1477 by Duke Eberhard of Württemberg Melanchthon was a lecturer here (1512–18). The university adopted the reformed faith in 1534, but in 1817 a Roman Catholic theological faculty was added to the other faculties. The leading faculty has long been that of theology The university was attended in 1925 by 2,478 students and had a teaching staff of 150. In the neighbourhood is the former Cistercian monastery of Bebenhausen, founded in 1185.

TUBUAI (or **AUSTRAL**) **ISLANDS:** *see* PACIFIC ISLANDS.

TUBUPHONE, a musical instrument resembling the Glockenspiel (*q.v.*), with metal tubes replacing the steel bars of the latter.

TUCKER, ABRAHAM (1705–1774), English moralist, was born in London, of a Somerset family, on Sept. 2, 1705, son of a wealthy city merchant He studied at Merton college, Oxford, and in 1727 settled down as a county gentleman at Betchworth castle, near Dorking. His chief work was *The Light of Nature Pursued* (7 vols 1,765 pp), which was completed but not all of it published when he died on the 20th of November, 1774.

In some important points Tucker anticipates the utilitarianism afterwards systematized by Paley "Every man's own satisfaction" Tucker holds to be the ultimate end of action; and satisfaction or pleasure is one and the same in kind, however much it may vary in degree This universal motive is further connected, as by Paley, through the will of God, with the "general good, the root where out all our rules of conduct and sentiments of honour are to branch "

The *Light of Nature* was republished with a biographical sketch by Tucker's grandson, Sir H P. St. John Mildmay (1905), 7 vols. (other editions 1834, 1836, etc), and an abridged edition by W Hazlitt appeared in 1807. *See* James Mackintosh, *Dissertation on the Progress of Ethical Philosophy* (Edinburgh, 1832); and specially Sir Leslie Stephen, *English Thought in the 18th Century*, iii. 119–130

TUCSON (tōō-sŏn′), a city in southeastern Arizona, lying in the broad valley of the Santa Cruz river. It is about 2,400 ft. above sea level and is sheltered by mountains 5,000–9,000 ft. high. Pop. (1910) 13,193; (1920) 20,292; (1925, Census Bureau estimate) 26,733. In 1920 5,181 were foreign-born, of which 82% were Mexicans Tucson has many irrigated farms in its vicinity and is the centre of one of the oldest agricultural districts of the State. Its climate is dry, mild and equable and attracts many winter visitors. It is on the main line of the Southern Pacific railway and is also the northern terminus of the Southern Pacific of Mexico railway, which gives direct service to Guadalajara and Mexico City. The Southern Pacific has its division headquarters and repair shops in the city.

The University of Arizona (1891; non-sectarian, coeducational) occupies a campus of 75 ac. upon a high hill in the northeastern part of the city. Its attendance increased from 201 in 1909 to 1,778 in the winter session 1926–27. There are 22 buildings, 11 of them built since 1910. Among them are the University library, containing 70,000 volumes, and Steward Observatory. Connected with the university is the State Museum, which houses extensive archaeological and natural history collections. At Tucson are also the Southwest experiment station of the U. S. Bureau of Mines and a desert botanical laboratory maintained by the Carnegie Institution of Washington. In 1900 Tucson became the see of a Roman Catholic bishop and the church maintains a cathedral, St. Joseph's Academy and San Xavier Mission for Indians. The city has an excellent Carnegie library.

In the immediate vicinity lie ruined villages of the ancient Pueblo peoples. In history Tucson is first heard of in 1699 as an Indian rancheria or settlement. In 1763 it was a *visita* of the Jesuit mission of San Xavier del Bac, founded between 1720 and 1732, 9 m. south of Tucson. It was made a presidio (San Augustin del Tugison), or military outpost in 1776, and, although a few Spaniards may have lived there before, the founding of Tucson as a Spanish town dates from this time. It was never afterward abandoned during the Indian Wars The first decade of the 19th century was the apex of its prosperity under Spanish rule, and its population was between 2,000 and 3,000 people By 1848 this number had dwindled to 760 Tucson lay within the territory acquired by the United States by the Gadsen Purchase in 1853 It was occupied by the United States in 1856, and with the arrival of American troops and traders a new era of prosperity began In the 60's and 70's the place witnessed considerable commercial activity, it being a general pack-train centre In 1860 the *Weekly Arizonian,* the first newspaper in the State, was established there Fort Lowell, 7 m north-east of the city, was built in 1873 as a protection against the Apache Indians, it was abandoned in 1891 Tucson was occupied by the Confederates in Feb 1862, and by the Union forces in May. It was the territorial capital from 1867 to 1877 The Southern Pacific railway arrived from the West in 1880, and in 1910 the connection with the Mexican railways was made Tucson was chartered as a city in 1883.

TUCUMÁN, a northern province of Argentina, bounded N by Salta, E by Santiago del Estero, S and W by Catamarca Area, 10,422 sq m Pop (1924), 332,933; 1927 estimate, 409,358 The Sierra de Aconquija is on the western frontier of the province and there is also broken country in the north, but in the east the country is flat, alluvial and very fertile The only large river is the Salí, or Dulce, which receives a large number of small streams from the Sierra de Aconquija and flows through Santiago del Estero to the Porongos lagoons on the frontier of Córdoba Tucumán's main industry is the production of sugar. Nearly a million acres of irrigated land in this province are devoted to the raising of cane and there are some 30 mills operating About 85% of the Argentine supply comes from this region, which yields an annual average of 500 million pounds of sugar as well as some seven million gallons of alcohol made from the residue of the cane

TUCUMÁN or **SAN MIGUEL DE TUCUMÁN,** a city of Argentina, capital of the province of Tucumán, on the right bank of the Salí, or Dulce river, 780 m by rail N W of Buenos Aires, in lat 26° 50′ S, long 64° 35′ W Pop. (1914) 91,216 The climate is warm A summer maximum of 104° F has been recorded, and frosts occur in occasional winters. The rainfall, which occurs almost wholly between September and April is moderate, about 30 in. per year Malarial diseases, especially "chucho" (fever and ague), are common Tucumán is laid out in regular squares, and still retains many of its old characteristics, low buildings enclosing large courts (*patios*), with large rooms, thick walls and tile roofs.

Tucumán was founded in 1565 by Diego Villaruel at the confluence of the Salí and Monteros rivers, but frequent inundations led to a removal to its present site in 1585 In 1680 it succeeded Santiago del Estero as the capital of the province of Tucumán, then under the government of the Spanish viceroy at Lima. The province of Tucumán then extended from Jujuy south to Córdoba. In 1776 the viceroyalty of La Plata was created and Tucumán was transferred to its jurisdiction. In 1816 a convention of delegates from the La Plata provinces met in Tucumán and signed (July 9) an act of independence, which formally dissolved all ties with the mother country.

TUDELA, a town of northern Spain, in the province of Navarre, on the Saragossa-Logroño and Tudela-Tarazona railways, and on the right bank of the river Ebro, which is here joined by its tributary the Queiles Pop. (1920), 10,362. Tudela, the Roman *Tutela,* was taken from the Moors by Alphonso I. of Aragon in 1114. The town was an episcopal see from 1783 to 1851. The

Ebro is here crossed by an ancient bridge of 19 arches. The Romanesque collegiate church, Santa Maria, founded in 1135 and consecrated in 1188 is one of the most perfect in northern Spain. There are many sawmills in the town, and an active timber trade.

TUDOR (Family) The house of Tudor, which gave five sovereigns to England, is derived by all the Welsh genealogists from Ednyfed Vychan of Tregarnedd in Anglesey, who is named in 1232 as steward of Llywelyn, prince of North Wales, and seven years later, as an arbitrator in a convention to which Davydd, the son of Llywelyn, was a party. Tudor Vychan ap Gronw of Trecastell was the father of four sons, of whom the eldest, Gronw Vychan, was in favour with the Black Prince and with Richard II He was forester of Snowdon and steward of the bishop of Bangor's lordship in Anglesey He died in 1382, an infant son being heir to his lands in Penmynydd, whose sister carried them to her husband Gwylym ap Gruffydd of Penrhyn.

Gronw's brothers Gwylym and Rhys served Richard II. as captains of archers Their youngest brother, Meredydd ap Tudor, escheator of Anglesey in 1392 and, like Gronw, an officer of the household of the bishop of Bangor, is said to have slain a man and fled to the wild country about Snowdon. He was the father of the handsome Owen ap Meredydd, commonly called Owen Tudor, a squire who appeared at the court of the infant king Henry VI., and attracted the admiration of the queen mother. About 1428 or 1429, it must have been common knowledge that Owen Tudor and Queen Catherine were living as man and wife. There is no direct evidence for their marriage An act had but lately been passed for making it a grave offence to marry with the queen dowager without the royal consent. this act is said to have been afterwards cut out from the statute book. Richard III denounced his rival Richmond as the son of a bastard, but it must be remembered that Richard was ready to foul the memory of his own mother in order to say the same of the young Edward V. But no one yet has found time or place of Owen Tudor's marriage with Catherine of France

Five children were born to them, the sons being Edmund and Jasper and another son who became a monk. In 1436, a date which suggests that Bedford had been Owen's protector, the influence of Gloucester was uppermost In that year the queen dowager was received within Bermondsey Abbey, where she died in the following January. Her children were taken from her, and Owen Tudor "the which dwelled with the said queen" was ordered to come into the king's presence. He had already seen the inside of Newgate gaol, and he would not obey without a safe conduct When he had the safe conduct sent him he came up from Daventry and went at once to sanctuary at Westminster, whence even the temptations of the tavern would not draw him Allowed to go back to Wales, he was retaken and lodged again in Newgate. He broke prison again and returned to his native Wales. When Henry VI came of full age he made some provision for his stepfather, who fought on the Lancastrian side At Mortimer's Cross (Feb 4. 1461) Owen fell into the hands of the Yorkists, who beheaded him in Hereford market place

His eldest son, Edmund of Hadham (b. *c.* 1430), was knighted in 1449, and in 1453 he was summoned as earl of Richmond He was declared of legitimate birth, and in 1455 he married Lady Margaret. daughter of John Beaufort, duke of Somerset. His only child, afterwards Henry VII., was born three months after his death

Edmund's younger brother, Jasper Tudor, survived him many years Jasper was knighted in 1449 and, about the date of Edmund's patent, was created earl of Pembroke. He bore the royal arms of France and England, differenced with a blue border charged with the royal martlets of the Confessor's fabulous shield, and the same was formerly to be seen upon his Garter stall-plate of 1459 He fought at St Albans in 1455 for the king who had advanced him, and two years later we find him strengthening the defences of Tenby In 1460 he seized Denbigh, where the queen joined him after Northampton He shared the defeat at Mortimer's Cross and left the country in 1462 In 1465 he made a last descent upon Wales, to be driven off by William Herbert, who was rewarded with his earldom of Pembroke, already forfeited by attainder. He came back again with Warwick in 1470 and was hurrying to join the queen when Tewkesbury was fought and lost After many adventures he carried off his young nephew Richmond to Brittany. The two came back together in 1485. After Bosworth, Jasper was created duke of Bedford and restored to his earldom, the earl-marshalship being given him in 1492. He lived to fight at Stoke in 1487 against Lincoln and Simnel his puppet and to be one of the leaders of the host that landed in France in 1492. He died in 1495 leaving no issue by his wife Catherine, the widow of the second duke of Buckingham and a daughter of Richard Widvile, Earl Rivers. But his bastard daughter Ellen is said to have been mother of Stephen Gardiner, bishop of Winchester.

TUDOR PERIOD, in architecture and the decorative arts, a loose term covering the final phase of Perpendicular Gothic and the earlier phases of Elizabethan or even Jacobean work, from which it is usually differentiated by the fact that those examples in which the Gothic influence predominates are termed Tudor, while those in which classic influence is more noticeable are known as Elizabethan or Jacobean Since the Gothic tradition persisted in various parts of England and especially in Oxford and Cambridge until late in the 17th century, it is difficult to assign date limits to the Tudor style. In ecclesiastical architecture the Tudor period saw the climax of Perpendicular development. (*See* Perpendicular Period.) The characteristics in exterior secular work are: large groups of rectangular windows; rich oriel or bay windows; interesting and sometimes fantastic chimney treatments; complex roofs with many gables; much brickwork, frequently in patterns and lavish half-timber (*q v.*) In interior secular work this period saw an extraordinary development of wood panelling which was frequently used to cover all four sides of a room, and often enriched with linen-fold (*q v.*) decoration and occasional naive travesties of classic forms and the lavish use of moulded plaster-work for ceilings, cornices and walls Characteristic examples of the style are. the older portions of Hampton Court palace (1515–25); Layer Marney (1522–25); Moreton Old Hall, Cheshire (1550); Compton Winyates (*c* 1520); Burton Agnes (1602–10); Ford's hospital, Coventry (begun 1529), at Oxford, Corpus Christi college (1516), the Founder's tower (1492–1505) and the hall (1541) at Magdalen, the tower of the old examination schools (*c.* 1620) and the chapel of Oriel (1637), at Cambridge, Queens' college (*c.* 1450), the two earliest courts of S. John's (between 1511 and 1600), and the King's gateway and Great Court at Trinity (built between 1518 and 1605)

(T F H)

TUFF, a rock consisting of volcanic ash, the ejectamenta of craters in a state of eruption (Ital *tufo*) The products of a volcanic eruption may be classified into (*a*) steam and other gases, (*b*) lavas, (*c*) ashes. The ashes have not been burnt in any way, though they resemble cinders in appearance; they are merely porous, slaggy pieces of lava which have been tossed into the air and have become vesicular by the expansion of the gases within them while they were still plastic

Among the loose beds of ash which cover the slopes of many volcanoes, three classes of materials are represented. In addition to true ashes (*a*) of the kind above described, there are lumps of the old lavas and tuffs (*b*) forming the walls of the crater, etc., and which have been torn away by the violent outbursts of steam, pieces of sedimentary rocks (*c*) from the deeper parts of the volcano, which were dislodged by the rising lava, and are often intensely baked and recrystallized by the heat to which they have been subjected. In some great volcanic explosions nothing but materials of the second kind were emitted, as at Bandaisan, Japan, in 1888. There have been many eruptions also at which the quantity of broken sedimentary rocks mingled with the ashes is very great; as instances we may cite the volcanoes of the Eifel and the Devonian tuffs, known as "Schalsteins" in Germany. In the Scottish coalfields some old volcanoes are plugged with masses consisting entirely of sedimentary débris; in such a case we must suppose that no lava was ejected, but the cause of the eruption was the sudden liberation and expansion of a large quantity of steam. These accessory or adventitious materials, however, as distinguished from the true ashes, tend to occur in

angular fragments; and when they form a large part of the mass the rock is more properly a "volcanic breccia" than a tuff. The ashes vary in size from large blocks 20 ft. or more in diameter to the minutest impalpable dust. The large masses are called "bombs"; they have mostly a rounded, elliptical or pear-shaped form, owing to rotation in the air while still viscous. Many of them have ribbed or nodular surfaces, and sometimes (at Vulcano and Mont Pelée) a crust intersected by many cracks like the surface of a loaf of bread. Any ash in which they are very abundant is called an agglomerate (*q.v.*).

In those layers and beds of tuff which have been spread over considerable tracts of country and which are most frequently encountered among the sedimentary rocks, smaller fragments preponderate greatly, and bombs more than a few inches in diameter may be absent altogether. A tuff of recent origin is generally loose and incoherent, but the older tuffs have been, in most cases, cemented together by pressure and the action of infiltrating water, making rocks which, while not very hard, are strong enough to be used for building purposes (*e.g.*, in the neighbourhood of Rome). If they have accumulated sub-aerially, like the ash beds found on Etna or Vesuvius at the present day, tuffs consist almost wholly of volcanic materials of different degrees of fineness with pieces of wood and vegetable matter, land shells, etc. But many volcanoes stand near the sea, and the ashes cast out by them are mingled with the sediments that are gathering at the bottom of the waters In this way ashy muds or sands, or even in some cases ashy limestones are being formed As a matter of fact most of the tuffs found in the older formations contain admixtures of clay, sand and sometimes fossil shells, which prove that there were beds spread out under water.

Apart from adventitious material, such as fragments of the older rocks, pieces of trees, etc, the contents of an ash deposit may be described as consisting of more or less crystalline igneous rocks If the lava within the crater has been at such a temperature that solidification has commenced, crystals are usually present. They may be of considerable size like the grey, rounded leucite crystals found on the sides of Vesuvius, many of these are very perfect and rich in faces, because they grew in a medium which was liquid and not very viscous. Good crystals of augite and olivine are also to be obtained in the ash beds of Vesuvius and of many other volcanoes; blocks of crystalline minerals (anorthite, olivine, augite and hornblende) are common objects in the tuffs of many of the West Indian volcanoes. Where crystals are very abundant the ashes are called "crystal tuffs." In St. Vincent and Martinique in 1902 much of the dust was composed of minute crystals enclosed in thin films of glass, because the lava at the moment of eruption had very nearly solidified as a crystalline mass Some basaltic volcanoes, on the other hand, have ejected great quantities of black glassy scoriae, which, after consolidation, weather to a red soft rock known as palagonite; tuffs of this kind occur in Iceland and Sicily.

Petrographically tuffs are classified according to the nature of the volcanic rock of which they consist; this is the same as the accompanying lavas if any of these were emitted during an eruption, and if there is a change in the kind of lava which is poured out, the tuffs indicate this equally clearly. Rhyolite-, trachyte-, andesite-, and basalt-tuffs are thus the most frequently occurring pyroclastic rocks of the present day. Tuffs are well represented in the stratigraphical record ranging from the Pre-Cambrian to Recent. The older tuffs are most often greatly changed by silicification and devitrification. They may be completely metamorphosed with loss of all original textures and can then only be recognized by their chemical composition and field relationships. Many chlorite and hornblende schists in metamorphic regions represent recrystallized ash beds of basaltic character. The Swedish hälleflintas (*q.v.*) include rocks of pyroclastic origin of the nature of rhyolite-tuffs, but they are completely changed by recrystallization to a granular assemblage of quartz, felspar, mica, etc. (*See* also VOLCANO.) (J. S. F.)

TU FU (杜甫, A.D. 713–770), a Chinese poet and painter of the T'ang dynasty, considered by some Chinese critics as the supreme poet. Tu Fu was born in Tu Ling in the Shensi province, and is therefore often called Tu Shao-Ling (杜少陵), although his father was a native of Hsiangyang in Hupeh. His family belonged to the military and literary class At 15, his essays and fantastic verses won great admiration. After ten years of wandering, he went to the capital, Changan (長安), for his literary examinations. Although his written papers were excellent he was not given a degree, as his views were unorthodox. He then became a wanderer, and on the "Lute Terrace" in Ching Hsien, he met his much admired friend Li Po, whom he immortalized in verse.

In 749 the emperor (玄宗) invited all great scholars for examination Tu Fu presented himself, but waited for four years until he managed to please the emperor with his three great *fu* (三大禮賦, a form of verse in six syllables in each line). He was given a post in the Chih Hsien library which he held for four years, he was then promoted to another post at Fêng-hsien. In 758, when the rebellion of An Lu-Shan (安祿山), which drove the emperor Ming Huang from the throne, broke out, he was exiled and went to live with a relative at White Water village (鄜州).

When a new emperor ascended the Dragon throne, Tu Fu went to pay his respects to him, but on the way he was captured by brigands, beaten, and made prisoner for a year. He escaped, and, emaciated and clad in rags, he reached the emperor. He was appointed to the post of censor, but fell into disgrace and was delegated to a minor post as governor of a small town in Shensi. This position he did not accept, and joined his family at Kansu. They were struggling for existence, and the poet supported them by digging up roots for food and by selling firewood. Several of his children, however, died of hunger After six months in office in Hua Chou, he retired to Chêngtu in Szechwan, living in a house of grass roots. Here he wrote some of his most beautiful lyrics.

In 768 he took up nomadic life once more. He was caught by floods and compelled to go into a ruined temple at Hu Huang without food. After ten days' starvation he was given a feast by the local officials, and died (770) of over-eating.

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TUGELA, the largest river in Natal, its basin being about 8,000 sq.m. in extent. It rises on Mont aux Sources, in the Drakensberg, at over 10,000 ft. above sea-level. After a mile or two it plunges over the great escarpment forming the most rugged and picturesque scenery, and then flows as a dignified stream in a broad, open valley to a point a few miles below Colenso, about 60 m eastward from the source Here the valley becomes steeper and narrower, owing to rejuvenation. This character persists until within a few miles of its mouth, the river being sometimes 2,000 ft. below the neighbouring plateau. The Tugela is quite unnavigable. Its volume has great seasonal fluctuations, being easily fordable in many places in winter, and often quite impassable during summer rains. The Tugela receives as tributaries on its right bank the Little Tugela, rising near Cathkin Peak, and the Bushman and Mooi rivers, which both originate near Giant's castle On its left bank it receives the Klip river, which flows past Ladysmith, the Sunday's river from the Biggarsberg, and the Buffalo river, which rises near Majuba and flows not far from Isandhlwana, at which place, and also at Rorke's Drift, on the Buffalo, memorable actions were fought in the Zulu War. The boundary between Natal proper and Zululand follows the Tugela from its mouth to the confluence with the Buffalo river, and then runs up the latter to its junction with the Blood river, so called on account of the defeat of Dingaan's impi by the Boers in 1838.

TUGGURT, capital of the region of the Wadi Ghir, Algerian Sahara, 127 m. S. of Biskra, with which it is connected by a railway. It is the chief town of a "mixed" commune and of a territory of 212,783 inhabitants. Tuggurt, which has a population of 12,108, was formerly surrounded by a moat, which the French

filled up. The town is entered by two gates. Just within the northern gate is the market place, which contains the chief mosque. The surrounding oasis contains about 200,000 date palms From Tuggurt a road 75 m. long leads across the desert north-east to El Wad (*q.v.*).

TUGUEGARAO, a municipality (with administration centre and 10 *barrios* or districts) and capital of the province of Cagayan, Luzon, Philippine Islands, on the Cagayan river, about 60 m from its mouth, and near the southern boundary of the province. Pop. (1918), 19,298, of whom 75 were whites. The river is navigable to Tuguegarao for vessels of light draught. The Cagayan valley is the great tobacco-producing region of the Philippines, and Tuguegarao is an important shipping point for tobacco Ibanag is the principal language but Ilocano and Tagalog are also spoken by many

TUKE, the name of an English family, several generations of which were celebrated for their efforts in the cause of philanthropy

WILLIAM TUKE (1732–1822) was born at York on March 24, 1732 His name is connected with the humane treatment of the insane, for whose care he projected in 1792 the Retreat at York, under the management of the Society of Friends, which became famous as an institution in which a bold attempt was made to manage lunatics without the excessive restraints then regarded as essential. His son HENRY TUKE (1755–1814) co-operated with his father in his reforms

Henry's son SAMUEL TUKE (1784–1857) continued the work begun by his grandfather, and published a *Description of the Retreat near York*, etc. (York, 1813). He also published *Practical Hints on the Construction and Economy of Pauper Lunatic Asylums* (1815) He died at York on Oct 14, 1857.

Samuel's son JAMES HACK TUKE (1819–1896) is chiefly remembered for his philanthropic work in Ireland, which resulted from a visit to Connaught in 1847, where he witnessed much distress. Letters descriptive of the state of things he saw when he was distributing relief in 1880, were published in *The Times*, and in his pamphlet, *Irish Distress and its Remedies* (1880), he pointed out that Irish distress was due to economic rather than political difficulties, and advocated state-aided land purchase, peasant proprietorship, light railways, government help for the fishing and local industries, and family emigration for the poorest peasants From 1882 to 1884 he superintended the emigration of poor families to the United States and the Colonies. To his reports on the distribution of seed potatoes in 1885, and his letters to *The Times*, which were reprinted under the title *The Condition of Donegal* (1889), were due in a great measure the bill passed for the construction of light railways in 1889 and the Irish Land Act which established the Congested Districts Board in 1891 He died on Jan 13, 1896

See *Report of the Select Committee of the House of Commons* (1815–16); Dr Conolly, *Treatment of the Insane without Mechanical Restraints* (1856), Dr Hack Tuke, *Chapters in the History of the Insane in the British Isles* (1882).

DANIEL HACK TUKE (1827–1895), younger brother of James Hack Tuke, abandoned a solicitor's career to undertake work at the York Retreat. After studying medicine in London, he graduated M D. at Heidelberg in 1853 In 1858, in collaboration with J. C. Bucknill, he published a *Manual of Psychological Medicine*, which was for many years regarded as a standard work on lunacy In 1853 he visited a number of foreign asylums, and later returning to York he became visiting physician to the York Retreat and the York Dispensary In 1859 he retired, but he resumed practice in London in 1875 as a specialist in mental diseases. In 1880 he became joint editor of the *Journal of Mental Science*. He died on March 5, 1895

Among his works were *Illustrations of the Influence of the Mind on the Body* (1872); *Insanity in Ancient and Modern Life* (1878); *History of the Insane in the British Isles* (1882); *Sleepwalking and Hypnotism* (1884), *Past and Present Provision for the Insane Poor in Yorkshire* (1889); *Dictionary of Psychological Medicine* (1892).

TUKHACHEVSKY, MIKHAIL NICOLAEVICH (1893–), Russian soldier, was born in the government of Smolensk. He was educated in the corps of cadets and the Aleksandrovsky military school, out of which he passed in July 1914. In Feb. 1915 he was taken prisoner by the Germans, and, after several fruitless attempts to escape, he succeeded in the autumn of 1917 and made his way back to Russia He was at once taken into the military service of the Soviet, took part in the operations in defence of Petrograd (Leningrad), and in June 1918 received the command of an army. He commanded successively the I., VIII. and V. Armies and then the Caucasian front. After the successful conclusion of operations against Denikin, Tukhachevsky was given the command of the Western front. After the Civil War he became chief of the military academy, and in April 1924 was appointed assistant chief-of-staff.

TUKULOR, a tall, long-headed, well-proportioned and muscular people with long faces and fine features, incorporating Serer, Wolof, Mandinga, Soninke and Fulani elements in Senegal and the French Sudan. They call themselves *Futankobe* or *Futanke;* the Wolofs call them *Tokoror* or dwellers in the Tekrur or Senegalese Futa, or Tukolor, the name adopted for them by the French. Their language resembles Fulani and is related to Wolof and Serer. The Tukulor organized a theocratic elective monarchy, with a religious chief (*Almamy*), a functionary whose office was abolished in 1881 Their present organization is by territorial groups. The Tukulor are fanatical Muslims. The people are skilled cultivators and cattle-raisers, and are very brave

See Dr. Lasnet, *Une mission au Sénégal* (1900); Delafosse, *Haut Sénégal Niger* (1912).

TULA, (1) a province of the Russian S F S R , surrounded by those of Kaluga, Moscow, Ryazan, Tambov and Orel, and not coinciding with the pre-1917 province of the same name Area 24,574 sq km Pop. (1926) 1,499,428, mainly Great Russians It consists of plateau land (950 to 1,020 ft), deeply entrenched by the Don and its tributaries, the Upa and Sosna About 9% is forested, the northern region having coniferous trees, and the south small and scattered patches of birch, ash and oak The south is in the steppe black earth region, where agriculture gives a good guarantee to the peasant, but the north is poorer grey forest soil. There is little good pasture and dairying is not much developed, though sheep, working and milch cattle, horses, pigs and goats are bred to some extent The climate is extreme, with five months' winter frost, an average July temperature of 66° F and 16–18 in. of rain per annum.

The chief crops are rye (48·2%), and oats (28·3%). Buckwheat, potatoes, wheat, millet, grass, hemp and sugar beet are grown, while along the Oka in the north-west of the province, apples, cucumbers, cabbages and onions are cultivated. Peat working is not profitable and the electric stations at Aleksin and Epifan use the local coal This is mined along the railway extending eastwards from Aleksin on the Oka through Tula to the province of Ryazan. The better agricultural conditions lessen the rôle of koustar (peasant) industries, which here consist mainly of the manufacture of small metal goods, especially samovars and wooden wares

(2) Tula is also the name of the chief town of the above province, situated in the broad but low, marshy and unhealthy valley of the Upa, in 54° 12′ N. 37° 37′ E Pop (1926) 150,132. Tsar Boris Godunov founded the first Russian gun factory here in 1595, and in 1632 a Dutchman, Winius, established an iron factory The factories were rebuilt on a larger scale in 1705 and 1714 and towards the end of the 18th century a marked expansion of the industry took place The making of rifles is still the main occupation of the town, other industries being the manufacture of samovars (tea urns), sugar refining, smelting, the making of cutlery, leather and sewn goods and flour-milling. The town is first mentioned in 1147, but its former site seems to have been higher up the Tulitsa, an affluent of the Upa Its wooden fort was replaced in 1514–21 by a stone *kreml* or citadel, which still exists.

TULAREMIA, a specific infectious disease caused by the *Bacterium tularense*. It occurs in rabbits and squirrels throughout the West and South of the United States and causes considerable loss of life among them. In many ways it is quite similar to a plague. The first authentic human case was reported in 1913

in Utah. Since then it has become increasingly important owing to its more general recognition and also to its undoubted increase in frequency. It is transmitted to man either by an intermediate host as the louse or flea or by direct handling of infected animals. It usually begins as a small swollen, ulcerated spot on the skin which is followed by enlargement of the neighbouring glands. This is soon followed by a chill and a high fever which has a tendency to remit daily There is sometimes a generalized skin rash with general involvement of the glandular system Occasionally there is a dull typhoid state. The average course is about two weeks The death rate is rather low but numerous fatalities have been reported. The disease is of particular importance because of its rapid spread to new territories indicating that it will probably occur more frequently in the future

TULCEA, the capital of the department of Tulcea, Rumania, picturesquely situated on the right bank of the Danube, 42 m. from its mouth at Sulina Pop (1928) 28 000, including many Russians, Turks, Greeks and Jews A railway to Cerna Voda is projected There is a large water-borne trade in cereals

TULIP, a genus (*Tulipa*) of bulbous herbs belonging to the lily family (Liliaceae) The species are found wild along the northern shores of the Mediterranean, in the Levant, Armenia, Caucasus, Northern Africa, Persia, and sporadically across North and Central Asia to Japan The cup-shaped flowers have six regular segments in two rows, as many free stamens, and a three-celled ovary with a sessile stigma, which ripens into a leathery many-seeded capsule The species are numerous, and are distinguished one from another by the scales of the bulb being woolly or smooth on the inner surface, by the character of the flower-stalks, by the filaments being hairy or otherwise, and by other characters Owing to the great beauty of the flowers they have been favourites in European gardens for two or three centuries, and have been crossed and recrossed till it has become almost impossible to refer the plants to their original types

The early flowering "Van Thol" tulips, the segments of which are mostly scarlet with yellow edges, are derived from *T. suaveolens*, a native of the Caspian region *T Gesneriana*, a native of Armenia and central Russia, is the origin of some of the later flowering varieties. *T pubescens*, which is probably a hybrid between the two species just named, is the source of some of the early flowering kinds known as Pottebakker, etc *T oculus-solis* and *T Clusiana* are lovely species, natives of southern Europe, and *T silvestris*, with elegant yellow flowers, is a doubtful native of England More recently, owing to the exertions of Russian naturalists, a large number of new species have been discovered in Turkistan, and introduced into Europe. Some of these are very beautiful, and render it probable that by intercrossing with the older species still further difficulties will be presented in the way of identification. These difficulties are further enhanced by the fact that, quite apart from any cross-breeding, the plants, when subjected to cultivation, vary so greatly in the course of two or three years from the original species from which they are directly descended that their parentage is scarcely recognizable This innate power of variation has enabled the florist to obtain, and ultimately to "fix," so many remarkable varieties At the present day tulips of all kinds are much more extensively grown than at any previous period. Not only are millions of bulbs cultivated in Holland for export every year, but thousands are now also grown for the same purpose in the Channel islands, more particularly in Guernsey Large quantities are also grown in the fen district of England and about Belfast in Ireland Tulips were introduced into the Low Countries in the 16th century from Constantinople and the Levant

The florists' varieties of tulips, which have sprung from *Tulipa Gesneriana*, are arranged in separate classes named bizarres, bybloemens and roses, according to their colour and marking. Tulips are readily raised from seeds, and the seedlings when they first flower (after about 7 years cultivation) are of one colour—that is, they are self-coloured. Judged by the florists' rules, they are either good or bad in form, and pure or stained (white or yellow) at the base; the badly formed and stained flowers are thrown away, while the good and pure are grown on, these being known as "breeder" tulips. The breeder bulbs and their offsets may grow on for years producing only self-coloured flowers, but after a time, which is varied and indefinite, some of the progeny "break," that is, produce flowers with the variegation which is so much prized The flower is then said to be "rectified"; it is a *bizarre* when it has a yellow ground marked with purple or red, a *bybloemen* when it has a white ground marked with violet or purple, or a *rose* when it has a white ground marked with rose colour

Tulips flourish in any good garden soil that has been deeply dug or trenched and manured the previous season To secure perfect drainage and greater warmth a fair quantity of sand or grit should be present. Fresh manure should be avoided, but the remains from an old hot-bed or mushroom bed may be incorporated. The best time to plant is in September and October, the bulbs being buried about 6 in deep and the same distance apart The best effects are produced in formal beds by planting the same variety in each, to secure the plants being of the same height and in flower simultaneously

Propagation.—Tulips are usually increased by offsets, which most varieties produce in fairly large numbers These are taken off and sown in drills, like seed They are usually strong enough to flower the third year from this sowing Some varieties produce offsets sparingly and must be increased by seed—a slow and uncertain method New varieties are raised from seed (The colour variation in the flowers of seedlings is discussed above) Seeds are sown in boxes or cold frames, in light sandy soil, and the young plants are allowed to remain undisturbed until the second year They are then lifted and treated like offsets, being sown thinly in beds out of doors They usually flower in about the seventh year The soil in which tulips are propagated should be sandy, free working and thoroughly drained. A warm sheltered position is a necessity

Cultivation.—Planting is best effected during September, October and early November It is usual thoroughly to dig and manure the ground in preparation Holes 6 to 8 in apart and 5 in. deep are then made with a dibbler Sometimes a little loose earth or sand is put in to the depth of about 1 in, and the bulbs laid singly thereon, the holes being closed by the dibbler and the whole raked over Valuable varieties are planted at about the same depth, with a trowel, a little sand being placed around them.

The early flowering varieties should be potted as early in September as practicable, later batches for succession being potted during October Pots 5 and 6 in in diameter are the most convenient for the early-flowering kinds, but seven-inch pots give the better results for the "Darwin" section of the May-flowering kinds which are now used for gentle forcing Five or six bulbs are put in each pot and the tops should be covered with half an inch of soil and half an inch left for water. The soil should be a light and fairly rich compost, comprising about 2 parts loam, 1 part decayed manure or horse droppings that have been thoroughly sweetened, 1 part leaf mould and half a part of sand Pot firmly, and plunge the pots in several inches of ashes out of doors, to protect the bulbs from frost. As soon as growth commences at the top and a fair amount of roots are formed they may be introduced into gentle heat, in batches according to the need and amount of stock available For market a slightly different method is adopted. The bulbs are placed in long shallow boxes, plunged in soil or ashes in semi-darkness, and are afterwards transferred to benches in the forcing houses where they flower Bulbs which have been forced are of no further value for that particular purpose. If planted in borders and shrubberies, however, they will continue to bear fairly good blossoms in the open air for several seasons

Varieties.—*Early Single* (or *Double*) *Flowering Kinds* are the most useful for bedding and pot culture

Late Single Flowering Kinds—These are all tall-growing hardy kinds suitable for growing in herbaceous borders where they can be left undisturbed, or for producing massed colour effects in flower beds. They include (a) "Cottage" or May-flowering tulips, so named because they were discovered in the gardens of old cottages, mansions, abbeys and monasteries, throughout England, Scotland, Ireland, Belgium and France; (b) "Darwin" tulips

which are a distinct race, having a wide range of large self-coloured flowers, but no yellows

Parrot Tulips.—This late flowering group is supposed to be derived from the curious green and yellow striped *T. viridiflora.* The flowers are mostly heavy and drooping, petals brightly coloured, the edges being curiously notched and wavy

TULIP-TREE (*Liriodendron Tulipifera*), a North American forest tree closely allied to the magnolia (*q v.*), called also yellow poplar and whitewood, native from Rhode Island and Vermont west to Michigan and south to Florida and Louisiana. It is one of the handsomest trees of eastern North America, with a straight trunk sometimes 190 ft high and 10 ft. in diameter, deeply furrowed bark, and large smooth leaves, truncate or broadly notched at the apex and two- to four-lobed at the base. The conspicuous tulip-like flowers, about 2 in deep, yellowish-green on the outside and orange-coloured within, are followed by a dry cone-shaped fruit, from which at maturity the numerous seeds hang suspended on short slender stalks. From Virginia to the lower Ohio valley and southward, where the tulip-tree attains its maximum size and abundance, it is a valuable timber tree, furnishing the light, fine-grained lumber known as yellow poplar, whitewood or tulipwood. In 1925 the total cut of yellow poplar lumber in the United States amounted to 375,662,000 bd ft, valued at the mill at $16,318,857 The largest and oldest tulip-tree in the eastern States is at Annapolis, Md

The tulip-tree is widely planted for ornament, and, with protection when young, thrives in England, sometimes attaining a height of 80 ft.

TULL, JETHRO (1674–1741), English agricultural writer and farmer, was born at Basildon, Berkshire, in 1674, probably in March. He entered St John's college, Oxford, in 1691, and was called to the bar at Gray's Inn in 1699 but never practised. In that year he married and began farming on his father's land at Howberry, near Wallingford, and here about 1701 he invented and perfected his machine drill, and began experiments in his new system of sowing in drills or rows sufficiently wide apart to allow for tillage by plough and hoe during almost the whole period of growth. In 1709 he moved to a farm near Hungerford and from 1711 to 1714 travelled in France and Italy, making careful observations of the methods of agriculture in those countries which aided and confirmed his theories as to the true use of manure and the importance of "pulverizing" the soil He did not publish any account of his agricultural experiments or theories until 1731, when his *Horse-hoeing Husbandry* appeared. This was followed by *Horse-hoeing Husbandry, or an Essay on the Principles of Tillage and Vegetation*, by J T., in 1733 He was attacked in the agricultural periodical *The Practical Husbandman and Farmer* and accused of plagiarizing from earlier writers He died on Feb. 21, 1741.

TULLAMORE, a market town and the county town of Co Offaly, Ireland, on the Grand Canal and a branch of the Great Southern railway, by which it is 58 m west by south of Dublin Pop (1926) 4,924 There is considerable trade in agricultural produce, and brewing and distilling are carried on There are several small ruined castles in the neighbourhood, notably Shragh Castle, dating from 1588

TULLE, a town of central France, capital of the department of Corrèze, 58 m S S E of Limoges by rail. Pop (1926) 10,520 Tulle (*Tutela*) owed its importance in the middle ages to the abbey of St Martin, founded in the 7th or 8th century The abbacy was raised to the rank of bishopric in 1317 The town was taken by the English in 1346 It was again conquered by the English in 1369, but, when the inhabitants succeeded in freeing themselves, they were exempted from all imposts by Charles V The Protestants seized Tulle in 1585 The town extends along the narrow valley of the Corrèze, its streets here and there ascending the hill-slopes on either side by means of stairways. Of its 12th century cathedral, once attached to an abbey, only the porch, nave and a tower of the 13th century, with a fine stone steeple of the 14th century, remain. The neighbouring cloister (12th and 13th centuries) has been restored. The abbot's house (15th century) has a carved doorway and well-preserved windows Tulle is the seat of a bishop, of a prefect, of tribunals of first instance and of a chamber of commerce and a board of trade-arbitrators. Its principal industry is the manufacture of small-arms, established in 1690, and now carried on by the state. There are other minor industries. The well-known cascades of Gimel formed by the Montane are near Tulle

TULLOCH, JOHN (1823–1886), Scottish theologian, was born at Bridge of Earn, Perthshire, in 1823, and received his university education at St. Andrews and Edinburgh. In 1845 he became minister of St. Paul's, Dundee, and in 1849 of Kettins, in Strathmore, where he remained for six years In 1854 he was appointed principal of St Mary's College, St. Andrews. The appointment was immediately followed by the appearance of his Burnet prize essay on *Theism* (1855). At St. Andrews, where he held also the post of professor of systematic theology and apologetics, he lectured on comparative religion and treated doctrine historically, as being not a fixed product but a growth. In 1862 he was appointed one of the clerks of the General Assembly, and from that time forward he took a leading part in the councils of the Church of Scotland. In 1878 he was chosen moderator of the Assembly. He did much to widen the national Church of Scotland. He was deeply interested in the reorganization of education in Scotland, both in school and university, and acted as one of the temporary board which settled the primary school system under the Education Act of 1872. He died at Torquay on Feb. 13, 1886

Tulloch's most important works include: *Leaders of the Reformation* (1859), *English Protestants and their Leaders* (1861); *Rational Theology and Christian Theology in the Seventeenth Century* (1872); a monograph on *Pascal* (1876); *Modern Theories in Philosophy and Religion* (1884); *Movements of Religious Thought in Britain during the Nineteenth Century* (1885). *See* the *Life* by Mrs Oliphant (1888).

TULLUS HOSTILIUS, third legendary king of Rome (672–640 B C). His successful wars with Alba, Fidenae and Veii shadow forth the earlier conquests of Latian territory and the first extension of the Roman domain beyond the walls of Rome It was during his reign that the combat between the Horatii and Curiatii, the representatives of Rome and Alba, took place He is said to have been struck dead by lightning as the punishment of his pride. Tullus Hostilius is simply the duplicate of Romulus. Both are brought up among shepherds, carry on war against Fidenae and Veii, double the number of citizens, organize the army, and disappear from earth in a storm. As Romulus and Numa represent the Ramnes and Tities, so, in order to complete the list of the four traditional elements of the nation, Tullus was made the representative of the Luceres, and Ancus the founder of the Plebs. The distinctive event of this reign is the destruction of Alba, which may be regarded as an historical fact. But when and by whom it was destroyed is uncertain—probably by the Latins

See Livy i 22–31; Dion. Halic. iii. 1–35; Cicero, *de Republica,* ii. 17 and ROME: *Ancient History.*

TULSA, a city of Oklahoma, U.S.A, 218 m. (by air) S. by W of Kansas City, on the Arkansas river; county seat of Tulsa county. It is on Federal highways 64, 66 and 75; and is served by the Frisco, the Midland Valley, the Missouri-Kansas-Texas, the Oklahoma Union, the Sand Springs, the Santa Fe and electric railways. Pop. (1920) 72,075 (84% native white and 12% negroes); estimated locally at 165,000 in 1928. It was the second largest city of the State in 1920, and is frequently called "the oil capital of the world." The city occupies 17 sq.m., 800 ft. above sea-level, at the meeting-point of the old boundaries of the Creek, the Cherokee and the Osage Nations. The old council tree of the Creeks, a large elm, still stands There has been a commission form of government since 1908; and a city plan and a regional plan have been adopted. The water supply is brought from a reservoir in the Spavinaw Hills (60 m. E) by force of gravity alone, though the difference in elevation of source and terminus is only 90 ft. Mohawk Reservoir, a 500,000,000-gal. reserve, is the central feature of a park of 2,000 ac. of timbered land, with lagoons, lakes and watercourses fed by the surplus from the reservoir. There are 34 public, two parochial and several private schools. The University of Tulsa, founded at Muskogee in 1894 as Henry Kendall College, was moved there in 1907. The

city's assessed valuation for 1928 was $126,352,220. Tulsa is the commercial and financial capital of a rich agricultural country, and of oilfields producing an average of 400,000 barrels of crude oil a day. All but one of the large companies operating in the Mid-Continent Field have headquarters here, and the International Petroleum Exposition is held here annually White settlement began in 1882, when an extension of the Frisco line was completed to the Indian trading post. "Tulsey Town," as it was called then, grew slowly, reaching a population of 1,390 in 1900. It was chartered as a city in 1902. Oil developments began in 1901. By 1910 the population was 18,182; from 1910 to 1920 it increased fourfold.

TULSĪ DĀS (1532–1623), the greatest and most famous of Hindī poets, was a Sarwariyā Brahman, born, according to tradition, in A D 1532, during the reign of Humāyūn, most probably at Rājāpur in the Bāndā District south of the Jumna. His father's name was Ātmā Rām Sukal Dubē; that of his mother is said to have been Hulasī A legend relates that, having been born under an unlucky conjunction of the stars, he was abandoned in infancy by his parents, and was adopted by a wandering *sādhū* or ascetic, with whom he visited many holy places in the length and breadth of India; and the story is in part supported by passages in his poems He studied, apparently after having rejoined his family, at Sūkarkhēt, a place generally identified with Sōrōṅ in the Etah district of the United Provinces, but more probably the same as Varāhakshētra on the Gogra River, 30 m W of Ajōdhyā (Ayōdhyā) He married in his father's lifetime, and begot a son His wife's name was Ratnāwalī, daughter of Dīnabandhu Pāthak, and his son's Tārak The latter died at an early age, and Tulsī's wife, who was devoted to the worship of Rāma, left her husband and returned to her father's house to occupy herself with religion Tulsī Dās followed her, and endeavoured to induce her to return to him, but in vain, she reproached him (in verses which have been preserved) with want of faith in Rāma, and so moved him that he renounced the world, and entered upon an ascetic life, much of which was spent in wandering as a preacher of the necessity of a loving faith in Rāma. He first made Ajōdhyā (the capital of Rāma and near the modern Fyzābād) his headquarters, frequently visiting distant places of pilgrimage in different parts of India. During his residence at Ajōdhyā the Lord Rāma is said to have appeared to him in a dream, and to have commanded him to write a *Rāmāyana* in the language used by the common people. He began this work in the year 1574, and had finished the third book (*Āranya-kānd*), when differences with the Vairāgī Vaishnavas at Ajōdhyā, to whom he had attached himself, led him to migrate to Benares, where he settled at Asī-ghāṭ. Here he died in 1623, during the reign of the emperor Jahāngīr, at the great age of 91.

The period of his greatest activity as an author synchronized with the latter half of the reign of Akbar (1556–1605), and the first portion of that of Jahāngīr, his dated works being as follows: commencement of the *Rāmāyan*, 1574; *Rām-satsai*, 1584; *Pārbati-mangal*, 1586; *Rāmāgyā*, 1598; *Kabitta Rāmāyan*, between 1612 and 1614 A deed of arbitration in his hand, dated 1612, relating to the settlement of a dispute between the sons of a land-owner named Ṭōḍar, who possessed some villages adjacent to Benares, has been preserved, and is reproduced in facsimile in Dr. Grierson's *Modern Vernacular Literature of Hindustan*, p. 51. Ṭōḍar (who was not, as formerly supposed, Akbar's finance minister, the celebrated Rāja Tōdar Mall) was his attached friend, and a beautiful and pathetic poem[1] by Tulsī on his death is extant. He is said to have been resorted to, as a venerated teacher, by Mahārāja Mān Singh of Jaipur (d. 1618), his brother Jagat Singh, and other powerful princes; and it appears to be certain that his great fame and influence as a religious leader, which remain pre-eminent to this day, were fully established during his lifetime

Tulsī's great poem, popularly called *Tulsi-krit Rāmāyan*, but named by its author *Rām-charit-mānas*, "the Lake of Rāma's deeds," is perhaps better known among Hindūs in upper India than the Bible among the rustic population in England Its verses are everywhere, in this region, popular proverbs Not only are Tulsī's sayings proverbial: his doctrine actually forms the most powerful religious influence in present-day Hinduism, and, though he founded no school and was never known as a *guru* or master, but professed himself the humble follower of his teacher, Narhari-Dās, from whom as a boy in Sūkar-khēt he heard the tale of Rāma's doings, he is everywhere accepted as an inspired and authoritative guide in religion and conduct of life

The poem is a rehandling of the great theme of Vālmīkī, but is in no sense a translation of the Sanskrit epic. Besides the *Lake of Rāma's deeds*, Tulsī Dās was the author of five longer and six shorter works, most of them dealing with the theme of Rāma, his doings, and devotion to him The former are (1) the *Dōhābalī*, consisting of 573 miscellaneous *dōhā* and *sōraṭhā* verses; of this there is a duplicate in the *Rām-satsai*, an arrangement of seven centuries of verses, the great majority of which occur also in the *Dōhābalī* and in other works of Tulsī; (2) the *Kabitta Rāmāyan* or *Kabittābalī*, which is a history of Rāma in in the *kabitta, ghanākshari chhappāī* and *sawaiyā* metres; like the *Rām-charit-mānas*, it is divided into seven *kānds* or cantos, and is devoted to setting forth the majestic side of Rāma's character; (3) the *Gīt-Rāmāyan*, or *Gītābalī*, also in seven kāṇḍs, aiming at the illustration of the tender aspect of the Lord's life; the metres are adapted for singing, (4) the *Krishnāwali* or *Krishna gītābalī*, a collection of 61 songs in honour of Krishna, in the Kanaujī dialect. the authenticity of this is doubtful, and (5) the *Binay Pattrikā*, or "Book of petitions," a series of hymns and prayers of which the first 43 are addressed to the lower gods, forming Rāma's court and attendants, and the remainder, Nos. 44 to 279, to Rāma himself Of the smaller compositions the most interesting is the Vairāgya Sandīpanī, or "Kindling of continence," a poem describing the nature and greatness of a holy man, and the true peace to which he attains. This work has been translated by Dr. Grierson in the *Indian Antiquary*, xxii. 198–201

A manuscript of the *Ayōdhyā-kānd*, said to be in the poet's own hand, exists at Rājāpur in Bānda, his reputed birthplace One of the *Bāl-kānḍ*, dated *Sambat*, 1661 (A D 1604) 19 years before the poet's death, and carefully corrected, it is said, by Tulsī Dās himself, is at Ajōdhyā. Another autograph is reported to be preserved at Malihābād in the Lucknow district, but has not, so far as known, been seen by a European Other ancient MSS. are to be found at Benares, and the materials for a correct text of the *Rāmāyan* are thus available Good editions have been published by the *Khadga Bilās* press at Bānkipur (with a valuable life of the poet by Baijnāth Dās), and by the *Nāgarī Prachārinī Sabhā* at Allahabad (1903). The ordinary bāzār copies of the poem, repeatedly reproduced by lithography, teem with interpolations and variations from the poet's language. An excellent translation of the whole into English was made by the late Mr F. S. Growse, of the Indian Civil Service (5th edition, Cawnpore, 1891)

The best account of Tulsī Dās and his works is contained in the papers contributed by Dr. Grierson to vol. xxii of the *Indian Antiquary* (1893) In Mr. Growse's translation of the *Rām-charit-Mānas* will be found the text and translation of the passages in the *Bhaktamālā* of Nābhājī and its commentary, which are the main original authority for the traditions relating to the poet In the introduction to the edition of the *Rāmāyan* by the *Nāgarī Prachārinī Sabhā* all the known facts of Tulsī's life are brought together and critically discussed For an exposition of his religious position, and his place in the popular religion of Northern India, *see* Dr. Grierson's paper in the *Journal of the Royal Asiatic Society*, July 1903, pp. 447–466.

(C J. L ; X.)

See Sir G A. Grierson, *Notes on Tulsi Das* (Allahabad, 1921).

TULU LANGUAGE, otherwise TULUVA, a language of the Dravidian family, found chiefly in the south Kanara district of Madras It has no literature, nor has it been adopted for official use even where it is spoken by the majority of the population. It is regarded as one of the most highly developed languages of the Dravidian family and must be classed as lying between Tamil and Kanarese, nearer to the latter than to the former. *See* Bishop Caldwell, *Comparative Grammar of the Dravidian Languages* (1875); *Linguistic Survey of India*, vol. iv. (1906).

TUMBEZ, a littoral province of Peru. located on the Pacific coast in the extreme north-west corner of the country, is bounded east by Ecuador and south by the department of Piura, from which it was created in 1901. Pop. 8,602; area 1,591 square miles.

[1]See *Indian Antiquary*, xxii. 272 (1893).

Its capital is the city of Tumbez (pop 2,000) located on the Tumbez river about 7 m. from its port on the Pacific ocean (Puerto Pizarro), with which it is connected by rail. Though a littoral province, it is administered by a prefect, and enjoys the other privileges belonging to a department. The province was an ancient stronghold of the Incas and when Pizarro landed in 1527, he found Tumbez already a prosperous city Nearby the Spanish founded their first settlement in Peru Because of its accessibility, modern development began early, dating from about 1883 The mountainous district behind the city contains oil and several hundred wells have been sunk Refineries have been built at Tumbez, Zorritos and Talara Sugar, tobacco, coffee and cocoa are produced in the district, and cobalt, coal, salt and sulphur are found Local and foreign trade are growing rapidly.

TUMBLE-WEED, a botanical term for a plant which breaks loose when dry, and is blown about, scattering its seeds by the way They are especially abundant in the prairie regions of the United States and Canada. Examples are. the old-witch grass (*Panicum capillare*), Russian thistle (*Salsola pestiver*), winged pigweed (*Cycloloma atriplicifolium*), bug-seed (*Corispermum hyssopifolium*) and tumbling mustard (*Sisymbrium altissimum*)

BY COURTESY OF THE IOWA GEOLOGICAL SURVEY

TUMBLING MUSTARD (SISYMBRIUM ALTISSIMUM), A FREELY BRANCHING PLANT WITH YELLOWISH FLOWERS

TUMBLING MUSTARD (*Sisymbrium altissimum*), a biennial herb of the cress family (Cruciferae, *q.v*), native to Europe and extensively naturalized in North America, especially in the North-western States and adjacent Canada, where it has become a pestiferous weed It grows from 2 ft. to 4 ft high, with erect, freely branching stems; deeply cut leaves; pale yellow, mustard-like flowers, and long, very narrow, divergent seed-pods. (*See* TUMBLE-WEEDS)

TUMKUR, a town and district of southern India, in the west of Mysore state The town (pop., 1921, 14,246), which is a health resort on the Devarayadurga hills, has a station on the Madras and Southern Mahratta railway, 43 m N W. from Bangalore. The area of the district is 4,061 sq m. It consists chiefly of elevated land intersected by river valleys A range of hills rising to nearly 4,000 feet crosses it from north to south, forming the water-parting between the systems of the Krishna and the Cauvery The principal streams are the Jayamangala and the Shimsha. The population in 1921 was 773,122. The cultivated products consist chiefly of millets, rice, pulses and oil seeds

TUMMEL, a river of Perthshire, Scotland. Discharging from Loch Rannoch, it flows eastward to a point near the Falls of Tummel, where it flows south-east until it falls into the Tay, just below Logierait, after a course of 58 m. from its source in Stob Ghabbar (3,565 ft) Its only considerable affluent is the Garry, 24 m long, which issues from Loch Garry (2½ m long, ¼ m wide) About midway in its course the Tummel expands into Loch Tummel (2¾ m long, ½ m. wide), between which and the confluence with the Garry occur the Pass and Falls of the Tummel

TUMOUR, a term applied, from the earliest period of medical literature, to any swelling of which the nature and origin were unknown. Consequently a heterogeneous collection of swellings was described as tumours, including such diverse conditions as an abscess, a tuberculous gland, the enlarged spleen of malaria or a cancer. With the progress of bacteriology and the improved technique of histology it became necessary to separate these various "swellings" into groups: (1) *Inflammatory or Infective Swellings;* (2) *Swellings due to Hypertrophy;* (3) *Cysts;* (4) *Spontaneous Tumours, or New-growths* By general consent the term "tumour" is now restricted to the last group. However, for the sake of completeness and because clinically it is not always easy to diagnose the true nature of a swelling, it is necessary to touch briefly on the distinguishing features of the first three groups.

1. **Inflammatory or Infective Swellings.**—These have certain characteristics which separate them sharply from other classes of swelling In the first place they are due to the irritative action of some micro-organism Inflammation due to microbial action always follows a typical course First, numbers of wandering cells derived from the blood, the lymph or the connective tissues collect at the site of irritation, and these, with the coagulable serum poured out from the blood vessels produce the hard painful swelling with which every one is familiar. The mass may gradually subside or it may soften in the centre so that an abscess results. Thus an inflammatory swelling may be solid or fluid according to circumstances. The common inflammatory bacteria—staphylococcus and streptococcus—cause suppuration in the majority of cases, but a few organisms such as the different varieties of streptothrix, Treponema pallida, and the tubercle bacillus, set up an inflammation so chronic that it does not usually end in the formation of pus, but rather in the development of a hard, solid mass of very slow growth, that may persist for months or even years

To the naked eye and to touch these solid inflammatory swellings may closely simulate the spontaneous tumours and, often, the two have been confused. but a microscopical examination will correct the mistake in nearly every case For the minute structure of infective swellings, whatever their situation, is almost identical; they consist merely of an irregular collection of inflammatory cells, and this of itself is sufficient to mark them off from the group of tumours proper. To this statement there is one exception, for a form of malignant tumour, known as a sarcoma, may bear a very deceptive likeness to an inflammatory swelling

2 **Swellings due to Hypertrophy.**—A tissue or organ is said to be hypertrophied when it is increased in size but remains approximately normal in structure The most familiar example is the hypertrophy of the skeletal muscles that follows increased use, or the hypertrophy of the heart muscle which helps to compensate for faulty action of the valves But neither of these constitutes a hypertrophic swelling For an instance of this we must turn to the enlargement of the spleen that occurs in malaria and certain forms of anaemia, of the thyroid gland in some varieties of goitre, and of the lymphatic glands in Hodgkin's disease. In each of these conditions there is an increase of apparently normal tissue, and from a microscopical examination of the hypertrophied organ it is difficult to say that it is unhealthy

3. **Cysts.**—A cyst may be defined as a collection of fluid surrounded by a wall or capsule. The nature of the fluid varies according to the site and origin of the cyst, the cyst-wall is usually composed of a tough layer of fibrous tissue Cysts arise by the dilatation of a pre-existing space with fluid, the central degeneration and liquefaction of a solid mass, as in some varieties of cancer, the disintegration of blood clot as in some cysts of the brain, the natural growth of some parasites, *e g*, hydatid cysts When the cyst-wall is tensely stretched by the pressure of the fluid within it, a cyst may easily be mistaken for a solid tumour.

4 **Spontaneous Tumours (Neoplasm, New Growth).**—The following definition of a spontaneous tumour, or tumour proper, suggested by Ziegler is perhaps the most satisfactory: "A neoplasm or tumour is a new formation of tissue, which is atypical in structure, serves no useful purpose to the whole economy, and the growth of which has no typical termination." In this definition the words "new formation of tissue" exclude the cystic swellings; the attribute "atypical in structure" excludes hypertrophies; and the final clause "the growth of which has no typical termination" excludes all inflammatory swellings which progress, however slowly, towards either suppuration or resolution and recovery.

These tumours arise by the exaggerated and abnormal proliferation of a single cell, or a group of cells. They increase in size solely by the multiplication of their own cells, and the only contribution which the surrounding tissues sometimes make to the process is the formation of a "stroma," or supporting framework of fibrous tissue; and even that is wanting in many cases Inasmuch as the

newly-formed cells of the tumour resemble the parent cells the minute structure of a tumour, whatever its situation, recalls that of the tissue whence it originated. A tumour growing from skin therefore imitates in its essential features the cell-structure of normal skin; the resemblance of some uterine tumours to normal endometrium is often so close as to make it a hard task to distinguish the one from the other; whilst the similarity of bony and cartilaginous tumours to true bone and cartilage is evident to all.

This imitation of the parent type by the spontaneous tumours is one of their most remarkable characteristics, and provides a reliable criterion by which they may be separated from the inflammatory swellings, which, as mentioned above, are all built up on the same general plan. Consequently it is almost always possible to determine the origin of a tumour from an examination of its histological appearances; and conversely we know that an epithelial tumour will never spring from a connective tissue nor a connective tissue tumour from an epithelium.

The spontaneous tumours are seen in every tissue and organ of the body, though in some they are relatively infrequent. Nor are they confined to man, for they have been found throughout the vertebrate kingdom. It is often stated that a higher state of civilization brings with it a greater susceptibility to tumour formation. As to this, reliable evidence is hard to obtain, and the apparent immunity of certain native races is, at least in part due to earlier death and lack of sufficient observations.

It is usual to divide the new-growths into two groups. The *Non-malignant, Innocent or Benign*, and the *Malignant or Cancerous*. Of these two groups the malignant have attracted most attention and study, on account of the danger to life which they involve, but in point of numbers they are greatly outweighed by the non-malignant group. Two or more non-malignant tumours, of different varieties, are often found in the same individual; but with the cancers this is rare.

Non-malignant Tumours.—These are usually rounded in shape. In size they vary enormously, a fibroid tumour of the uterus or a fatty tumour may be as small as a pea or may weigh forty pounds. Often they cease growing after attaining a certain size, but there are very many exceptions to this, and it is seldom possible to predict the subsequent course of one of these growths. They possess, however, four constant characteristics by which they may be distinguished from the malignant variety.

1. A non-malignant tumour, whatever its size, remains localized to the part from which it originates. It is not an "infiltrating" growth, *i.e.*, does not eat its way into the surrounding tissues, but rather pushes them aside, and so may be called "expansive." Moreover, it is separated from them by a thin but usually well-marked layer of fibrous tissue known as the "capsule" of the tumour and formed by the surrounding healthy tissues and representing their reaction to its presence.

2. Non-malignant tumours are not of themselves dangerous to life but may be so from secondary conditions to which they give rise. They may, however, cause a great deal of pain and even death, when situated in special positions. Thus, a small tumour may cause intense pain by pressing on a nerve, or dropsical swelling of a limb by obstructing a vein, or death from suffocation by blocking the larynx.

3. Non-malignant tumours never reproduce themselves in distant parts of the body. More than one may be present in the same individual, but each arises independently.

4. A non-malignant growth never recurs after operation. The boundaries of the growth are so well defined that complete removal is usually easy, and the operation is a simple and satisfactory proceeding. Apparent exceptions to this statement as in adenoma of the thyroid are due to later growth of an adjacent but independent minute neoplasm set free by removal of the pressure exerted by the larger one.

Malignant Tumours, or Cancers. (*See* CANCER.)—There are three main varieties of malignant tumour: the *Sarcomata,* arising from the connective tissues; the *Carcinomata,* arising from epithelial tissues; the *Endotheliomata,* arising from endothelium. It is customary to describe them as cancers. The main features of these tumours are as follows:—

1. *Infiltrating Nature.*—A cancer follows a course very different from that of an innocent tumour. Its growth has no appointed termination, but continues until death, moreover, it is more rapid than that of the innocent tumours, and does not permit of the formation of a capsule by the neighbouring tissues. In consequence such a tumour shows no well-defined boundary, but from its margin fine tendrils of cancer cells, travelling by the lymphatic channels in all directions invade the surrounding parts and induce pressure atrophy of the essential tissue cells in the process. Thus a cancer of the breast will attack both the skin covering it and the underlying muscle and bone, a cancer of the womb will eat its way into the rectum, bladder and even sacrum, until these organs become to a great extent replaced by cancer cells, and can no longer perform their proper functions.

2. *Formation of Secondary Growths.*—In addition to this spread of growth by direct extension, another characteristic of malignant tumours is their tendency to reproduce themselves in parts of the body far removed from the original site. These secondary deposits, or metastases, are due to the tumour cells making their way through the walls of the small lymph and blood vessels and becoming detached in small groups by the force of the circulation, by which they are carried to some distant part of the body, there to continue their career of uncontrolled growth.

The sarcomata and carcinomata differ somewhat as regards the path of dissemination. The sarcomata are tumours with blood-containing spaces between the cells, consequently dissemination usually occurs by way of the blood-stream, and the commonest site for the secondary deposits of sarcoma is the lung. In carcinomata the blood vessels are well formed, and the growth invades the small lymph channels, and the first metastases are in the lymphatic glands, later, these deposits may occur throughout the body, particularly in the liver and other abdominal organs, the lungs and the bones.

The formation of metastases is of the utmost importance from a clinical point of view, as the success of an operation for cancer depends on the removal of all cells of the growth. For instance, a few months after the first appearance of a cancer of the breast the axillary lymph glands will be found to be hard and enlarged. This means that some of the cells of the primary growth have been carried in the lymph stream to these glands, and have multiplied there, consequently any operation for the removal of the cancer of the breast must include the removal of these glands. If the breast tumour only be taken away the growth will continue unchecked in the glands. In many cases where there is no evident enlargement the microscope reveals cancer cells; and a certain opinion can only be given after a microscopical examination.

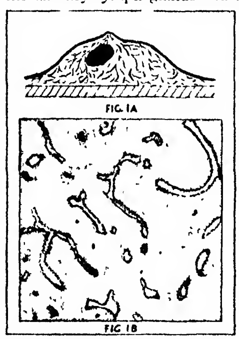


FIG. IA
FIG. IB

FROM BARLOW, "PATHOLOGICAL ANATOMY AND HISTOLOGY" (J. & A. CHURCHILL)

FIG. 1A.—DIAGRAM TO SHOW RELATIONS OF AN INNOCENT TUMOUR (ADENOMA) OF THE BREAST.
Showing tumour, normal breast tissue, and underlying muscular tissue.

FIG. 1B.—SECTION OF TUBULAR FIBRO-ADENOMA OF BREAST X 180.

In operations for cancer of the breast or tongue the modern practice is to regard the lymphatic glands of the axilla or neck respectively as infected in every case, however early it be, and to remove them accordingly. In other parts of the body where the glands are inaccessible, the only solution of the difficulty is to urge the removal of the tumour at the earliest possible moment.

The frequency and rapidity of metastasis formation varies greatly. As a general rule cancer of the breast is more liable than other forms of growth to be followed by widespread secondary deposits. On the other hand, in cancer of the skin secondary infection is usually confined to the neighbouring lymphatic glands, and in a large proportion of cases affecting the neck of the womb,

the cancer extends locally but forms no metastases whatever

3. *Nature of Termination*—In one or two well authenticated cases a malignant tumour has disappeared of its own accord without any treatment, and a natural cure may be said to have occurred. But these form such an infinitesimal proportion of the whole that they do not affect the general truth of the statement that the universal and natural tendency of a malignant tumour is to cause death

Although the separation of new growths into the malignant and non-malignant groups is supported by their respective clinical and histological characters, the difference between them is probably one of degree rather than of kind It is beyond doubt that occasionally a tumour, which for years has been devoid of malignant characters may suddenly become cancerous. Moreover, certain tumours seem to lie on the border line, for example, rodent ulcers and cancers of the parotid gland These are malignant in that they are undoubtedly infiltrating tumours, they are innocent in that they never form metastatic deposits. Therefore it seems that malignancy or the reverse is not to be regarded as an absolute and constant attribute of any particular tumour or class of tumours, but rather as an expression of the balance struck in the conflict between the opposing forces of the tumour and its host.

FIG 2A

FIG 2B

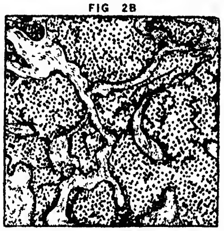


FIG 2A —DIAGRAM TO SHOW RELATIONS OF MALIGNANT TUMOUR FIG 2B.—SECTION OF SPHEROIDAL-CELL CARCINOMA

Histology of Tumours.—In tumours it is generally true that the essential cells behave approximately in the same fashion as in the corresponding normal tissue In a duct or tubular gland the lining columnar cells are arranged in a single layer side by side to leave a lumen, and in tumours formed from duct-like structures the same tubular arrangement is recognizable. Similarly, just as in a secreting gland the epithelium multiplies and breaks down into the secretion so in tumours formed from secreting glands the cells multiply and fill the acini (spheroidal cell carcinoma) or in part break down into a representative of the normal secretion (adenoma) So also the characteristic of a connective tissue cell that it forms some substance around it, *e g*, fibrous tissue, cartilage or bone, is reproduced more or less faithfully in the connective tissue tumours

To understand clearly the differences and likenesses that obtain between the malignant and the non-malignant new growths it is necessary to compare the histology of the two groups These are shown in Figs 1a, 1b, 2a, 2b, 3 and 4.

In the adenoma the individual gland cells and their mutual relations resemble those of the normal breast from which the adenoma is derived and follow the normal arrangement very closely though the collections of cells are irregularly disposed throughout the stroma Finally the growth is surrounded by a well defined capsule of fibrous tissue.

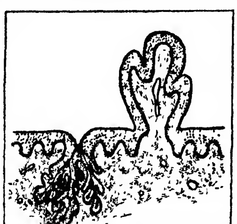


FIG. 3.—SEMI-DIAGRAMMATIC REPRESENTATION OF MALIGNANT AND NON-MALIGNANT TUMOUR

In the carcinoma, the resemblance of cancerous to normal breast cells is slight; their mutual arrangement is disturbed, the collections of cells are arranged in disorderly masses not enclosed by any semblance of a capsule. but transgressing their proper boundaries and invading the underlying muscles Figs. 3 and 4 show semi-diagrammatically analogous changes in the formation of an innocent and a malignant tumour of the intestinal mucosa and the skin respectively.

Speaking generally it may be said that the cells of an epithelial non-malignant growth are fully differentiated and typical of the normal, whereas the cells of a carcinoma show less perfect differentiation, are in some degree atypical and resemble rather the actively growing cells found at an early stage of embryonic life. But it is in the cells of a sarcoma that the widest departure from type is seen A sarcoma is a malignant growth arising from connective tissue, but the resemblance to adult connective tissue is almost non-existent and the cells are essentially of an embryonic type. These differences between the innocent and the malignant cell bear out the well-established physiological rule that the less the functional development of a cell or tissue the greater its power of growth

In theory it is always possible to distinguish with certainty between an innocent tumour and a cancer by means of the microscope. In practice this is, unfortunately, not the case. There are some tumours whose histological appearances are on the borderline between the two conditions, and often these are the very cases in which the clinical features give no direct clue to their nature In such circumstances it is only by taking into consideration every detail, that an opinion can be formed

The Causation of Tumours.—Innumerable suggestions as to the causation of tumours have been put forward from time to time. Here, reference can only be made to the more important

First in point of time comes *Virchow's hypothesis* that tumours arise as the direct result of chronic irritation or injury A cancer of the lip or tongue may follow the irritation of a clay pipe or a jagged tooth, cancer of the urinary bladder may result from the irritation of Bilharzia ova (*see* BILHARZIASIS), of the gall-bladder from irritation of a gall-stone, of the skin from prolonged exposure to X-rays But, on the other hand, there must be innumerable instances in which such causes of irritation have not been followed by a tumour As a complete explanation Virchow's hypothesis is insufficient, but it is certain that chronic irritation has, at least, an accessory or predisposing influence in tumour formation

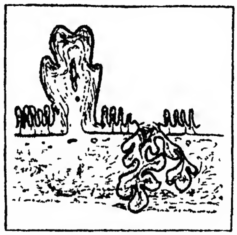


FIG 4 —SEMI-DIAGRAMMATIC REPRESENTATION OF A MALIGNANT (RIGHT) AND A NON-MALIGNANT (LEFT) TUMOUR INVOLVING INTESTINAL MUCOSA OR ENDOMETRIUM

Another theory is *Cohnheim's hypothesis of embryonic remnants* According to Cohnheim more cells are, at times, produced in embryonic life than are required for the development of the body, and a remnant is left unappropriated Owing to their embryonic nature, these cells possess an exaggerated power of proliferation, and if at a later period of life this should be roused into activity by some mechanical or other form of stimulus, their rate of growth will outstrip that of the adult cells and a tumour will develop This is at best only a partial explanation which may be applicable to a small proportion of tumours

The *Parasitic hypothesis* is still a matter of keen debate (*see* CANCER RESEARCH) In some degree cancer with its localized primary growth and widespread secondary deposits resembles certain infective diseases of microbial origin, such as pyaemia, where from a small primary site of infection the bacteria become disseminated throughout the body From this analogy it was argued that tumour formation was due to the activity of some parasite. But if the mode of dissemination of a cancer and of a micro-organism be carefully examined this analogy is found to be false. When a micro-organism lodges in a gland or other part of the body, by its irritative action it stimulates the cells of that gland or tissue to increased activity, and any swelling that occurs is produced by the proliferation of those cells. But when a group of cancer-cells is deposited in a gland the subsequent growth arises entirely from the multiplication of those cancer-cells, and the gland cells take no part whatever in its formation.

At the present time the general weight of evidence seems to

favour the idea that tumour formation is ultimately due to some intrinsic cause, whereby the normal processes of growth are disturbed, rather than to any extrinsic cause such as microbial infection. Therefore it is from a careful study of the laws of growth, and from research directed along broad biological lines that the best results are to be looked for in the future.

Classification of Spontaneous Tumours.—Many classifications have been suggested but one on a scientific basis is not yet within reach. That given below is suggested as convenient for the commoner varieties but owing to the complexity of new growths often a specimen cannot be placed in a single group and is better classified, for example, as a fibro-myoma, myxo-chondroma, chondro-sarcoma, adeno-carcinoma, etc. Rarer neoplasms such as the hypernephroma, chloroma, chordoma, seminoma and sympathoma are not considered here.

I. MESOBLASTIC OR CONNECTIVE-TISSUE TUMOURS

Innocent	*Malignant*
Lipoma (fatty tumour).	
Fibroma (fibrous tumour).	Sarcoma.
Myoma (muscular tumour).	
Osteoma (bony tumour).	
Chondroma (cartilaginous tumour).	
Odontoma (tumour in connection with teeth).	
Myxoma (mucoid tumour).	
Neuroma (tumour in connection with nerves).	
Glioma (neuroglial tumour).	
Angioma (tumour composed of blood or lymphatic vessels).	

II. EPI- AND HYPOBLASTIC OR EPITHELIAL TUMOURS

Innocent	*Malignant*
Papilloma.	Carcinoma.
Adenoma.	

III. ENDOTHELIAL TUMOURS (MESOBLASTIC)

Innocent	*Malignant*
Some parotid and similar growths.	Some pleural, periboneal, and similar growths.

I. Connective-tissue Tumours[1].—*Lipoma* (fig. 5).—Of the connective-tissue group the fatty tumours are the most common. They often arise from the layer of fat beneath the skin on the back, though at times they are found on the limbs and elsewhere. They are soft, painless swellings, sometimes of great size; though usually single, as many as a dozen may be present in the same individual. Lipomata are also found in the abdominal cavity, growing from the subperitoneal layer of fat.

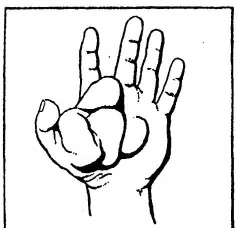


FIG. 5.—LIPOMA OF THE PALM

Fibroma.—Pure fibromata are rare and chiefly seen in the sheaths of nerves (fig. 10) where they are often multiple, the larynx, the gums forming one variety of so-called *epulis* and the subcutaneous tissue (painful subcutaneous nodule). But almost all tumours contain some admixture of fibrous tissue and of these the commonest and most important are the so-called fibroids of the uterus (*see* under *Myoma*).

Myoma.—This tumour is composed of muscle fibres, unstriated except in one very rare variety *rhabdo-myo-sarcoma.* Pure myomata are rare and sometimes found in the oesophagus, stomach and bladder. In the uterus, with more or less admixture of fibrous tissue, and therefore better termed fibro-myomata, they are very common. They originate in the wall of the uterus, but generally come to project either internally into the cavity of the uterus, or externally into the peritoneal cavity; and often their sole connection with the uterine wall is a stalk or pedicle formed from the capsule of the tumour. Fibromyomata of the uterus occur in married and unmarried women and are most common from 35 to 45 years of age; in girls under 20 they are almost unknown. They may attain a great size and are often multiple. Not every fibroid is a source of danger or discomfort, for in many cases they are discovered by chance or not until after death. On the other hand they may give rise to severe symptoms, in many different ways (*see* GYNAECOLOGY). A fibroid tends to prevent conception, whilst, should pregnancy occur miscarriage is common, and if carried to term, labour is greatly impeded. Occasionally a fibroid undergoes sarcomatous change.

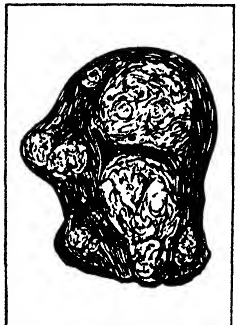


FIG. 6.—UTERUS IN SAGITTAL SECTION SHOWING INTERSTITIAL AND SUBMUCOUS FIBROIDS

Osteoma (fig. 7).—Bony tumours not infrequently arise from the bones of the head or face. They grow very slowly, and are so hard that surgical removal may be very difficult. They also occur as irregular outgrowths from the bones of the limbs, and are then known as *Exostoses* (fig. 8). A common site for these is the inner and lower end of the femur, at the point of attachment of the adductor muscle, and such a tumour seems to originate from an ossification of the tendon of this muscle.

Chondroma (fig. 9).—Cartilaginous tumours occur chiefly in children and young people, growing from the bones of the limbs in the neighbourhood of the joints. They are frequently multiple, especially in the hands and feet, but never affect the terminal phalanges. These tumours grow slowly and are quite painless.

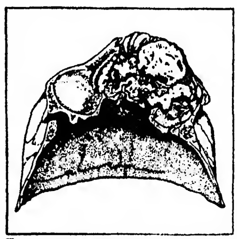


FIG. 7.—OSTEOMA OF THE LEFT FRONTAL SINUS (SEEN FROM BELOW)

Odontoma.—Several varieties of this tumour have been described arising in connection with the teeth and due to delayed or faulty development. They may cause great deformity of the jaw.

Myxoma.—This is composed of loose, gelatinous connective tissue similar to that found in the umbilical cord. Some nasal polypi seem to be of this nature, but true myxomatous tumours are rare. It is, however, not uncommon for a fibroma or a sarcoma to be converted by degeneration into myxomatous-like tissue.

Neuroma.—A pure neuroma is very uncommon, but a tumour known as a *Pseudo-neuroma* is to be often found in the course of a nerve. This is formed by a localized overgrowth of the fibrous tissue of the nerve sheath.

Glioma.—This variety of tumour arises from the neuroglia, the supporting tissue of the brain and spinal cord. Consequently gliomata are only found in these two structures, and the retina which is really an extension of the brain.

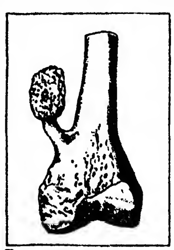


FIG. 8.—EXOSTOSIS OF THE FEMUR PRODUCED BY THE OSSIFICATION OF THE TENDON OF THE ADDUCTOR MAGNUS

Angioma.—This consists of a mesh-work of blood vessels bound together by a small amount of fat and fibrous tissue. Two varieties are described: (*a*) The *simple naevus,* or *port-wine stain,* scarcely deserves to be called a tumour. It appears as a reddish-blue discolouration of the skin due to over growth and dilatation of the underlying blood-vessels. This condition is most commonly found in the face or scalp, and may be of congenital origin. (*b*) In the *cavernous naevus* the vascular hypertrophy is on a larger scale, and may produce a definite pulsating tumour. Here, again the head is the usual situation. (For illustrations *see* PATHOLOGY.)

Sarcoma.—This is the malignant type of the connective-tissue

[1]Figs. 5, 6, 7, 8, 13, 14 and 16 have been redrawn from Bland Sutton's *Tumours,* by permission; figs. 9, 10, 11 and 12 are from Rose & Carless, *Surgery,* by permission.

tumour Hence, fibro-sarcoma, chondro-sarcoma, osteo-sarcoma, glio-sarcoma, etc , are met with. The general arrangement of a sarcoma shows a mass of atypical cells loosely bound together by a small amount of connective tissue. The cells vary greatly in size and shape in different tumours, and in accordance with the prevailing type the following varieties of sarcoma have been described: (i) *round-cell sarcoma*, (ii) *spindle-cell sarcoma*, (iii) *melanotic sarcoma*, (iv) *myeloid sarcoma* Nevertheless the melanotic growth is held by many authorities not to be of connective tissue origin and therefore a sarcoma, but epithelial and therefore a carcinoma To it the non-committal name *melanoma* is often given Similarly the myeloid variety owing to its peculiar characters is by many excluded from the group of sarcomata and placed in a separate class "myeloma" The round and spindle cell varieties contain the great majority of all sarcomata, and may occur in almost any part of the body, but they are especially liable to attack the bones (fig 11) A sarcoma of bone may be either *periosteal* when it grows from the periosteum covering the outer surface of the bone, or *endosteal* when it lies in the medullary cavity A peculiar form of sarcoma, by many classified as an endothelioma, is found in the parotid and other salivary glands The cells are usually spindle-shaped, and among them lie scattered masses of cartilage and fibrous tissue These tumours are seldom very malignant, and dissemination is rare (fig 12) The melanoma consists of cells widely irregular in shape and may be pale yellow or brown or black owing to the presence of few or many granules of pigment (melanin) in and among the tumour cells. A melanotic sarcoma may arise from a pigmented wart or mole, or from the pigmented layers of the retina The primary growth is usually small, but dissemination occurs with great rapidity throughout the body Melanomata are intensely malignant, whether the cells contain little or much melanin The *myeloid sarcoma*, or *myeloma* (fig. 13), is composed of irregularly shaped cells amongst which are large multinucleated cells like the myeloplaxes of bone-marrow (*see* BONES, ANATOMY OF; BONES, DISEASES OF) It is only found in the interior of bones, chiefly in those of the arm and leg The degree of malignancy is low, dissemination possibly never occurs, and recurrence after operation is rare.

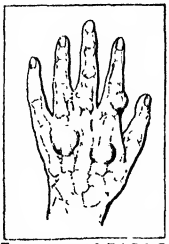
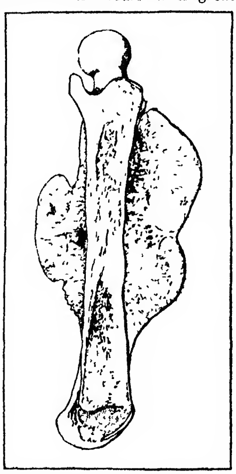


FIG 9—MULTIPLE CHONDROMATA OF THE FINGERS

FIG 10—PSEUDO-NEUROMA FIBROUS TUMOUR GROWING FROM NERVE SHEATH AND CAUSING THE FIBRES TO BE STRETCHED OVER IT



FROM BARLOW, "PATHOLOGICAL ANATOMY AND HISTOLOGY" (J & A CHURCHILL)

FIG 11—PERIOSTEAL SARCOMA OF FEMUR

II. Epithelial Tumours.—*Papilloma*—The familiar example of a papilloma is the wart, which is formed by a proliferation of a few papillae of the skin together with the overlying squamous epithelial layers (fig 3). It seems probable that some warts are of an infective nature, for instances of direct contagion are not uncommon and in special regions they occur in the definitely infective diseases gonorrhoea and syphilis Occasionally warts are pigmented, and as noted above the melanoma is apt to start in such a wart. Papillomata are also found in the bladder (fig. 14), as long delicate filaments growing from the bladder wall. These consist of a connective-tissue core covered by a thin layer of epithelium.

Adenoma—(Figs. 1*a* and 1*b*) The glandular tumours are common in the breast, the ovary and the intestinal canal The structure of an adenoma of the breast has already been described (*vide supra*), and the structure of other adenomata is on the same general plan, subject to the difference imposed by the tubular or acinous character of the gland concerned (*see* GLAND). The main features of an innocent glandular tumour are. (*a*) the presence of a rounded, painless swelling with a well-defined margin; (*b*) the swelling is freely movable in the surrounding tissues, not attached to skin; (*c*) neighbouring lymphatic glands are not enlarged.

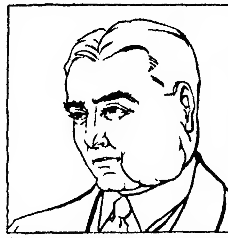


FIG 12.—MALIGNANT TUMOUR OF THE PAROTID GLAND

Carcinoma.—The following varieties of carcinoma are described —

i *Squamous-cell carcinoma* (fig 4), arising from those parts of the body covered by squamous epithelium, namely the skin, lips, tongue, mouth, pharynx, oesophagus, vagina, anus and bladder

ii *Spheroidal-cell carcinoma* (figs 2*a* and 2*b*), arising from spheroidal epithelium, as in the breast, pylorus, pancreas, liver and prostate.

iii. *Columnar-cell carcinoma* (figs 15 and 16), arising from columnar epithelium, as in the intestine, stomach and ducts of the breast

The general histology of these tumours corresponds to that of a spheroidal-cell carcinoma already described (*vide supra*), variation between the three groups being dependent on the character of the cells Thus Keratinization is a common feature of squamous cell carcinoma and when colloid degeneration of a carcinoma occurs it is always either a spheroidal or a columnar cell growth Amongst spheroidal cell carcinomata great variation occurs in the amount of fibrous tissue present; when fibrosis is very great the growth is often termed a "scirrhus." The clinical characteristics of a carcinoma, whatever its situation, are (*a*) the presence of a swelling which has no well defined margin, but fades away into the surrounding tissues to which it is fixed; (*b*) when the tumour lies in or near the skin it becomes fixed to this and ulcerates at an early date; (*c*) the tumour is painful and tender though the degree of pain varies widely, and in the early stages there may be none; (*d*) the neighbouring lymphatic glands soon become enlarged and tender, showing that they are the seat of metastatic deposits.

FIG. 13—LOWER END OF A FEMUR IN LONGITUDINAL SECTION, SHOWING A MYELOMA

iv. *Rodent cancer or rodent ulcer*, often called basal cell carcinoma, is a special variety of squamous cell carcinoma arising from the germinal layer of the skin probably in the close relation to the sebaceous glands. It shows itself as a slowly progressing ulceration of the skin, and is especially common on the face near the eye or ear The condition is one of purely local malignancy, and dissemination does not occur.

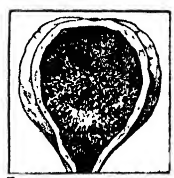
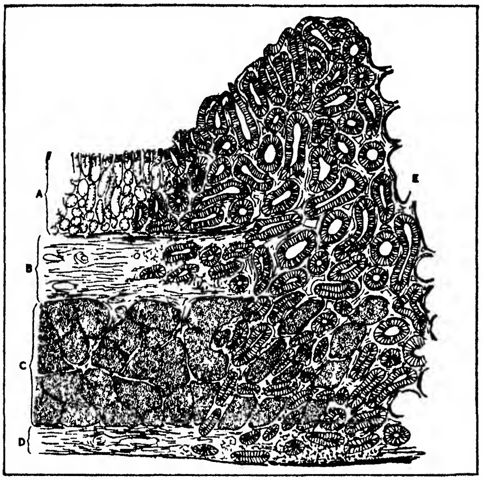


FIG. 14.—VILLOUS PAPILLOMA OF THE BLADDER

III. Endothelial Tumours.—*Endothelioma* is a variety of

growth that is rather inferred on general histological grounds than founded upon indisputable miscroscopic or clinical characters.



FROM ZIEGLER, "PATHOLOGICAL ANATOMY" (MACMILLAN)

FIG. 15—SECTION THROUGH ADVANCING MARGIN OF COLUMNAR CELL CANCER OF STOMACH SHOWING, (A) MUCOSA, (B) SUB-MUCOSA, (C) MUSCULAR COATS, (D) PERITONEUM

Since endothelial cells lie next one another without intervening substance they resemble in this respect epithelial cells but embryologically they are mesodermal and therefore allied to the connective tissue group. The features of endothelial tumours therefore might be expected to resemble now the one, now the other group and, indeed, there is some tendency to refer to the endotheliomata unusual varieties of growth which cannot well be placed in recognized groups. Nevertheless a primary subdural growth or one of the pleural cavity cannot be glandular however much it may resemble a carcinoma microscopically Growths involving proliferation of the endothelium lining blood and lymphatic channels (*perithelio-mata*) are perhaps the most convincing examples of endothelioma

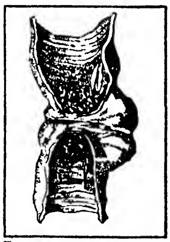


FIG. 16—CANCER OF THE SIGMOID FLEXURE OF THE COLON

See also CANCER; CANCER RESEARCH.

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(W. S. L.-B.)

TUMULUS, an artificial mound of earth or stone, usually conical in shape, erected either as a memorial, or over the grave of a royal personage, noble or hero, or the relic of a saint. Funerary tumuli are sometimes known as barrows (*q.v*).

TUNBRIDGE WELLS, a municipal borough and inland watering-place of England, chiefly in the Tonbridge parliamentary division of Kent, but extending into the eastern division of Sussex, 32 m. S.E. by S. of London by the S railway. Pop. (1921) 35,551. It owes its popularity to its chalybeate spring and its beautiful situation in a hilly wooded district. The wells are situated by the Parade (or Pantiles), a walk associated with fashion since the time of their discovery. It was paved with pantiles in the reign of Queen Anne. Reading and assembly rooms adjoin the pump-room. The town is built in a picturesquely irregular manner, and a large part of it consists of districts called "parks" occupied by villas and mansions. On Rusthall Common about a mile from the town is the curiously shaped mass of sandstone known as the Toad Rock, and a mile and a half south-west is the striking group called the High Rocks. The Tunbridge Wells sanatorium is situated in grounds sixty acres in extent. Five miles south-east of Tunbridge Wells is Bayham Abbey, founded in 1200, where ruins of a church, a gateway, and dependent buildings adjoin the modern Tudor mansion. The vicinity of Tunbridge Wells is largely residential. To the north lies the urban district of SOUTHBOROUGH (pop. 7,102). There is a large trade in Tunbridge ware, which includes wood-tables, boxes, toys, etc, made of hard woods, such as beech, sycamore, holly, and cherry, and inlaid with mosaic. Tunbridge Wells was incorporated in 1889

The town owes its rise to the discovery of the medicinal springs by Dudley, Lord North, in 1606. Henrietta Maria, wife of Charles I, retired to drink the waters at Tunbridge Wells after the birth of her eldest son Charles. Soon after the Restoration it was visited by Charles II. and Catherine of Braganza. It was a favourite residence of the princess Anne previous to her accession to the throne, and from that time became one of the chief resorts of London fashionable society. In this respect it reached its height in the second half of the 18th century, and is specially associated with Colley Cibber, Samuel Johnson, Cumberland the dramatist, David Garrick, Samuel Richardson, Sir Joshua Reynolds, Beau Nash and Mrs Thrale. The Tunbridge Wells of that period is sketched in Thackeray's *Virginians*

TUNDRA, the cold, desert, treeless plains which form the Arctic lowlands of Europe and Asia. The name is also generally applied to a similar area in North America. The word is of Russian origin and means a marshy plain The prevailing low temperatures are consequent on high latitude and proximity to the frozen northern ocean and result in very scanty vegetation.

TUNGABHADRA, a river of southern India, the chief tributary of the Kistna It is formed by the junction of two streams, the Tunga and the Bhadra, which both rise in Mysore in the Western Ghats The united river for nearly all its course forms the boundary between Madras and the dominions of the nizam of Hyderabad On its right bank stood the capital of the ancient Hindu dynasty of Vijayanagar, now a wilderness of ruins.

T'UNG-CHOW, a city in the province of Chih-li, China, on the banks of the Peiho, 12 m. E. of Peking. Its population is estimated at about 50,000

It is situated at the highest point of navigation of the Peiho, and is the port of Peking It is an old settlement known to the founder of the Han dynasty (206 B C.) as Lu-Hien; under the T'ang dynasty (A D 618) its name was changed to Hūan-Chow, and at the beginning of the 12th century, with the advent of the Kin dynasty, Hūan-Chow became T'ung-Chow During the Boxer outbreak in 1900 T'ung-Chow was occupied by the allied armies, and a light railway built connecting the city with Peking.

TUNGKWAN, a Chinese fortress near the junction of Wei-ho and Hwang-ho. The way down the valley is hemmed in by great loess walls, sometimes on one side of the valley, sometimes, as at Tungkwan, on both. The river is rapid and flows, at places, over a rocky bed, so it is unsuited for navigation in this region

TUNG OIL. Two varieties are known, differing slightly in their physical properties, termed Chinese Tung Oil (China wood oil) and Japanese Tung Oil according to the country of origin. In China the oil is prepared from the seeds ot *Aleurites cordata;* these are roasted in flat dishes over a fire, then coarsely powdered and expressed in primitive wooden presses. The kernels which contain up to 53% of oil yield in practice about 40%. The pale yellow oil for exportation, known as "white tung oil" is obtained by expressing the seeds in the cold; the hot-pressed oil—"black tung oil"—is dark brown in colour and possesses a strong, unpleasant odour. Chinese tung oil has the highest specific gravity (0·940 to 0·944) of all known fatty oils, with the exception of castor oil, and the highest refractive index. The characteristic property of Chinese tung oil is the readiness with which it becomes polymerized, setting to a hard jelly on being heated for a short time to a temperature of 250° Centigrade. Polymerization is also induced by dropping saturated solution of iodine on to the

surface of the oil, which immediately solidifies. The pronounced drying properties of tung oil render it suitable for use in the manufacture of paints and varnishes. In China it is further used for water-proofing paper Tung-oil trees have been successfully introduced in the United States in the north-central part of Florida where more than 1,500 acres are planted Up to 1929 all available seed was being used for planting More than 100,000,000 pounds of the oil are imported annually and it is hoped that eventually the domestic supply will meet American needs (*See* also OILS AND FATS; and M Toch. *Chemistry and Technology of Paints*, 1926) (E L.; G. H. W.)

TUNGSTEN. The name tungsten means "heavy stone" (Sw. *tung*, heavy, *sten*, stone), and directs attention to the high specific gravity of the element and its ores (Symbol W, atomic number 74, atomic weight 184 0) Up to the middle of the 18th century the mineral then known as tungsten, but now called scheelite, together with wolfram, were both considered to be ores of tin. In 1781, K W. Scheele showed that this mineral contained a peculiar acid, which he named tungstic acid, combined with lime as a base, and in the same year Bergmann advanced the opinion that the new acid was a metallic calx. Two years later the Spanish chemists, the brothers d'Elhuyar, proved that this acid was present in wolfram, and by heating the acid with carbon produced metallic tungsten for the first time.

Tungsten occurs in nature in the form of tungstates of iron, manganese and calcium, which may be divided according to their crystalline form into two groups The iron and manganese tungstates, crystallizing in the monoclinic system, form the wolfram group, whilst calcium tungstate or scheelite belongs to the tetragonal system Pure iron tungstate ($FeWO_4$) is known as ferberite and pure manganese tungstate ($MnWO_4$) as hubnerite The mineral wolfram or wolframite is normally a mixture of these two compounds in varying proportions Wolfram generally occurs in columnar, blade-like or massive forms, though sometimes it is found in well formed prismatic or tabular crystals It breaks up readily into thin flakes and its specific gravity ranges from 7 2–7 5 The colour may vary from nearly black to a brownish tinge characteristic of specimens rich in manganese Scheelite or calcium tungstate ($CaWO_4$) may occur in the form of well developed crystals which are usually double tetragonal pyramids, but frequently it is found in a massive form with four good cleavages. The specific gravity is about 6 and the colour variable. It is generally grey, pale-yellow, or pale-brown, rarely green or reddish, with a waxy lustre The world's principal supplies of tungsten ores have come from China, Burma, Japan, Australia, Bolivia and the United States

Extraction and Manufacture.—The tungsten content of the ore as mined is usually 0 5 to 2 0%, so that a concentration process is necessary for extraction The wolfram in the ore is associated with quartz and other gangue material, but it can be readily separated from these impurities owing to its high density. To remove cassiterite (SnO_2) which is present in a large proportion of wolframite ores, magnetic methods are employed. Wolfram, containing iron, is fairly magnetic, whilst cassiterite is not attracted as a rule even by powerful magnets. With scheelite, fortunately, the association of cassiterite is not common, otherwise (since scheelite is non-magnetic) chemical processes would have to be employed to effect the separation.

Many methods are available for the extraction of tungsten from its ores but the general principles involved in the extraction from wolfram may be illustrated by a brief summary of the sodium carbonate fusion process. The concentrate, after removal of cassiterite and other deleterious impurities, is mixed with excess of sodium carbonate and heated in a reverberatory furnace to about 1,000° C in an oxidizing atmosphere. Thereby sodium tungstate is produced, and the iron and manganese present are converted to oxides:

$$4FeWO_4+O_2+4Na_2CO_3 = 4Na_2WO_4+2Fe_2O_3+4CO_2$$
$$6MnWO_4+O_2+6Na_2CO_3 = 6Na_2WO_4+2Mn_3O_4+6CO_2.$$

The soluble sodium tungstate is extracted with boiling water and on treatment with boiling hydrochloric acid an amorphous yellow precipitate of tungstic acid (H_2WO_4) is obtained which yields WO_3 on calcination. In the preparation from scheelite the finely ground ore is decomposed with hydrochloric acid, whereby calcium chloride passes into solution, and tungstic acid, together with insoluble impurities like silica, remains as a sludge:

$$CaWO_4+2HCl = CaCl_2+H_2WO_4.$$

To purify the tungstic acid produced in these processes, it may be dissolved in ammonia and crystallized out as ammonium paratungstate, $5(NH_4)_2O,12WO_3,xH_2O$. This is decomposed by hydrochloric acid to yield purified tungstic acid, or ignited in air to tungstic oxide (WO_3).

Freedom from impurities and a suitable physical condition are absolutely necessary if tungsten is to be used for incandescent lamps or for wireless work. In this case, the method universally adopted for the preparation of the metal is reduction of the oxide by hydrogen, whereby the tungsten is obtained as a powder. For alloying purposes, however, where greater latitude is allowed in the amount of impurity and where the physical condition of the metal is of minor importance, the oxide is reduced by carbon and the resulting powder used for tungsten steels and other alloys.

The high melting point of tungsten precludes its industrial manufacture in the cast state from the powdered metal, and even if this were possible the product would be of little value as it would be both brittle and difficult to work mechanically. From the researches of Coolidge, who took out his first patent in 1906, a process has been developed which is capable of producing a fine tungsten wire that can be manipulated with little more difficulty than any other fine wire In this process the powder is compressed in a hydraulic press into bars which are then heated to a high temperature in a furnace in an atmosphere of hydrogen, whereby a strong but brittle product results This is now converted into rods by a mechanical hammering process in which the metal, previously heated to 1,500° C in an electric furnace in a hydrogen atmosphere, is subjected to 10,000 blows per minute in a special swaging machine Further reduction of the diameter of the wire—usually from 1mm—is effected by drawing through dies Tungsten wire can be drawn to 0·011mm diameter, whilst by immersion for 45 seconds in a fused mixture of sodium nitrate and nitrite at 340° C a wire of diameter 0 014mm is uniformly reduced to 0·007mm

Physical and Chemical Properties.—Tungsten in the form of wire or sheet is dull white The physical properties alter with changes in the structure of the metal, so that values for density, tensile strength, specific electrical resistance, etc, vary with the stage of swaging or drawing The theoretical value for the density of pure tungsten, calculated from the atomic spacings, is 19·32. The probable melting point is 3,382° C, although the value 3,267°±30° C is also quoted Tungsten has the highest melting point of the metals. X-Ray analysis shows that tungsten has a body-centred cubic lattice, the length of the cube edge being 3·155±0·001 A For further physical data, *see* C. J. Smithells, *Tungsten* (1926). Tungsten undergoes no appreciable oxidation on heating in air below red heat nor does it react with nitrogen, except when in the state of vapour. It is very resistant to the action of acids, neither *aqua regia* nor hydrofluoric acid attacking it to any appreciable extent The best solvent for the fused metal is a mixture of concentrated nitric and hydrofluoric acids. Aqueous alkalis are without action but fused alkalis dissolve the metal.

Tungsten in its compounds exhibits valencies of 3, 4, 5 and 6, whilst, in addition, compounds of the empirical formula WR_2 (where R=Cl, Br, or I) are known. In the case of chloride, however, the molecular formula is W_6Cl_{12}. The trioxide WO_3 is a bright canary-yellow powder which becomes dark orange when heated and fuses between 1,300°–1,400° C. It is insoluble in most acids including *aqua regia* but hydrofluoric acid dissolves it. With aqueous alkali hydroxides or carbonates it forms tungstates containing varying proportions of WO_3 to metallic oxide. A hexachloride and hexafluoride are known. The compounds $[WO_2Cl_4]$, $K_2[WOCl_5]$, $K_4[W(CN)_8]$ exhibit tungsten with co-ordination numbers of 4, 6 and 8.

Applications.—Tungsten finds wide application as a filament

in electric lamps, and as it has a hardening effect on other metals with which it is alloyed it is a constituent of some of the most important industrial alloys. Tungsten steels are employed in the manufacture of cutting tools and permanent magnets. The stellite alloys containing cobalt, chromium and tungsten are extremely hard and are used for cutting tools and surgical instruments, as they are not affected by organic acids and ordinary antiseptics. Other uses of the metal include X-ray targets, thermionic devices, galvanometer suspensions, electrical contacts, refractory crucibles, etc. (W. WA.)

TUNGSTEN STEEL. The earliest alloy of this type is Mushet steel (*q.v.*). It contains from 5·5 to 9·0% of tungsten and also carries enough manganese to give it air-hardening properties and to class it as a quaternary alloy. This article considers principally commercial ternary alloys of tungsten. High carbon steels containing tungsten up to 6% are essentially water-hardening steels. (*See* IRON AND STEEL HEAT TREATMENT; METALLOGRAPHY.) The atoms of tungsten, being so much larger and heavier than those of iron, diffuse comparatively slowly in solid metal, so that a high temperature is required for solution before the quench. Accumulation of carbide particles upon tempering is also slow, hence the ability of tungsten steels to hold their hardness at high temperatures. Tungsten carbide also has a very high intrinsic hardness, approaching that of the diamond. For keen edged tools tungsten in the alloy seems to prevent small particles from being torn away during use, and thus retards dulling.

Steel containing 0·9% carbon or more together with 1 to 2% tungsten is used for hack saw blades and for reamers, broaches and other tools which must show a minimum change in dimension after heat treatment. Steels with 1% carbon or more, and 3 to 7% tungsten, are much used for "fast-finishing" tools to cut hard metals or to make a fine smooth cut on softer tough metal Dies for cold drawing wire and other shapes are made of higher carbon steels (2%) with tungsten ranging from 1 to 12%. Dies with the higher tungsten percentages are used for the harder metals or the finer wires.

Chromium is often added to facilitate the diffusion of tungsten. When 0·5% or more is present the alloy may crack during water hardening An oil quench, however, will harden it through to the centre. Chromium also causes the useful hardness to be retained at higher working temperatures For working hot metal, tools would be made of 0·3% carbon steel with 10% tungsten and 3½% chromium (known as "semi-high-speed") Permanent magnets for electric meters, magnetos, radio and telephone equipment absorb annually several thousand tons of steel containing 0·7% carbon and 5 to 6% tungsten.

In tungsten-iron alloys, substantially free from carbon, tungsten has the property of lowering the temperature at which delta iron changes to gamma iron and also of raising the temperature at which gamma changes to alpha iron Consequently the American metallurgist W P Sykes was able to show that no gamma iron is formed in carbon-free alloys containing more than 7% tungsten. Such an alloy is permanently austenitic, and cannot be hardened or tempered by heat treatment. In the alloys containing more tungsten the compound Fe_3W_2 appears; its solubility decreases with the temperature, and it is precipitated throughout the metal at a slow rate. To harden such an alloy it is necessary to anneal or "age" it at a moderate temperature for several hours or days. Brinell hardness numbers indicate the extent of this action

	Brinell
Carbon free iron	70
Carbon free solid solution alloy, 80% iron, 20% tungsten	160
Above after aging	330
Carbon free aged alloy, 78% iron, 22% molybdenum	530

Such aged alloys of iron and tungsten and of iron and molybdenum (tungsten and molybdenum being very similar chemically) form excellent wire drawing dies, and have given 10 to 40 times the service that can be had from best high speed steel before the edge needs re-dressing. (*See* IRON AND STEEL; HIGH SPEED STEEL.) (E. E T.)

TUNGUSES, a widespread north Asiatic people. They are the *Tung-hu* of the Chinese, probably a corrupt form of *tonki* or *donki,* that is, "men" or "people." The Russian form *Tungus,* wrongly supposed to mean "lake people," appears to occur first in the Dutch writer Massa (1612); but the race has been known to the Russians ever since they reached the Yenisei. The Tungus domain stretches from long. 60° E. to the Pacific ocean and from the Arctic to the Chinese frontier The Tunguses are known to the Samoyedes by the name of *Aiya* or "younger brothers." The Oroches, Chapogir, Goldi, Lamut, Manjour, Manegre and Oroke are partly in Manchuria and are Tungusic. The Tungus type is essentially Mongolic, with broad flat features, small nose, wide mouth, thin lips, small black and somewhat oblique eyes, black lank hair, dark olive or bronze complexion, low stature, averaging not more than 5 ft 4 in The square shape of the skull and the slim, wiry, well-proportioned figure are features especially of the typical Tunguses They are classed according to their various pursuits, as Reindeer, Horse, Dog, or Sedentary, Nomadic and Wandering Tunguses. A few have become settled agriculturists; but the great bulk of the race are still essentially forest hunters, using the reindeer both as mounts and as pack animals. Nearly all lead nomad lives in pursuit of fur-bearing animals, whose skins they barter in exchange for provisions, clothing and other necessaries of life. The national costume shows in its ornamentation and general style Japanese influence, due to intercourse at some period previous to the spread of the race to Siberia Many of the Tungus tribes are reckoned as "Greek Christians"; but most of them are still Shamanists and nature-worshippers, secretly keeping the teeth and claws of wild animals as idols or amulets, and observing Christian rites only under compulsion Family and exogamic clan organization is relatively strong. Intercourse begins before marriage as soon as a portion of the bride price has been paid. Some practise polygamy. Exchange marriages occur. The levirate is common. A man may take his son's widow Cousin marriage occurs and tree-burial (*q.v*) is found among them.

See M Czaplicka, *Aboriginal Siberia* (1914)

TUNICATA, a well-marked class of marine animals, normally distinguished by the possession of an external cuticle of cellulose (the *tunic* or *test*), and of two more or less prominent *siphons,* one inhalant. the other exhalant, leading into corresponding internal chambers (the *branchial sac* and *atrium*), which communicate with one another by a system of ciliated *gill-slits* or *stigmata* These maintain through the body a circulation of sea-water subservient both to food-collection and respiration The class was instituted and named in 1816 by Lamarck, who included the fixed Solitary Ascidians or Sea-squirts (the Tethya of Aristotle) and the Compound Ascidians, which form colonies by budding (first distinguished from Alcyonarian polyps in the previous year by Savigny), together with various pelagic free-swimming forms (*Thalia, Salpa, Pyrosoma*), at that time very imperfectly known The minute tailed Appendicularians, first described in 1819 by Chamisso, were added to the class thirty years later either as larval forms (Joh. Muller, Krohn, Vogt, 1846–1854) or as a definite adult type (Huxley, 1851)

"Acephalous Mollusca."—Cuvier (1798, 1815) ranged the Ascidians alongside the bivalved Lamellibranchs as "Acephalous Mollusca," being led to this view by the similarity of their siphons, and by the interpretation of the combined branchial sac and atrium as a mantle-cavity containing a pair of "branchial membranes." The opening of the oesophagus into the branchial sac was regarded as the true mouth This view dominated zoology until 1871, when it became clear, as a result of Kowalevsky's observations on the development, that the so-called "branchial sac" was simply a dilated *pharynx*, and that the real affinities of Tunicata were with the Vertebrates, owing to the larval possession of *notochord, dorsal nerve-tube* and *gill-slits.* The group is now recognised as forming with *Amphioxus* (*q v*) the lowest section of the Chordata, the subphylum Protochordata of Balfour.

The feature which, above all others, distinguishes this subphylum from the rest of the Chordata is the possession throughout life of an endopharyngeal ciliary feeding mechanism of subdivided *gill-slits*, glandular *endostyle*, and ciliated *peripharyngeal bands* This apparatus, beautifully adapted for straining off mi-

nute floating particles is still represented by vestiges in Vertebrate embryos (*cf.* development of thymus and thyroid glands, which are modified remnants of tongue-bars and endostyle). Thus the Protochordata have the unique interest of preserving some of the characters of the immediate ancestors of the Vertebrata.

Apart from this the class Tunicata presents a number of special features of considerable physiological interest, such as the presence in the test of "animal cellulose" (*tunicin*, $C_6H_{10}O_5$), the presence in the blood-cells of the rare element *Vanadium*, which probably acts as a catalyst, and, with its five oxides, accounts for the diversified colouring of these animals (Henze, 1911–1913; Hecht, 1918); the reversibility in the direction of the heart-beat; the prevalence of gemmation of different types, whether simple or complicated by polymorphism; and, in Appendicularians, the phenomena of cell-reduction and of partial neoteny.

Classification.—With the exception of a few imperfectly known forms, existing Tunicata fall readily into one or other of three sub-classes named by Herdman (1891) Ascidiacea, Thaliacea and Larvacea. The first includes the fixed Ascidians, both simple and compound, the second the pelagic, tailless, free-swimming types reproducing by budding (inclusive of *Pyrosoma*, which Herdman referred to the Ascidiacea), and the third the minute, solitary, tailed, Appendicularians The name Larvacea, however, has not received general recognition, and is here replaced by Gegenbaur's older (1878) and in other ways more acceptable term Copelata (from *Kopēlátēs*, oarsman, sculler).

The order in which these groups are here presented is believed to represent the natural, or phyletic, sequence; but the pelagic Thaliacea and Copelata, though far less rich in numbers and variety than the Ascidiacea, are treated in greater detail, both on account of their importance to students of evolution, and from the fact that our knowledge of them has been greatly extended by the oceanic expeditions of recent times, which renders more complete treatment desirable The classification adopted will perhaps be more readily intelligible as a record of Tunicate evolution if it be added that the ground-plan of the Tunicate pharynx, like that of *Amphioxus*, consists of a median ciliated and glandular groove below (the endostyle), flanked by gill-slits of the *Amphioxus* pattern on either side, *i e*, each U-shaped, completely bisected by a tongue-bar, and each half (or *protostigma*) further divided into a row of stigmata by outgrowth of processes (*synapticulae*) from the tongue-bar It should also be noted that the power of budding is assumed to have been possessed by the earliest Tunicata, since in some form or other many solitary Ascidians, even *Amphioxus* and Appendicularians, retain structures which are probably vestiges of the endodermal budding organ or *epicardium*. (*See* below) Indeed *loss* of budding has probably been no slight factor in the evolution of the later forms, both fixed and free, by releasing energy for increased size and longer life, or more continuous muscular activity

Class Tunicata

Unsegmented, hermaphrodite Protochordata with an atrio-cloacal cavity, a recurved intestine and a gelatinous resistant cuticle or test of cellulose

Order I. Ascidiacea

Sessile, with dorsal atriopore (*cloacal siphon*); pharynx with transverse rows of ciliated stigmata, variously shaped, and an internal accessory apparatus of ciliated bars, ridges or papillae.

Section I. **Enterogona,** Perrier, *sens, lat.* (= *Endoblastica*, Garstang)—Gonads unpaired, lodged in the intestinal loop or projecting behind it; budding epicardial; larva with cerebral eye and otolith

Suborder 1. Phlebobranchia, Lahille (=*Dictyobranchia*, Seeliger).—Pharynx with accessory, tubular, internal longitudinal vessels, often supporting ciliated papillae, intestinal loop usually alongside pharynx; budding rare (*Perophora, Diazona*), the epicardium in other cases sterile (*Ciona*) or absent.

Families: Perophoridae, Diazonidae, Cionidae, Phallusiidae (=Ascidiidae), Corellidae.

Suborder 2 Haplobranchia, Lah *emend* Garst (=*Krikobranchia*, Seeliger). Pharynx without internal longitudinal vessels or bars, but with transverse ciliated ridges (horizontal membranes); body elongated, with distinct abdominal region, *i.e.*, intestinal loop always behind the pharynx; budding universal.

Families: *Clavelinidae* (including *Distomidae*=*Polycitoridae*), Gonads in intestinal loop, heart alongside, budding purely epicardial; *Didemnidae*, Intestinal loop short, gonads projecting, budding epicardio-intestinal; *Polyclinidae* (=*Synoicidae*, Hart), Gonads and heart behind the intestinal loop, budding by post-abdominal (rarely abdominal) fission.

Section II. **Pleurogona,** Perrier (=*Periblastica*, Garst.). Gonads parietal (in atrial wall), usually paired; body compact; budding peribranchial (lateral); larval brain with otolith, but no separate eye, larval suckers reinforced by a peripheral ring of adhesive papillae.

Suborder 3 Stolidobranchia, Lah. (=*Ptychobranchia*, Seeliger). Pharynx with internal longitudinal bars, not tubular vessels; its walls often folded longitudinally, or with clusters of bars representing folds; budding rare (*Botryllidae, Polystyelinae*); epicardium vestigial or absent.

Families. *Botryllidae, Styelidae* (=*Tethyidae*, Hart), *Tethyidae* (Huntsman, not Hartmeyer; =*Pyuridae*, Hart, formerly *Cynthiidae*), *Molgulidae* (=*Caesiridae*, Hart)

Order II. Thaliacea

Pelagic, with mouth and atriopore at opposite ends; pharynx with persistent undivided protostigmata; budding from a complex ventral stolon, containing both pharyngeal and peribranchial outgrowths

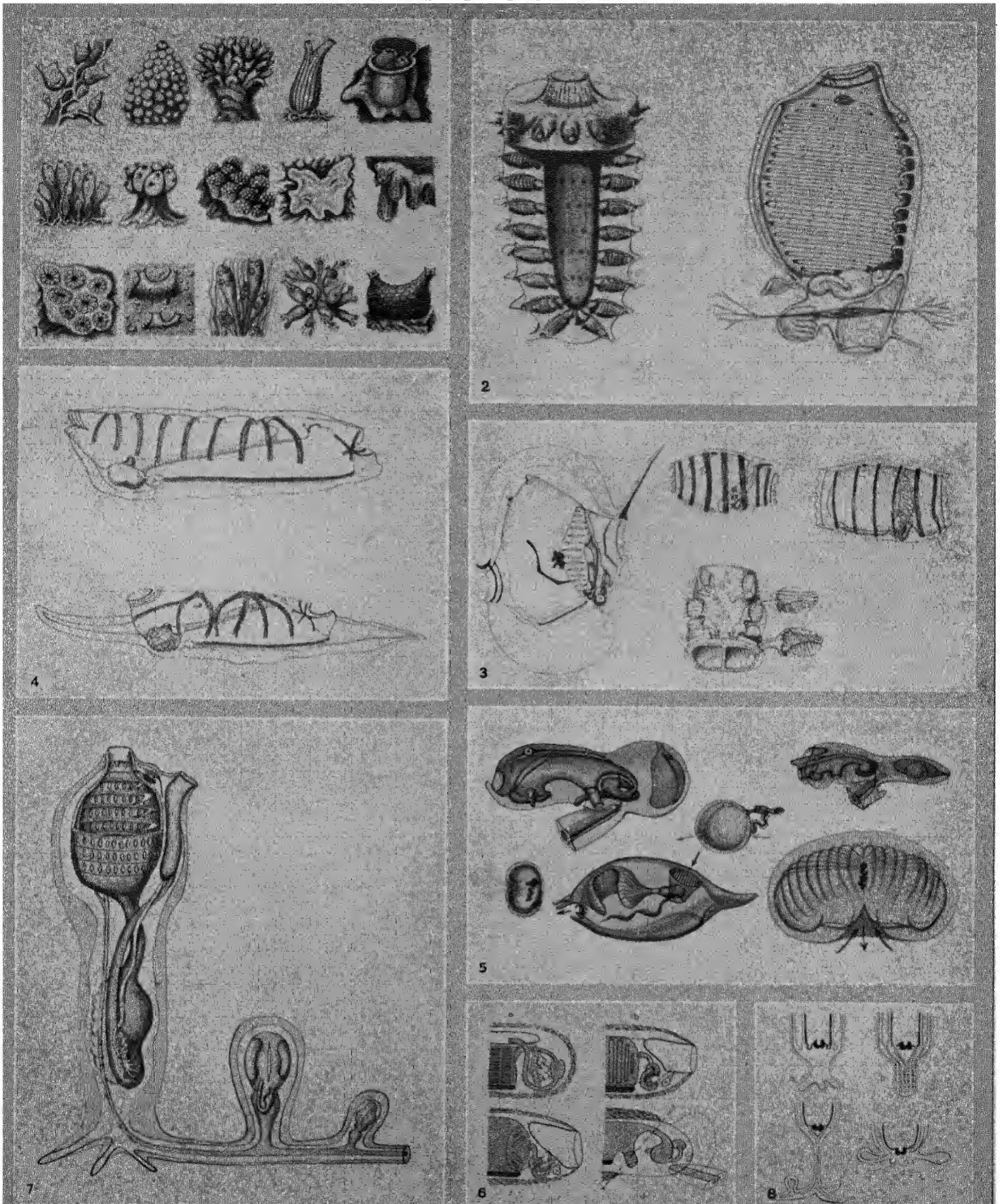
Suborder 1. Pyrosomata has the following characteristics: Oozooid incompletely developed Blastozooids forming a permanent colony, each hermaphrodite and capable of budding Protostigmata numerous, and crossed by internal longitudinal bars A cerebral eye, and a sub-neural gland, with duct and ciliated funnel, always present. Fam *Pyrosomatidae.*—Colony a hollow cylinder closed at one end, the zooids imbedded in its walls, mouths outside, atriopores inside, and endostyles towards the closed end (the starting point). Each zooid has a pair of transverse lateral muscles connected with fibres in the common test (*colonial muscular system*) A single egg develops in each cloaca into a ring-like primal colony of 4 zooids (*tetrazooid colony*). Phosphorescent

Pyrostremma, nov gen. (from *stremma*—a twist or sprain; =*Pyrosomata fixata*) Protostigmata oblique; a cloacal languet; "colonial" muscle crossing the pharynx; also an anterior biradiate muscle-plexus, concentrated dorsally. Stolon multi-annulate, buds not migratory. Orifice of colony guarded by 4 test-processes containing muscular test-vessels. Two species, *P. spinosum, agassizii.*

Pyrosoma, s. str. (=*Pyrosomata ambulata*) Protostigmata at right angles to endostyle. No cloacal languet or anterior muscle plexus. "Colonial" muscle crossing the cloaca. Stolon short; buds carried to their places by phorocytes. Orifice of colony with sphincter in a test-diaphragm containing vascular processes, e.g., *P. atlanticum, verticillatum*, etc

Suborder 2. Doliolida (=*Cyclomyaria*) is characterized by: Oozooid asexual, free-swimming, and budding freely. Peribranchial cavities shallow. Pharynx without internal longitudinal bars. Peripharyngeal bands twisted spirally at their dorsal junction (ciliated spire). Protostigmata in oozooid few (4 pairs), forming a transverse series behind the endostyle, in blastozooids more numerous. Oozooid with a dorsal outgrowth to which the free buds are carried from the ventral stolon by phorocytes. Blastozooids polymorphic, the first being nutritive and sessile (*trophozooids*), the second sterile and locomotive (*phorozooids*), the last sexual (*gonozooids*). Cloaca posterior, atriopore terminal. Intestine in oozooid uncoiled, with posterior anus. A subneural gland, with duct and ciliated funnel. Eye absent.

Fam. I. *Doliopsidae.* Atria and protostigmata entirely behind endostyle. Ciliated spire behind the brain. Somatic muscles not forming loops. Stolon extended on to dorsal outgrowth. Blastozooids globose, arranged on the outgrowth in groups, not rows. *Doliopsis* Vogt (=*Anchinia*, Esch). (Oozooid known only by



PARTLY AFTER (2) SEELIGER, (3) KOROTNEFF AND NEUMANN, (5) FOL AND LOHMANN; FROM (6, 8) GARSTANG, "MORPHOLOGY OF TUNICATA" IN THE QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE (CLARENDON PRESS)

TYPES OF THE VARIOUS ORDERS OF TUNICATA

1. Ascidiacea: top row, Phlebobranchia; middle row, Haplobranchia; bottom row, Stolidobranchia. 2. Pyrosoma colony and a single zooid. 3. Doliopsis (left to right), gonozooid, oozooid and phorozooid; dorsal fragment, oozooid of Doliolum (bottom). 4. Salpida. Salpa fusiformis oozooid (top) and blastozooid (below). 5. Copelata. Top row across, Oikopleura, Fritillaria, [illegible] Stages in retrograde evolution: a. Ascidian (cionid); b. Pyrosoma (blastozooid); c. Doliolum (oozooid with gonads); d. Appendicularian, with rudimentary gonads. 7. Clavelina, showing two stages of buds. 8. Budding: a. Hypothetical Protunicate; b. Protothaliacean; c. Endoblastic ascidian (Enterogona); d. Periblastic ascidian (Pleurogona)

fragments of dorsal outgrowth.) Phorozooids and gonozooids with a praeoral and a supracloacal tentacle, lacking in the trophozooids. Somatic muscles a pair of S-shaped strands.

Fam. II. *Doliolidae.* Oozooid and locomotive buds barrel-shaped, the former with 9, the latter with 8, muscular hoops. Oozooid with an otocyst on the left side, and 4 longitudinal rows of buds on its dorsal process—trophozooids along the sides, phorozooids down the middle, the latter carrying gonozooid buds on their stalks of attachment. Trophozooids with gaping mouth and half-obliterated cloaca. Phorozooid and gonozooid without supra-cloacal outgrowth or otocyst. Ciliated spire before the brain. Stolon short; buds all migratory.

Doliolina, Borgert All protostigmata (<50) in a transverse series behind endostyle. Intestine U-shaped, e g., *D. mülleri, D. krohni* (with 3 pairs of lateral vascular appendages) *Doliolum,* Q and G. with antero-dorsal atrial extensions in gonozooid, carrying numerous additional protostigmata. Intestine directed backwards or twisted to right, e.g., *D. denticulatum.*

Suborder 3 SALPIDA (=*Desmomyaria*)

Oozooid (*solitary form,* or *nurse*) asexual, free-swimming and budding freely, in general resembling the blastozooids, but tending to greater size (often twice as large) and muscularity. Blastozooids all locomotive and hermaphrodite. Cloaca dorsal, atriopore posterodorsal, separated from pharynx by an oblique median vascular tract (the *gill*), with transverse ciliated stripes and an elongated gap on either side Muscles as transverse bands often connected dorsally (*i e.,* Desmomyarian), usually incomplete ventrally (*i e ,* Hemimyarian), with a tendency to polymerisation and elongation of cloacal siphon in oozooid Oesophagus ventral. Gut a sinistral loop, protruding as a postero-ventral hernia, or compressed into a compact "nucleus." A cerebral eye, but no otocyst No typical neural (hypophysial) gland, but a detached ciliated pit in front, and below the brain a pair of peculiar pharyngeal diverticula (*extra-neural glands*), unpaired in *Thetys,* rarely absent (*Thalia*)

Stolon long Buds at first vertical in a linear series; then in two alternating rows with atriopores outwards; finally adhering to one another merely by papillae (usually 8). Portions detached at intervals as free colonies, usually in chains, rarely wheels (*aggregated* or *chain forms*), certain features of the blastozooids being related to this phase (asymmetry of right- and left-sided individuals, elevation and forward rotation of eye, adhesive organs, etc) Ultimately the blastozooids become free and give rise to embryos (usually 1 each) with placental development.

Salp Classification.—The classification of Salps has hitherto been based on the idea that a *Doliolum*-like arrangement of muscle-bands and an elongated intestine are primitive for the group, as exemplified in *Cyclosalpa.* It is not easy to reconcile this view with the retention by Salps of a dorsal cloaca, sinistral intestinal loop, and bud-retaining stolon, primitive features which have been lost by every Doliolid. It is more probable that the musculature in both groups was originally plexiform (*cf. Pyrostremma*), that Salps have retained this condition more completely than Doliolids (the blastozooids more completely than the oozooids), and that the partial resemblances of certain oozooids to Cyclomyaria are examples of simple convergence.

Pending completion of certain investigations on the endostyle (Garstang and Platt, 1928), some results of which are here embodied, the following attempt at a phyletic grouping of the various forms is provisional. Metcalf's sub-genera (1918) are adopted as natural groups of species, though the homogeneity of the *Ritteriella* group is not above question. In *R. amboinensis* the marginal bands of the endostyle are asymmetrical.

Abbreviations.—M = Muscles, OZ = Oozooid, BZ = Blastozooid. The fractions represent the number of conspicuous muscle-bands in $\frac{OZ}{BZ}$, omitting those of the siphons. Unless otherwise stated the muscles are complete dorsally and incomplete ventrally, and the embryos are single on the right cloacal wall.

Fam. I. *Salpidae.*—Colonies as chains. Intestine in a sinistral loop, or if elongated (*Ritteriella*), produced backwards. (i.) Intestinal hernia moderate. Marginal bands of endostyle symmetrical (*Traustedtia?*).

Sub-fam. i. *Pegeinae.*—M in two small dorsal bundles, forking laterally, nearly alike in OZ and BZ: a pair of "tails" in BZ. —*Traustedtia,* $\frac{6}{5}$, with radiating appendages in OZ; *Pegea,* $\frac{4}{4}$ endostyle deep.

Sub-fam. ii. *Iasinae*:—M separate, but incomplete dorsally in OZ, embryos 3–5, endostyle shallow, the accessory gland-tract reduced or obsolete. *Iasis,* $\frac{6}{5}$, no tails, *Thetys,* $\frac{18-20}{5}$, tails in OZ.

(ii.) Intestinal hernia inconspicuous or absent. Marginal bands asymmetrical, the left vestigial or absent.

Sub-fam. iii. *Thaliinae.*—M usually grouped (3–4) in front and separate (2–5) behind, especially in OZ, sometimes complete ventrally. *Thalia,* $\frac{5-6}{5}$, tails in OZ, *Salpa,* $\frac{8-9}{6}$, BZ with unpaired pointed processes in front and behind; *Ihlea,* $\frac{7-8}{6}$, all M in OZ complete ventrally.

Incertae sedis.—*Ritteriella,* $\frac{10-25}{6}$, M connected dorsally by a long anastomosis, intestine loosely coiled and protruding, or in OZ produced backward beneath extended cloaca; *Brooksia,* $\frac{7}{4}$, with ventral muscular proboscis in OZ

Fam. II. *Cyclosalpidae*—Colonies as wheels (except *C. virgula*) Intestine in OZ extended forward above the gill Endostyle with interlocking lips, left marginal band obsolete

Cyclosalpa, $\frac{6}{3}-\frac{7}{4}$, M highly variable, intestinal hernia in BZ enormous, except *C. pinnata* in which the intestine extends forward below the endostyle! Usually phosphorescent

Order III. COPELATA (=Larvacea)

This order is characterised by small pelagic forms with one pair of tubular gill-slits (spiracles), reduced endostyle, and a horizontal tail bent forwards beneath the body Cloaca absent, represented behind by a large, thin-walled tunic-free area which includes the apertures of intestine, spiracles, and gonads (genito-spiracular area) Test differentiated and expanded as a filtering mechanism (the house), formed by thickened ectoderm of the pregenital region (oikoplastic epithelium) From its boundary frequently arises a transverse dorso-lateral fold, directed forwards (dorsal hood or veil). Intestine normally coiled to right of oesophagus No budding, but epicardial vestiges possibly represented by the pharyngeal packets of *Fritillaria* (and oral glands of *Oikopleura?*) The minute structure of the body is characterised by great economy of cellular elements.

(As elaborations of the test in Appendicularians replace in bionomical value the internal modifications of other Tunicates, a phyletic classification of Copelata should rest largely upon the structure of the house, but various uncertainties prevent us from making use of more than a few conspicuous features Fol's account of the house of *Appendicularia* [1874] seems to have been misunderstood by Lohmann, who has nevertheless made valuable observations on the house-rudiment [1896, 1899] This genus is regarded by the present writer, in agreement with its discoverer, as the most central and primitive type of the Copelata. The classification adopted differs accordingly in various respects from Lohmann and Buckman's recent revision [1926]).

(N.B. The terms *anterior, posterior,* etc , when applied to the house, are here used in their usual morphological sense, and not with reference to the direction of locomotion, as used by Lohmann. For brevity *oikothelium* is used for *oikoplastic epithelium.*)

Suborder I. ENDOSTYLOPHORA (Garstang, 1895). Pharynx with endostyle. House bilaterally symmetrical, with separate inhalant and exhalant apertures.

Fam. I *Appendicularidae.*—Intestine tubular, to right of stomach. Rectum ventral, directed forwards Endostyle an open groove with an anterior tuft of cirri. House enclosing the body, with an anterior (oral) aperture, a paired filtering mechanism above, and a caudal chamber below.

Sub-fam. i. *Appendicularinae*—Anus behind spiracles, to right of tail-base. Oesophagus ventral. Oikothelium broad and long, giving rise to two dissimilar pairs of fibrillated membranes. Dorsal hood arising far back. House not much expanded, taller and broader than long, caudal chamber vertical (with postero-ventral

aperture?), tail pointing downwards

Only genus and species, *Appendicularia sicula*, Fol,—body <0.5mm, house <2.6mm. in greatest diameter.

Sub-fam. ii. *Oikopleurinae*.—Anus mid-ventral, between or in front of spiracles Oesophagus dorsal House much expanded, usually with lateral filtering windows; caudal chamber horizontal, tail pointing forwards

Oikopleura—Stomach bilobed, clamped between dorsal oesophagus and ventral rectum Mouth with projecting under-lip. The species in general fall into two sections, which differ in details of the oikothelium—(i.) *fusiformis, longicauda,* etc. without oral glands, and (ii) *labradoriensis, albicans, dioica,* etc with oral glands *O longicauda* (=*spissa,* Fol) is the only species with a postero-dorsal "veil," and a median posterior inhalant aperture to the house, without filtering windows

In various oceanic types related to the second group, but with gelatinized blastocoele, the intestinal loop opens out, either (i) vertically (e g, *Folia, Stegosoma,* etc) or (ii.) horizontally (viz, *Bathochordaeus* and *Althoffia*). In several respects *Bathochordaeus* approaches *Appendicularia.* The houses of all are unknown Only *Folia* and *Stegosoma* possess oral glands.

Fam. II. *Fritillaridae*—Stomach and intestine reduced (oligocytic) and vesicular; anus behind spiracles, on right side. Endostyle without flagella, nearly closed Genital region produced, blastocoele gelatinised Oikothelium short and narrow, covered by a dorsal hood arising far forward No house, but an elastic *filtering capsule*, projected over the mouth from the hood-cavity

Fritillaria—Hood not produced in front of snout The numerous species mostly fall into two groups (i) with tail forked, mouth complicated, usually a "pharyngeal packet" behind endostyle, e g, *borealis, pellucida* (=*furcata,* Fol.), and (ii) with tail pointed, mouth structure very simple, pharyngeal packet completely wanting or when present very greatly reduced to a small number of peculiar cells, e.g, *haplostoma.*

Tectillaria—Hood greatly produced and pointed, arising in front of spiracles, and bearing the far greater part of the oikothelium on its lower surface—*T fertilis,* Lohm

Sub-order II POLYSTYLOPHORA (Garstang, 1895) Endostyle absent Spiracles slit-like Peripharyngeal and ventral ciliated bands replaced by 4 longitudinal rows of ciliated processes, forming an endopharyngeal sieve House capacious, bi-radially symmetrical round a single aperture

Fam *Kowalevskidae*—Oikothelium mainly dorsal, radially arranged around a central boss, under a delicate hood arising far back (Lohmann, 1896). Oesophagus ventral, gut bi-vesicular, stomach left, rectum and anus right.

Only genus and species, *Kowalevskia tenuis,* Fol. (1872)

If the preceding classification accurately resumes the facts of structure and the affinities of the numerous living forms of Tunicata, it presents some remarkable features the three orders stand at three different morphological levels, but in descending, instead of ascending, order. The Ascidiacea with their transverse rows of stigmata are followed by the Thaliacea, with undivided protostigmata, and these by the Copelata with a single pair of simple perforations. The situation is much the same with regard to atrial cavities and endostyle.

The following considerations appear to justify the order in question as representing a true phyletic sequence The development of Ascidians shows that protostigmata are the bisected halves of tongue-barred U-shaped slits, as in *Amphioxus,* and that lateral atria actually precede their formation. The possession by Appendicularians of a testless area behind an anterior test-producing one, indicates that the genito-spiracular area is really a shallow atrio-cloacal cavity, like that of *Doliolum,* reduced and everted. The intestinal loop of Tunicates, adult or larval, is sinistral (*i.e*, rectum to left of oesophagus) except in Doliolids and Appendicularians. Only in these and in one or two Salps is the loop straightened out. only in the same two groups are rectum and anus twisted to the right The Appendicularian condition is thus the climax of a retrograde evolutional process of which the Thaliacean, especially the Doliolid, type, with posterior cloaca, reduced atria, and a few simple protostigmata (in the oozooid stage of development) is regarded as an intermediate step.

ANATOMY

A general impression of the structure of a fairly typical Ascidian can be gathered from the figure of *Clavelina* (Pl. fig. 7). In this form, as in all Haplobranchs, the intestinal loop lies completely behind the pharynx, and the latter is free from the complexities caused by the presence of internal longitudinal bars or vessels; but these are the only conspicuous points—apart from the arrangements for budding—in which the general structure differs from that of such a typical "simple" Ascidian as *Ciona.* In both the body is erect, fixed by a multitude of "rootlets," and carrying mouth and atriopore at its upper extremity, the mouth terminal, the atriopore a little to one side. Between the two siphons lies the small solid brain, giving off nerves in front and behind, and defining the dorsal side of the body by its presence On the opposite (ventral) side the endostyle runs along the whole length of the pharynx, which contracts immediately behind it, and is continued by the dorsal oesophagus into the digestive portion of the alimentary canal This consists of a descending limb, including the stomach, and an ascending limb (mainly rectum) which crosses the other on its left side, the two being connected at the bend by a mid-gut or intestine From the lower end of the stomach issues a slender diverticulum which forks repeatedly on the wall of the rectum opposite (the pyloric gland) The rectum opens into the cloaca by a dorsal anus

The cloacal cavity extends along the dorsal side of the pharynx, the cloacal siphon or atriopore being situated in this case and in *Ciona* at its anterior extremity Right and left this cavity is continued over the sides of the pharynx as the lateral atria, or peribranchial cavities, which terminate ventrally on either side of the endostyle. Beneath the endostyle runs a large ventral blood-channel, which is continued behind into the abdomen A corresponding dorsal blood-channel runs longitudinally between the pharyngeal roof and the cloacal floor, and is also continued into the abdomen The two are connected by transverse channels between the rows of stigmata, and these are connected by smaller channels running longitudinally between adjacent stigmata, the whole constituting a vascular network moulded to the form of the pharynx. The heart is always situated in the course of the ventral blood-sinus, but at different points according to the position of the intestinal loop In "simple" Ascidians, in which the loop lies against the left side of the pharynx, the heart lies close behind the endostyle, as it does also in the young *Clavelina;* but during the later growth of *Clavelina* and its allies the intestinal loop stretches considerably downwards, and the heart is carried with it, in Polyclinids even beneath it into the "postabdomen."

The heart itself in all Tunicates is part of a larger structure, the *cardio-pericardial vesicle* This is at first a closed oval sac, arising ventrally to the gut Its dorsal wall becomes invaginated, and the invaginated epithelium becomes contractile The inner vesicle constitutes the heart, the outer the pericardium, the two being separated by the pericardial cavity. The lips of the cardiac invagination tend to meet, thereby closing its cavity, except at the two ends, where they remain open to the blood in the ventral sinus The heart undergoes waves of contraction either from behind forwards, or from before backwards, the whole course of the circulation being subject to periodic reversal

In *Clavelina* the roof of the cardiac groove is partly provided by a third structure, the *epicardium,* an epithelial septum which arises as a pair of outgrowths from the hinder wall of the pharynx on either side of the endostyle. These epicardial diverticula fuse behind the pharynx into a single tube, which becomes flattened dorso-ventrally and extends down the abdominal cavity as a thin broad septum between the main dorsal and ventral blood channels. It continues its course into the small branching rootlets by which the *Clavelina* is attached (*the creeping stolon*). Its relations with the circulatory system appear to be secondary; its real *raison d'etre* is to be found in the budding process.

In *Ciona,* which never buds, the two epicardial outgrowths are present in a modified form; they remain distinct, and the cavity of each expands to form a *perivisceral space* behind the pharynx.

The left sends prolongations into the numerous rootlets of attachment, and thus also functions as a septum dividing afferent and efferent blood-streams both in the free rootlets and in other tubular outgrowths (the *test-vessels*) which penetrate the substance of the test covering the body itself. In other less primitive Phlebobranchs, in which the test becomes greatly thickened, these adventitious outgrowths become greatly multiplied, but in the majority of these cases the epicardium is vestigial or altogether absent, and the septation of the test-vessels is accomplished by longitudinal folds of their own walls. This secondary process of septation may proceed so far as to divide each vessel into two complete and parallel halves, the so-called *double-vessels* In Molgulids, which possess such vessels, the vestigial epicardia are converted into a pair of renal excretory organs; but both in Molgulids and *Ascidia,* the test-vessels are mainly or entirely derived from a basal vessel opposite the end of the endostyle.

The reproductive organs, as in all Enterogona, consist of a single lobulate ovary and testis, each provided with its own duct, which runs alongside the intestine to open into the cloaca. The two glands occupy the typical position in the loop of the intestine. Among the Pleurogonous Ascidians the loop of the intestine tends to open out, and the lobules of the gonads become independent and dispersed (*polycarps*) over the wall of the atrial cavities, in some cases with a remarkable degree of metameric regularity, recalling that in *Amphioxus.*

MODE OF NUTRITION

The Endopharyngeal Apparatus.—The *endostyle* has a characteristic and very constant structure throughout the Ascidiacea. It is a deep groove with high upstanding edges, which are strongly ciliated as the *marginal bands*, the general pharyngeal epithelium being unciliated The bands unite behind the endostyle, but at the anterior end they diverge right and left and encircle the pharynx in front of the first row of stigmata as the *peri-pharyngeal bands* In the mid-dorsal line they unite once more and form a single ciliated tract which runs backwards as the *epi-* or *hyper-pharyngeal band* until it merges in the general ciliation at the entrance to the oesophagus On one side the dorsal edges of the various *horizontal membranes* are produced as a series of *dorsal languets,* which in life are recurved upon themselves like so many flexible hooks. The edges of the horizontal membranes are ciliated. Between the endostyle and the oesophageal aperture runs the *retropharyngeal band,* also ciliated.

Within the groove of the endostyle run 3 pairs of longitudinal tracts of gland-cells, of which the two lower pairs resemble one another in their wedge-like section, and may be distinguished as the *primary tracts,* comparable with those in *Amphioxus,* while the upper pair, consisting of cylindrical cells, constitute the *accessory tracts.* When any reduction takes place, these are the first to go (e g , *Distaplia, Doliolum, Iasinæ*). The three tracts are separated from one another on each side by two narrow bands of minute ciliated cells (the *intermediate bands*). The floor of the groove is composed of a few rows of small cells bearing long flagella, which reach to the top of the groove. These disappear only in the Copelata

This apparatus works as follows. The gland cells pour into the groove a constant stream of mucus-like slime, and, apparently by the action of the long median flagella, this is thrown out into the general cavity of the pharynx. The cilia bordering the stigmata beat outwards into the atrial cavities, and cause a strong stream of water to pour in through the open mouth. The slime from the endostyle is carried with the water towards the nearest gill-slits (*i.e.,* the ventral ones), but is at once worked into the form of longitudinal threads which, alighting upon the ciliated edges of the horizontal membranes, are swept dorsally, and entangle suspended food-particles as they are rolled upwards in rapid succession. The combined marginal and peripharyngeal bands convey a separate stream of mucus directly round the front end of the pharynx into the hyper-pharyngeal groove, along which it streams backwards to the oesophageal aperture, supported by the dorsal languets. Fringes of slime trailed off the peripharyngeal bands connect with the series rolled up from the endostyle, and all become entwined together dorsally into a single rotating cord of mingled slime and food-particles which passes uninterruptedly into the oesophagus.

In *Clavelina,* owing to its perfect transparency, this process can be readily observed by adding powdered carmine to the seawater round a living example under a binocular microscope. In other types of Ascidians the phenomena cannot be followed so completely, but there is good reason to believe that all the elaborations of the Ascidian pharynx are so many contrivances to the same end The longitudinal bars and terminal papillae of Stolidobranchs and Phlebobranchs assist the process by muscular means, swinging to and fro transversely in such a way as mechanically to pick up the longitudinal slime-ropes and push them upwards from one bar or papilla to the next. The concave "minute plications" or "meshes" of Phlebobranchs, and the longitudinal folds of Stolidobranchs subserve the same purpose by withdrawing the perforated surface of the pharynx away from the collecting surface, and by concentrating the longitudinal bars of the latter into closer proximity. In this way a secondary collecting sieve is produced within the primary current-producing one—which enables a stronger stream to be poured through the pharynx without waste of food-particles The formation of this inner cyclinder of muscular bars and ciliated ridges explains the elevation of the side-walls of the endostyle to its own level

In Thaliacea the mode of food-collection changes Except at its extremities, the endostyle of *Doliolum* is closed by apposition of its lips, and the slime is all driven forwards and upwards along the peripharyngeal bands, from which it is trailed off in fringes by the current which sets towards the gill-slits behind The fringes of each side are carried dorsally until their bases meet in the "ciliated spire," where they are twisted together into a rotating cord, the free end of which is directed diagonally through the pharyngeal cavity into the oesophageal aperture. The moving fringes thus constitute a conical sieve at the entrance to the pharynx, although the individual threads are constantly being caught into the food-rope dorsally and renewed from the endostyle ventrally (Fol, 1878)

In *Salpa* the *modus operandi* is not so clear. The ciliated stripes across the sides of the gill appear to play much the same part as true gill-slits and the food-rope passes backwards along its lower face, instead of freely traversing the pharyngeal cavity. (Fol, *l.c.*). The fringes of *Doliolum* are replaced by an almost continuous "curtain" of mucus in *Thalia democratica,* but the whole process needs re-examination in relation to the great variations now shown to exist in the structure of the Salp endostyle, which presents every gradation from a flat symmetrical *Amphioxus*-like pad in *Iasis* and *Thetys* to a closed tube with asymmetrical marginal bands in *Salpa* and *Cyclosalpa.*

In Copelata Fol's experiments on *Oikopleura* leave no doubt that the mucus from the small endostyle only supplies the peripharyngeal bands, which function essentially as in *Doliolum.* The pharynx, however, merely imbibes food-particles already concentrated by previous filtration in the "house," one function of which, at least in forms with "filtering windows," is the exclusion of all but the minutest pelagic organisms (the *Nannoplankton* of Lohmann). The meshes of the filtering windows of *Oikopleura* exclude almost every organism exceeding 30μ in diameter, and the internal filter-tubes entrap organisms as small as 3μ. Thus *Chaetoceras,* the elongated *Rhizosolenias, Ceratium* and most Radiolaria are excluded, while the food captured consists mainly of small *Nitzchia,* Chrysomonads, Peridinia, naked Flagellates, Rhizopods and Bacteria between 3μ and 20μ in diameter (Lohmann). Thus the reduction of size and structure in Appendicularians is to be connected with their having tapped a rich reserve of minute food which is wasted by other Tunicates, and the organ elaborated to this end is no longer the pharynx, but their wonderful filtering house, the only clue to the origin of which is provided by *Doliolina,* which has the habit of periodically exuviating its barrel-like test.

DEVELOPMENT

The egg of Ascidians furnishes one of the typical examples of

"mosaic" structure and predetermined development, contrasting remarkably in these respects with that of *Amphioxus*. In *Styela (Cynthia) partita* destruction of one blastomere in the 2-celled stage results in the formation of a half-gastrula, which may develop even into a half-larva, with notochord, muscles, and mesenchyme all lying on one side of the neural folds. The embryo possesses little or no power of regenerating the missing parts—a remarkable fact when one notes the great regenerative powers of adult Ascidians.

It follows that the early stages of development throw no particular light on pre-Tunicate history; they point forwards to the larval organisation, and not backwards to pre-Chordate ancestors Neural and neurenteric canals are formed; the archenteron differentiates into pharynx in front, into notochord and mesoderm behind; and the tail in its growth backwards carries with it extensions of the neural tube and of the posterior group of archenteric derivatives The whole of the intestinal loop arises as an outgrowth from the pharyngeal rudiment The mesoderm divides at once into somatic and caudal portions; no enterocoeles are produced; the somatic portion breaks up into blood corpuscles and wandering cells, and the extended caudal portion differentiates *in situ* into muscle-cells on either side of the notochord The whole of the embryonic processes lead directly by the nearest route to the building up of the larva, which is characterised by three features, a locomotive tail, an organ of fixation, and a transitory sensory and nervous mechanism controlling them Until the close of larval life feeding is entirely suspended, and usually only the rudiments of the pharyngeal mechanism are established prior to fixation and metamorphosis

The larval brain is developed from an enlargement of the neural canal near its anterior extremity (the *cerebral vesicle*), in the wall of which two sense-organs normally arise, a stalked unicellular *otolith* in front, and a multicellular *eye* behind As the cerebral vesicle dilates unequally, the otolith cell migrates from a mid-dorsal to a ventral position, while the eye remains postero-lateral Simultaneously the cerebral vesicle becomes gradually constricted off on the right side, and from before backward, leaving a narrow canal on its left, which is continuous with the neuroporal extremity in front and the main part of the neural canal behind. According to the extent of the constriction the cerebral (now the *sensory*) *vesicle* may open into the neural canal behind, or be completely cut off from it (*Botryllus*) Its postero-ventral wall becomes greatly thickened as the *larval brain* ("visceral ganglion"), and gives off nerves to the adhesive papillae in front and, along the neural canal, to the caudal muscles behind, but gives no nerves to the viscera There is thus a stage of development when the neural canal is forked in front, and into two unequal branches,—a short dilated branch on the right, the sensory vesicle, and a longer narrower canal on the left The apex of this canal fuses with the pharyngeal wall close to the base of the oral siphon, and becomes converted into the *ciliated funnel* in front, and the *subneural duct and gland* behind. This remarkable feature of the development is not without many minor modifications in different types (esp. *Botrylloides*), but the important point remains that, except in Salps, ciliated funnel, duct and neural gland are invariably developed from the foremost region of the neural canal.

The sensory vesicle, larval brain and caudal nerve-cord are entirely destroyed by phagocytes at the metamorphosis The adult brain arises as a proliferation from the hinder end of the sub-neural ("hypophysial") duct, and the viscera are first innervated after its formation. The caudal part of the neural canal naturally disappears with the tail at metamorphosis, but the pharyngeal portion appears to persist in certain cases as the "rapheal" or "visceral" cord. The neural canal accordingly gives rise to two independent nervous systems, one after the other, for larva and adult respectively, as well as to ciliated funnel, duct, and gland in front of them

In Enterogona the atrium arises in the embryo as a pair of ectodermal invaginations, and their dorso-lateral apertures usually remain separate until fixation, when they unite dorsally to form the cloacal siphon. Two pairs (rarely one only) of simple gill-slits now arise, either simultaneously (Enterogona) or successively (Pleurogona). Normally the pharynx persists in this state over the larval period, but after fixation it expands greatly, and rapidly increases its fenestration. The various modes are reducible to the remarkable process exemplified in *Ciona*. Each primary perforation elongates ventrally, turns back on itself at its lower end, and divides into two at this point. The short limb extends dorsally until two equal and parallel "protostigmata" have been produced from the original single perforation. This is the evidence for regarding the gill-slits of Ascidians as essentially similar to those of *Amphioxus*. Here, however, by a modification of the growth-process, the U-shaped form is attained by the gill-slit extending round the tongue-bar, instead of the tongue-bar growing down into the slit. Although the rows of stigmata ultimately produced may be very numerous, no Ascidian ever shows more than 3 pairs of these potential U-shaped slits, for with increased size the later fenestration of the pharynx is produced by the subdivision of the 6 rows of stigmata first formed

The process just described undergoes considerable abbreviation in most types. In Stolidobranchs, other than Molgulids, the primary perforations elongate into protostigmata, but do not recurve; and in all Haplobranchs even protostigmata cease to appear as such, owing to the precocity of synapticulation.

BUDDING AND REGENERATION

It is highly characteristic of Tunicata that their buds possess a certain complexity from the outset of their formation. In Ascidiacea the ectodermal envelope of the bud, continuous with that of the parent, includes from the start an inner vesicle, derived as an outgrowth from some internal organ. The inner vesicle gives rise to all the organs of the bud except the outermost skin with its covering of test. It usually becomes trilobed, the lateral lobes developing into atrial chambers, the middle lobe into pharynx, gut, pericardium and nervous system But the original inner vesicle has a different origin in the two primary groups of Ascidians—in Enterogona from the endodermal pharynx, through the intermediation of the epicardium, and in Pleurogona directly by outgrowth from the outer peribranchial (ectodermal) wall Thus two modes of budding are distinguishable, viz., epicardial (or pharyngeal) and parietal (or peribranchial). The former alone is associated with the formation of a stolon, the apex of which is provided by a ventral prominence of the larval body beset with three "suckers" for fixation After fixation (e g, *Clavelina*) the larval body rotates on this ventral prominence, through a horizontal to an upright position, and the epicardium enters the stalk thus produced, dividing with it in all its subsequent ramifications In Haplobranchia the intestinal loop also usually extends into the stalk, and the dilatation of this to form the abdominal cavity causes the epicardium to be greatly extended between its point of origin behind the endostyle and the basal zone where budding normally proceeds.

In the Pleurogona (e.g., *Botryllus*) these changes do not take place. The adhesive papillae are surrounded in the late larva by a marginal ring of additional processes (ampullae), fixation takes place over a much wider area, and the body normally retains a more or less horizontal attitude. The apex of the stolon is thus buried beneath the area of fixation, and only Molgulids preserve vestiges of the original epicardium. The parietal origin of the buds in this section is thus correlated with a distinctive type of metamorphosis, which is plainly secondary.

In Thaliacea the primitive ventral position of the epicardial stolon is retained, but the stolon itself presents a more complex structure, uniting the two modes which in Ascidiacea are separated. It is traversed by a median or paired outgrowth from the back of the endostyle as well as by a pair of atrial diverticula. The buds are produced by direct segmentation of the stolon, and in *Pyrosoma* the various parental outgrowths give rise in the bud to the same organs as those from which they arise, *i.e.*, the pharyngeal outgrowth reproduces a pharynx, and the atrial outgrowths produce atria. In *Salpa* this specificity of the stolonial components is less complete, and in *Doliolum* it has largely disappeared.

Assuming the process in *Pyrosoma* to be relatively primitive, it would seem that budding has much in common with regeneration. In *Amphioxus* the various tissues have a certain power of self-regeneration, like repairing like, but incapable of more (Andrews, Franz). Many small Ascidians undergo periodically a process of thoracic degeneration followed by repair, which implies the retention of undifferentiated material at the base of pharynx and atrium, where growth normally takes place most actively (cf. *Diazono-Aphanibranchion*, Oka). We may safely assume that in primitive Tunicates thoracic degeneration was a normal phenomenon, and that the machinery for rapid repair took the common form of regenerative disks or pockets in these places But there is a certain antithesis between regeneration and budding. Only when budding is slight is regeneration useful: the repair of the individual ceases to be important when new individuals are turned out rapidly by mass-production.

It thus seems possible to account for the variety in the modes of Tunicate budding by assuming that the primitive Tunicate possessed a simple stolon like that of *Cephalodiscus* and regenerative pockets at the base of pharynx and atrium As the specialisation of the ectoderm for test-production tended to disqualify the ectoderm from playing its original major part in the budding process (e g, *Cephalodiscus*), the descent into the stolon of extensions from the regenerative pockets would produce a complex stolon like that of Thaliacea, with the result of speeding up the rate of budding and reducing the value of mere regeneration. The elimination of one or other pair of stolonial elements in Ascidiacea may be readily associated with the changes already described in their respective attitudes after metamorphosis.

The organisation of the buds to form locomotive colonies in the Thaliacea has been outlined in the systematic part Both in *Pyrosoma* and the wheel-colonies of *Cyclosalpa* the integration reaches a notable degree, even though in the latter case the zooids remain capable of a free life after break-up of the colonies The following early account of the wheels of *C. pinnata* is worth saving from oblivion: "A beautiful sight, these rings of a dozen gelatinous finger-long individuals, all set vertically with their mouths above (and with their ventral 'ins' converging to the centre like the spokes of a wheel), swimming about with rhythmic motions as if controlled by a common will, now gently rocking, now twisting and turning, or steering straight on through the quiet water" (translated from Carl Vogt, *Bilder aus dem Thier-leben*, 1852)

Equally noteworthy are the arrangements in Doliolids by which clusters of small amoeboid "phorocytes" take possession of the small buds, as they are detached from the ventral stolon, and transport them to their places on the dorsal outgrowth In *Pyrosoma*, where the conditions are simpler, these phorocytes resemble the ordinary stellate and spindle-shaped "test-cells," and must be regarded as test-cells devoted to this particular task In *Doliolum* they are proliferated in great numbers by the ectoderm at the base of the stolon (Neumann), although the test itself is homogeneous and ordinary test-cells are absent The remarkable capacity of some Tunicates to return to a less differentiated condition is discussed in detail in the article DEDIFFERENTIATION.

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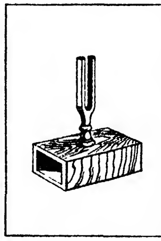
TUNICLE, the distinctive vestment of the subdeacon at mass, practically identical with the dalmatic (*q.v.*)

TUNING-FORK, a two-pronged instrument of high-grade steel, which by the vibration of its prongs gives out a single pure musical tone of constant pitch. The pitch depends upon the natural period of vibration of the prongs, that is, upon their length and thickness. Tuning-forks may be made for all musical pitches in the audible range, and the fork which gives the A above middle C is usually taken as the musical standard For laboratory purposes the forks may be mounted upon hollow boxes to increase the volume of sound by resonance. They may be set in momentary vibration by a light blow, or kept in constant vibration by the action of an intermittently energized electromagnet upon one of their prongs The tuning-fork was invented by John Shore in 1711 (*See* PITCH)



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THE TUNING FORK, INVENTED IN 1711

TUNIS, capital of Tunisia, situated in lat 36° 48′ N, and long 10° 12′ E The town stands on a mountainous isthmus which separates the Sebkha Sedjumi from the Bahira, or Lake of Tunis, the west bank of which it occupies; La Bahira communicates with the sea 10 km. E N E of the town by a narrow, open channel, on the margin of the shore Tunis has the same natural advantages as those which made the fortune of Carthage, being situated on the threshold of the western bay of the Mediterranean, at the natural outlet of the Tunisian Tell, and in easy communication with the south and centre of the Regency But its topographical situation differs profoundly from that of the ancient town; built at the end of a shallow lagoon, it has been obliged, until recently, to make use of an intermediate town, La Goulette, for its sea trade While Carthage had an almost insular position, Tunis was sheltered from the attacks of Christian fleets and has an almost continental site

Tunis consists of two towns side by side the old native town lies between the hills of Bir-Kassa and those of Ras-Tabia, on a slope down to the Bahira; the European town has developed in chequer-pattern on the flat, low-lying ground between old Tunis and the lake

European Tunis is built on a regular, somewhat monotonous plan, the blocks of houses are bordered by rectilinear avenues, some of which are planted with trees One large avenue, 1,500 metres long, has been laid out from east to west, and bears successively the names of Avenue Jules-Ferry, Avenue de la Marine and Avenue de France On this artery stand the Residency, surrounded by gardens, the cathedral, the casino-theatre, the banks, and the principal hotels and cafés It is cut at right angles, near the middle of its length, by another avenue called, in its southern part, Avenue de Carthage and in its northern part Avenue de Paris, which stretches for more than 3 km from north to south From these two main avenues numerous streets branch off, the chief being the rue Es-Sadikia, which ends at the railway station, the rue de Rome and the rue d'Italie, with the post office, the market and the Protestant church The Avenue de France is the most animated street of Tunis and is the centre of the city's life; it ends at la porte de France, from which start the tramways that go around the native town, and beyond which is the small Place de la Bourse, with the British consulate and the old Frank quarter, where the Europeans and the various consular representatives live

The native town itself includes three distinct parts; the Médina, or central city, which represents the primitive settlement, several gates of which are still standing, and recall the nearly oval form of the ramparts, now replaced by a girdle of streets and boulevards; the suburb of Bab-Souika on the north, where the Jews live; and that of Bab-Djazira on the south. The rue de la Kasba and the rue de l'Eglise cross the Médina; they lead to the Djamâ Zitouna, or mosque of the olive-tree, which is the seat of an important Muslim university, founded in 732 by the Ommiad governor, Obeid-Allah, and reconstructed by the Aghlabides (9th century); most of its buildings date from the 13th to the 15th centuries. Behind the Zitouna are the suks, which are the most interesting feature of the native town, they date from the Hafside period, and are composed of little shops opening on

to narrow, tortuous streets, covered by arches or roofs of planks, where only foot passengers can go. Each kind of trade, each group of craftsmen, has its special quarter. Tunis possesses many mosques, notably those of the Kasba (13th century) and Sidi-Mahrez (17th century), but Christians may not enter them.

The port of Tunis was constituted in 1893 by the digging of a sea channel more than 10 km. long, with a depth of 6½ metres, recently increased to 9 metres; this channel gives access to a basin 12 hectares in extent; a second basin, for the export of phosphates, was made in 1905, 3,985 ships, registering 3,589,000 tons have entered the port of Tunis-la-Goulette; the tonnage of merchandise has reached 1,695,000 tons and the number of passengers 111,000.

The population of Tunis is 185,996, of which 82,729 are Muslim, 24,131 Jews, and 79,136 Europeans (27,922 French, 44,076 Italians, 4,994 Maltese, 2,144 various other Europeans) If the suburban population be added, the total is 118,000 natives and 86,000 Europeans.

South-east of the city, along the valley of the Wadi Melain, are hundreds of large stone arches, magnificent remains of the Roman aqueduct from Zaghwan to Carthage At Zaghwan (38 m. by rail from Tunis), over the spot whence the spring which supplies the aqueduct issues from the hill, are the ruins of a beautiful Temple of the Waters The spring is now diverted direct into the aqueduct and is not visible at the surface

Tunis existed in the Carthaginian epoch, but its importance dates only from the Muslim conquest; it was then that Tunis replaced Carthage politically and commercially. It became capital towards the end of the 9th century, under the Aghlabides, and reached its greatest prosperity in the Hafside period, when it is said to have surpassed Cairo Attacked in 1270 by Saint Louis, who died under its walls, it was taken by Keir-ed-Din Barberousse in 1533 Charles V took possession of it in 1535; the Spanish were driven out in 1569, re-took it in 1573, but ceded it to the Turks in 1574 Since then the history of Tunis is merged in that of Tunisia (*q v*).

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TUNISIA, a country of North Africa under a French protectorate, bounded on the west by Algeria, on the north by the Mediterranean, on the east by the Syrtis (Gulfs of Hammamet and of Qabes) and by the Italian territory of Libya from the sea to Ghadamès, on the south by the Sahara (Southern Territories and Algeria) It reaches from 30° to 37° 20′ (Cap Blanc) N lat., and from 7° 35′ to 11° 40′ E longitude. The total area is somewhat less than 49,000 sq m., of which about 21,500 sq m. is Saharan territory beyond the Shott Jerid, while the remainder is Tunisia proper. The country is placed half way between the Straits of Gibraltar and the Suez canal and, with Sicily, forms the barrier between the eastern and western Mediterranean This situation, to which ancient Carthage owed its greatness, together with the possession of nearly 900 miles of coastline, gives Tunisia special economic and political importance

Structure and Relief.—The mountains are formed of Secondary and Early Tertiary rocks, while later Tertiary and Quaternary rocks cover the plains The folds are Miocene in the main, as in the Atlas, but movement continued long after that period. There are numerous short discontinuous chains of varying orientation, and a number of small circular or elliptical domes.

The *Northern Zone*, continuing the Algerian coastal forest, includes Kroumirie and the Mogods; Numidian sandstone is a dominant element. It is bounded southwards by the Medjerda valley, which widens into the plain of Suk-el-Arba (Dakhla basin), an old lake basin filled with alluvium, then narrows to form the gorges of Bejaura, and finally enlarges into the great plain of Late Tertiary deposits that extends between Bizerta, Mateur and Tunis. The large *Central Zone* is nearly 180 m. long by 90 broad, extending from Tebessa to Cap Bon, and from the Medjerda to Sbeïtla, and including the continuations of the Saharan Atlas of Algeria. South of the chains of Kef and Tebursuk are the central plateaux of Tunisia, the Mactar massif, a large Cretaceous dome partly covered by Lower Eocene deposits, including phosphatic marls, while the calcareous elements stand out as hammadas and kalaas, plateaux with abrupt sides, *e.g.*, the Kalaa-es-Senan (4,108 ft.). In this massif folding is barely discernible. Next follow the chains of Thala, a projection of the main Tunisian ridge or Zeugitan chain which begins at Jebel Serdj, is continued in the Bargou and the Zaghouan (4,249 ft), an important dome of liassic limestone with sharp features and almost vertical walls, and ends in Jebel Ressas and Bou-Kornein, on the Gulf of Tunis A related fold forms the Cap Bon peninsula. Attached to the same system are the Chambi and Feriana chains. The *Southern Zone* includes the chains of Sidi Aich, of Gafsa, which include large phosphatic deposits (Metlaoui-Ain-Moularès), of Shott Fedjedj, in an elliptical curve from Tozeur to Qabes. Eastern Tunisia is occupied by large plains (less than 1,300 ft. above sea-level) which form 80% of the surface of Tunisia and are the Byzacene of the ancients, the Sahel of Sous and Sfax, with their special climatic and vegetative features. Beyond the great depression of the Shotts Gharsa, Djerid and Fedjedj, which are in part below sea-level, are the calcareous platforms of the Matmatas and the Ourghammas (Jebel Demmer and Jebel Douirat), separated from the sea by the coastal plain of Jeffara

Climate and Hydrography.—With a Mediterranean climate, Tunis shows less contrasts in its different regions than do the Tell, the steppe and the Sahara in Algeria. Here the Tell is, in places, half steppe, and the steppe half Tell. The average January temperature at Tunis is 52·7° (max. av. 59·7°, min. av 45·6°); the hottest month has an average of 79·2° (max av 92°, min av. 66·4°). The winds are chiefly north-west in winter and north-east in summer; the rainy season runs from October to May, and the dry one from May to September; January is usually the rainiest month, but in the interior spring rains are rather important—summer rains are less exceptional The distribution of rain is, however, highly irregular from region to region and from year to year; North Africa, in general, is in a zone of climatic discontinuity, and a small change of the winds may mean great changes in rainfall. One zone gets more than 600 mm. of rain per annum, and this includes the massifs of Kroumirie and Mogods (Ain Draham, 5,384 ft); the next zone, with 400–600 mm. of rain, includes central Tunisia, the valley of the Medjerda, Cap Bon and the region of Tunis (Tunis 404, Teboursouk 513, Kef 491); a zone with 200–400 mm. south of the Tunisian ridge includes the region of Qairwan and the Sahel (Qairwan 289 mm., Susa 347, Sfax 209); a zone with less than 200 mm. in the south and extreme south (Qabes 180 mm., Gafsa 155, Medenine 136). The Tunisian ridge forms a climatic barrier; the north-western side is a part of the Tell (Tunisian-Friquia); the south-eastern slope belongs to the steppe region. In the Sahel, the olive prospers, in spite of the low rainfall, on account of nearness to the sea and importance of the dew. In the extreme south the influence of the sea still tempers that of the Sahara.

The principal river is the Medjerda, rising in Algeria near Suk-Ahras and flowing into the Mediterranean near Porto Farina. It is 228 m. long; its chief affluent is Wad Mellègue, which joins it on the plains of Suk-el-Arba; Wad Siliana brings it the drainage of central Tunisia In flood time the volume of the Medjerda may be 1,000 cu. metres; in drought it may go down to 1 cu. metre This river has formed large alluvial plains, filling up the ancient Gulf of Utica and joining up a series of shore islets. The rivers of the eastern slope (Wad Zeroud, Wad Merguellil) dry up in basins of the lowland which communicate with the sea only when rains are exceptionally heavy.

The north coast is much dissected with outstanding points. C Negre, C. Serrat, C Blanc, Ras Sidi Ali el Mekki. Standing out to sea is the island of Galite; the Lake of Bizerta has kept its depth because the alluvium is deposited in the Garra Aghkel above it. The Lake of Tunis, on the other hand, is very shallow.

Beyond the Cap Bon peninsula, the eastern limit of the Gulf

of Tunis, the east coast is low and sandy, bordered by lagoons in several places, and shelving slowly into shallow water around the Kerkennah archipelago and Gerba island.

Flora and Fauna.—These are Mediterranean, 1,350 out of 2,000 plant species occurring also in Italy. Forest, scrub and steppe are the characteristic formations. The cork oak and the zean oak are dominant in the north and, in Kroumirie, form compact blocks (160,000 hectares) The woods of the centre are far less compact, and the Aleppo pine (850,000 hectares) and the evergreen oak are the chief forms. In the south one finds, chiefly, the juniper and the wild olive, with some Aleppo pines and pistachio nuts Wad-Tala has a forest-steppe with gum trees (*Acacia tortila*), the most northerly occurrence of a species found from Senegal to Arabia. The scrub is usually degraded forest, and its most characteristic tree is *Zizyphus lotus*, the spiny jujube tree. The steppe is covered by grass-like types such as the alfa. Of the Salsolaceae alfa covers about 1,500,000 hectares

The mammalian fauna is mainly eurasiatic, but among reptiles and fishes some Africano-Brazilian forms persist. In general, the fauna is much like that of Algeria, with European species, especially in the forests of cork oak *Cervus elaphus barbarus* (stag) is found in Kroumirie and the sleeved mouflon in the mountains.

People.—The population (1926 census) is 2,159,708, of whom 1,932,184 are Muslim, 54,243 are Jews and 173,281 Europeans. Almost everyone, native and European, lives in towns or on the coast; the interior is almost empty The Muslim are mostly Berber mixed with Arab, but Berber speech has died out, though it survives in Morocco, Algeria and Tripolitania The population of Gerba belong to the same Muslim group as the Mozabites of Algeria, that of the Kharedjites or Ibadhites Of the Muslim some 419,000 are tent-dwellers, 572,000 live in gourbis, and 477,000 in houses The Matmatas are troglodytes, and dwell in caves or rhorfas cut in rock or clay (100,000) The native element in the towns is much stronger than in Algeria, 90 agglomerations have more than 2,000 natives each and account for 40% of the total Apart from rural folk who have become urban, the towns contain some primarily urban elements such as the Andalusian Moors and the Jews Europeans include 71,020 French, of whom 33,272 are Tunisian-born; 89,216 Italians including 50,395 Tunisian-born; 8,396 Maltese, and 4,649 other Europeans In 1911 the number of French was 46 000, against 88,000 Italians By a law of 1923, children born in Tunis of parents who were born in Tunis too become French on attaining their majority, whatever their ultimate origin, unless they definitely choose otherwise For Maltese an extra generation is needed, and individual naturalization of Italians is possible only in virtue of the terms of the Franco-Italian convention of 1896 Under the new legislation about 5,000 Maltese and 5,000 Italians have acquired French nationality. The Tunisian towns have 109,000 European inhabitants, or about 62% of the total, nearly 50% being in Tunis itself

Towns.—Tunis (*q v.*) is the chief city, with 185,996 people (106,860 native and 79,150 European) With its suburbs, the population is 204,000 (118,000 native and 86,000 Europeans). Sfax, the capital of the south, has within its walls 27,723 people (6,884 Europeans), but in the olive groves near the town an additional 44,000 raises the real population of the agglomeration to 72,000. Susa has 21,298 people (6,856 Europeans), Bizerta 20,593 (6,738 Europeans), besides 4,155 Europeans at the arsenal at Ferryville Qairwan has 19,426 people (629 Europeans), Beja 10,468 (1,911 Europeans) Another type of agglomeration is the large agricultural village: Msaken (16,583), Moknine (12,155), Kalaa Kebira (11,830). Still another type is that of the southern oases, Qabes (15,119), Mafta (13,250), Tozeur (11,056), Zarzis (6,305), El-Hamma (4,905) and Gerba (4,645).

Government and Administration.—Tunisia became a protectorate of France by the Treaty of Bardo (May 12, 1881), whose rights were defined by this treaty and by the convention of June 8, 1883. A resident-general of France, under the Ministry of Foreign Affairs, sits beside the native bey and controls all the public services. The army, education, finance, public works and agriculture have French directors; the native ministers, under French supervision, are the minister of State and the minister of justice The budget is examined by the Grand Council of Tunisia, constituted under decrees of July 13, 1922, with elected members, some French and some native. There are also five regional councils (Bizerta, Kef, Tunis, Susa, Sfax), and also caidate councils Municipalities have been established in the most important towns Native administration is based upon the division of the population into caidates and sheikhates. French officials called *contrôleurs civils* are stationed beside the caids, and play the same rôle with regard to them as does the resident with the bey Tunisia is divided into 19 *contrôles civils* and 37 caidats The south forms military territories administered by officers of native affairs The principal direct taxes are the capitation tax (*istitan*), the tax upon olive trees and date-palms (*canour*), upon cereals (*achour*), upon vineyards, and upon cattle, the chief indirect taxes are the customs dues, postal duties, registration, etc. To these must be added the revenues from monopolies, the receipts from postages and transfers of domanial The budget amounts to 380 million fr. of receipts and expenditure There are two tribunals of first instance, those of Tunis and of Susa, with reference to the court of appeal of Algiers, and 15 justices of the peace For natives, the cadi is judge in all matters concerning personal matters and real estate, when Europeans are not involved, other affairs are judged by the caids, or regional tribunals

Land, Tenure and Settlement.—Tunisia has *Melk* lands which are completely freehold, *Habou* lands subject to special rules of inheritance, and tribal or group-lands A Cadastral register was established by law in 1885, with the object of lessening doubts as to ownership of land and of giving proper publicity to transactions involving landed property Since 1886, 1,200,000 hectares of land have been registered Colonization depends mainly on private enterprise, and the Government has come late into the matter By laws of 1914, 1920 and 1924, those who take up previously domanial lands must live on them for life or 20 years *Habou* lands can be leased for long terms on payment of a perpetual rent (*Enzel*), which rent may be redeemed on a basis of 20 years' purchase European lands are extensive; the domain of l'Enfile has an area of 120,000 hectares, 1,700 French proprietors own 554,000 hectares, 1,500 Italians own 60,000 hectares

Agriculture.—Tunisia has 2,859 000 hectares of cultivable land, of which 1,371,000 hectares are planted to cereals The returns are generally poor, and variable from year to year, especially in the hands of the natives The crops are hard wheat (540,000 hectares and 1,800,000 quintals), barley (450,000 hectares and 1,500,000 quintals), soft wheat (51,000 hectares and 400,000 quintals), oats (54,000 hectares and 395,000 quintals), maize and sorghum (17,000 hectares and 58,000 quintals); beans occupy 27,000 hectares and give 185,000 quintals The vine is essentially a European production, it covers 28,000 hectares, of which 15,000 belong to Italians; the principal vineyards are in the regions of Tunis, of Grombalia and of Suk-el-Arba; the production averages 700,000 hectolitres Tunisia, especially in its eastern part, is very suitable for olive-growing; there are 16 millions of trees, ten millions of which are in full bearing, the three principal districts are those of Cap Bon (1,500,000 trees), Susa (three millions) and Sfax (two millions) One of the greatest achievements of French colonization of Tunisia is the reconstruction of a great olive forest in the region of Sfax Fine olive yards reach to the extreme south, at Gerba (400,000 trees) and at Zarzis (500,000) The average production of fruit and oil is about 300,000 quintals, with great variations (150,000 quintals in 1917, 450,000 in 1920) The orange (68,000 trees) is grown chiefly in the region of Cap Bon, early vegetables in the neighbourhood of Tunis. The oases provide 1,200,000 date-palms

Cattle-rearing and Natural Products.—Cattle-rearing and crop-growing are both carried on extensively rather than intensively, with arable, fallow and stubble pasture. There are considerable variations, both in stock and crops On an average, Tunisia raises 350,000 oxen, 80,000 horses, 30,000 mules, 167,000 asses, 100,000 camels, 15,000 pigs, 1,500,000 sheep, 1,000,000 goats. Transhumance is practised in the rearing of sheep, but in Tunisia the journeys of the nomads are shorter than in Algeria; 50,000 sheep are exported annually and 6,000 quintals of wool.

The principal product of the forests is cork (35,000 quintals). Alfa (100,000 tons) is exported chiefly to England, for the manufacture of paper-pulp. Sea-fishing is carried on in Tunisia under more favourable conditions than in Algeria. The continental plateau is of wider extent, the lakes of Bizerta, of Tunis, of Biban, form natural nurseries, and the fish are more varied in kind. There are 15,000 fishermen, of whom 10,000 are natives and 4,000 Italians Sponge fishing is carried on along the whole of the east coast, from Monastir to the frontier of Tripoli, especially at Sfax and in the Kerkennah islands, the production of sponge fishing reaches 160,000 kilogrammes

Mines.—Tunisia possesses practically inexhaustible deposits of phosphates The chief exploitation is carried on in the Gafra region (Metlaoui, Ain, Moularès, Redeyef), from which two railway lines run to the ports of Sfax and Susa; two other deposits, those of Meheri Zebbeus and Moilla, are in course of organization. The phosphates of Kalaâ-es-Senan and Kalaâ-Djerda, found as a prolongation of those of Tebessa, are exported through Tunis The Tunisian production exceeds 2,500,000 tons, that of the whole world is eight million tons. Iron ores, abundant and of good quality, are found, especially to the south of Kef and not far from the Algerian frontier, at Jebels Slata, Djerissa, Hameima, to the north of Kef, at Nebeur, and at the Netzas in Kroumirie The production exceeds 500 000 tons. Tunisia is thus an important mining region

Zinc (12 000 tons), and lead (40,000 tons) come from Khanguet-Kef-Tout, between Bija and Tabarka, from Zaghouan and Jebel Ressas Apart from the somewhat poor lignites of Cap Bon, no fuel minerals have been found up to the present; petrol has been sought at Slougonia and at Medjez-el-Bab The minerals are exported in the raw state, and the only important industries are those dependent upon agriculture, flour-milling, oil-refining, distilling Thermal and mineral springs are numerous

Communications.—Tunisia possesses 5,180 km of roads, of large and medium size, and 2,000 km of railway lines The line from Medjerda, built before the French protectorate, is a trunk line of Central North Africa and links Algeria with Tunis; two branches diverge to the north towards Bizerta, they reunite at Mateur, from which a line runs to Tabarka, in the south, a line reaches Nebeur. From Tunis a line runs parallel to the east coast, passing through Susa, Sfaz and Gabes, three lines linking the interior with the sea join this coastal one, the lines Tunis-Kalaâ-es-Senan, Susa-Henaghir-Souatir, Sfax-Gafsa, with branches to Tozeur and Metlaoni The law of April 6, 1902, gave Tunisia the control of its railways, they are managed by two companies, the leaseholding company of the Tunisian railways and the Sfax-Gafsa company The Medjerda and Bizerta lines are broad gauge (1·44m), the other lines narrow gauge (1 055m)

The four ports of Bizerta, Tunis, Susa and Sfax are very well equipped, the other ports being of only secondary importance. Of a tonnage of 3,900,000 tons, Tunis takes 1,700,000, Sfax 1,300,000, Susa 390,000 and Bizerta 250,000. The French warehouse stores 900,000 tons

Trade.—For a certain number of products, notably cereals, Tunisia, France and Algeria are under one customs union For other products, notably wines, Tunisia is under a contingent *régime*, that is to say, its products are allowed free into the metropolis in quantities determined each year. On the other hand, French goods receive privileged treatment in Tunisia. The trade of Tunisia in 1927 rose to 2 798 million fr (imports 1,772 millions, exports 1,026 millions) The share of France was 1,378 millions (imports 999 millions, 56%, exports 383 millions, 37%); that of Algeria 215 millions, that of Great Britain 122 millions (imports 51 millions, especially cotton goods and coal; exports 61 millions, especially alfa, phosphates and iron ore); that of Italy 360 millions.

Tunisia imports manufactured articles, particularly cotton goods, colonial produce, sugar, tea, coffee, machines (especially motor-cars), coal and petrol She exports cereals (37 million fr., 81,000 quintals of wheat, 100,000 of barley, 40,000 of oats), olive oil (269 million fr , 245,000 quintals), sheep (two million fr., 14,000 head), wine (65 million fr., 327,000 hectolitres), alfa (54 million fr., 84,000 tons), fishery products (20 million fr., of which 14 million are sponges), phosphates (201 million fr., 2,956,000 tons), iron ores (60 million fr., 992,000 tons), lead (12 million fr., 9,000 tons), zinc (17 million fr., 36,000 tons).

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HISTORY

The history of Tunisia begins with the establishment of the Phoenician colonies (*see* Phoenicia and Carthage). The Punic settlers semitized the coast, but left the Berbers of the interior almost untouched. The Romans entered into the heritage of the Carthaginians and the vassal kings of Numidia, and Punic speech and civilization gave way to Latin, a change which from the time of Caesar was helped on by Italian colonization; to this region the Romans gave the name of "Africa," apparently a latinizing of the Berber terms "Ifriqa," "Ifrigia" (in modern Arabic, *Ifriqiyah*)

Rich in corn, in herds, and in later times also in oil, and possessing valuable fisheries, mines and quarries, the province of Africa, of which Tunisia was the most important part, attained under the empire a prosperity to which Roman remains in all parts of the country still bear witness Carthage was the second city of the Latin part of the empire, "after Rome the busiest and perhaps the most corrupt city of the West, and the chief centre of Latin culture and letters " In the early history of Latin Christianity Africa holds a more important place than Italy. It was here that Christian Latin literature took its rise, and to this province belong the names of Tertullian and Cyprian, of Arnobius and Lactantius, above all of Augustine Lost to Rome by the invasion of the Vandals, who took Carthage in 439, the province was recovered by Belisarius a century later (533–534), and remained Roman till the Arab invasions of 648–669 The conqueror, 'Oqba-bin-Nafa, founded the city of Kairwan (673) which was the residence of the governors of "Ifriqiyah" under the Omayyads and thereafter the capital of the Aghlabite princes, the conquerors of Sicily, who ruled in merely nominal dependence on the Abbasids.

Arab and Berber Dynasties.—The Latin element in Africa and the Christian faith almost disappeared in a single generation; the Berbers of the mountains, who had never been latinized and never really christianized, accepted Islam without difficulty, but showed their stubborn nationality, not only in the character of their Mohammedanism, which has always been mixed with the worship of living as well as dead saints (marabouts) and other peculiarities, but also in political movements The empire of the Fātimites (*q.v.*) rested on Berber support, and from that time forth till the advent of the Turks the dynasties of North Africa were really native, even when they claimed descent from some illustrious Arab stock. When the seat of the Fātimite empire was removed to Egypt, the Zīrites, a house of the Sanhaja Berbers, ruled as their lieutenants at Mahdia, and about 1050 Mo'izz the Zīrite, in connection with a religious movement against the Shi'ites, transferred his very nominal allegiance to the Abbasid caliphs. The Fātimites in revenge let loose upon Africa about A D. 1045 a vast horde of Bedouins from Upper Egypt (Beni Hilāl and Solaim), the ancestors of the modern nomads of Barbary. All North Africa was ravaged by the invaders, who, though unable to found an empire or overthrow the settled

government in the towns, forced the agricultural Berbers into the mountains, and, retaining from generation to generation their lawless and predatory habits, made order and prosperity almost impossible in the open parts of the country until its effective occupation by the French. The Zīrite dynasty was finally extinguished by Roger I. of Sicily, who took Mahdia in 1148 and established his authority over all the Tunisian coast. Even Muslim historians speak favourably of the Norman rule in Africa; but it was brought to an early end by the Almohade caliph Abd-ul-Mumin, who took Mahdia in 1160.

The Almohade Empire soon began to decay, and in 1336 Abū Zakarīyā, prince of Tunis, was able to proclaim himself independent and found a dynasty, which subsisted till the advent of the Turks The Hafsites (so called from Abū Ḥafs, the ancestor of Abū Zakarīyā, a Berber chieftain who had been one of the intimate disciples of the Almohade mahdi) assumed the title of Prince of the Faithful, a dignity which was acknowledged even at Mecca, when in the days of Mostansir, the second Hafsite, the fall of Bagdad left Islam without a titular head. In its best days the empire of the Hafsites extended from Tlemçen to Tripoli, and they received homage from the Merinids of Fez, they held their own against repeated Frankish invasions, of which the most notable were that which cost St Louis of France his life (1270), and that of the duke of Bourbon (1390), when English troops took part in the unsuccessful siege of Mahdia They adorned Tunis with mosques, schools and other institutions, favoured letters, and in general appear to have risen above the usual level of Muslim sovereigns But their rule was troubled by continual wars and insurrections, the support of the Beduin Arabs was imperfectly secured by pensions which formed a heavy burden on the finances of the state, and in later times the dynasty was weakened by family dissensions. Leo Africanus, writing early in the 16th century, gives a favourable picture of the "great city" of Tunis, which had a flourishing manufacture of fine cloth, a prosperous colony of Christian traders, and, including the suburbs, nine or ten thousand hearths

Turkish Conquest.—The conquest of Algiers by the Turks gave a dangerous neighbour to Tunisia, and after the death of Mohammed the Hafsite in 1525 a disputed succession supplied Khairad-Dīn Barbarossa with a pretext for occupying the city in the name of the sultan of Constantinople Al-Hasan, the son of Mohammed, sought help from the emperor, and was restored in 1535 as a Spanish vassal, by a force which Charles V commanded in person, while Andrea Doria was admiral of the fleet But the conquest was far from complete, and was never consolidated The Spaniards remained at Goletta and made it a strong fortress, they also occupied the island of Jerba and some points on the south-east coast; but the interior was a prey to anarchy and civil war, until in 1570 'Alī-Pasha of Algiers utterly defeated Ḥāmid, the son and successor of Al-Ḥasan and occupied Tunis In 1573 the Turks again retreated on the approach of Don Juan, who had dreams of making himself king of Tunis; but this success was not followed up, and in the next year Sultan Selim II sent a strong expedition which drove the Spaniards from Tunis and Goletta, and reduced the country to a Turkish province Nevertheless the Spanish occupation left a deep impression on the coast of Tunis, and not a few Spanish words passed into Tunisian Arabic

After the Turkish conquest, the civil administration was placed under a pasha; but in a few years a military revolution transferred the supreme power to a Dey elected by the janissaries, who formed the army of occupation The government of the Deys lasted till 1705, but was soon narrowed or overshadowed by the authority of the Beys, whose proper function was to manage the tribes and collect tribute. From 1631 to 1702 the office of Bey was hereditary in the descendants of Murād, a Corsican renegade, and their rivalry with the Deys and internal dissensions kept the country in constant disorder. Ibrahīm, the last of the Deys (1702–05), destroyed the house of Murād, and absorbed the beyship in his own office; but, when he fell in battle with the Algerians, Ḥussein b 'Alī, the son of a Cretan renegade, was proclaimed sovereign by the troops under the title of "Bey," and, being a prince of energy and ability, was able to establish the hereditary sovereignty, which has lasted without change of dynasty to the present time

A Pirate State.—Frequent wars with Algiers form the chief incidents in the internal history of Tunisia under the Beys Under Deys and Beys alike Tunisia was essentially a pirate state Occasionally acts of chastisement, of which the bombardment of Porto Farina by Blake in 1655 was the most notable, and repeated treaties, extorted by European powers, checked from time to time, but did not put an end to, the habitual piracies, on which indeed the public revenue of Tunis was mainly dependent The powers were generally less concerned for the captives than for the acquisition of trading privileges, and the Beys took advantage of the commercial rivalry of England and France to play off the one power against the other. The release of all Christian slaves was not effected till after the bombardment of Algiers, and the definite abandonment of piracy may be dated from the presentation to the Bey in 1819 of a collective note of the powers assembled at Aix-la-Chapelle The government had not elasticity enough to adapt itself to so profound a change in its ancient traditions, the finances became more and more hopelessly embarrassed, in spite of ruinous taxation; and attempts at European innovations in the court and army made matters only worse, so long as no attempt was made to improve the internal condition of the country. In the third quarter of the 19th century not more than a tenth part of the fertile land was under cultivation, and the yearly charge on the public debt exceeded the whole annual revenue. In these circumstances only the rivalry of the European powers that had interests in Tunisia protracted from year to year the inevitable revolution The French began to regard the dominions of the Bey as a natural adjunct to Algeria, but after the Crimean War Turkish rights over the regency of Tunis were revived After the Franco-German War the embarrassed Bey turned towards Great Britain for advice, and a British protectorate—suggested by the proximity of Malta—was not an impossibility under the remarkable influence of the celebrated Sir Richard Wood, British diplomatic agent at the court of Tunis from 1855 to 1879. The railways, lighthouses, gas and waterworks and other concessions and industries were placed in British hands. But in 1878, at the Congress of Berlin, Lord Salisbury agreed to allow France a "free hand" in Tunisia in return for French acquiescence in the British lease of Cyprus

FRENCH OCCUPATION

After 1862, however, the kingdom of Italy began to take a deep interest in the future of Tunisia When the country went bankrupt in 1869, a triple control was established over Tunisian finances, with British, French and Italian "controllers." In 1880 the Italians bought the British railway from Tunis to Goletta This and other actions excited the French to act on the secret understanding effected with the British foreign minister at the Berlin Congress In 1881 a French force crossed the Algerian frontier under pretext of chastising the independent Khmir or Kroumir tribes on the north-east of the regency, and, quickly dropping the mask, advanced on the capital and compelled the Bey to accept the French protectorate. The actual conquest of the country was not effected without a serious struggle with Muslim fanaticism, especially at Sfax, but all Tunisia was brought completely under French control, military posts being placed at every important point (H H. J)

Muhammed VI , the reigning Bey, signed the treaty acknowledging a French protectorate at his summer residence, the Bardo palace, on May 12, 1881. He died in Oct 1882, and a new treaty, that of La Marsa (June 8, 1883) was signed by his brother and successor, Ali IV A resident general was appointed by France, and he also became foreign minister of the Regency From 1884 onward the French carried out a thorough reform of the administration. The native government was retained, but the majority of the ministers were Frenchmen The resources of the country were steadily developed, order was maintained, native laws and customs were respected and Tunisia was much benefited Great Britain, as was to be anticipated, early recognized the protectorate, as did most of the other Powers Turkey did not, and though by 1892

she so far acknowledged the *de facto* situation as to consent to define, partially, the Tunisian-Tripolitanian frontier, it was not until 1920, by the treaty of Sèvres, that Turkish claims to the Regency were finally renounced Italy, however, was in fact more deeply concerned than were the Turks by the establishment of the French protectorate In Tunisia her interests were not merely geographical and political. Italians formed by far the largest European colony, and Italy had hoped to secure the Regency for herself It was not until 1896 that Italy formally acknowledged the protectorate, and by the terms of a convention then concluded the right of Italians in Tunisia to maintain their nationality was guaranteed. British subjects had the same right; this affected chiefly the large number of Maltese settled in the country The persistence shown by Italians and Maltese in maintaining their nationality was a cause of annoyance to the French, and of some practical inconvenience. As part of an effort to give the protectorate a more French character decrees were issued in 1921 declaring that British and Italian subjects, born of parents who were themselves born in Tunisia, would be deemed to be of French nationality. These decrees provoked resentment, especially among the Italians. As to the British (*i e*, Maltese) an arrangement was reached with France in 1923 whereby the persons affected were entitled to decline French nationality. With Italy no settlement had been reached up to 1929—the convention of 1896 being still in force.

The nomad tribes in the South gave occasional trouble, but French rule was generally accepted During the World War tribesmen from Fezzan, led by Turkish officers, attacked the French outposts in southern Tunisia. There was some sharp fighting in Sept. and Oct. 1915, when the French re-established order. Later on large numbers of Tunisian soldiers were employed in France. In 1919–20 by agreement with Italy the territory south of Tunisia forming salients between the oases of Ghadames and Ghat and between Ghat and Tummo was transferred by France to Italy.

In northern Tunisia, where agriculture and industry flourished, there was some assimilation by the Tunisians of Western thought, and a generation arose which, not having experienced the misrule existing before the French occupation, sought larger political rights. In 1922, to meet the desire of the Tunisians for a share in the administration, a general council for the protectorate—consisting of 44 French and 18 nominated native representatives—and regional councils, were established The general council superseded a consulting conference set up in 1905, and had wider powers than that body. There had already arisen a nationalist agitation, and this in 1924–25, when the cost of living was four times as great as in 1914, was mixed up with a Communist agitation, accompanied by some disturbances in the towns The Communist agitation was not deep rooted, but among educated Tunisians there was a demand for a democratic form of government. This demand was not met, but as an educational measure further powers were conferred in 1925 on municipal councils.

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TUNNEL, a more or less horizontal underground passage made without removing the overlying rock or soil. In former times any long tube-like passage, however constructed, was called a tunnel. In 1928 the word was sometimes popularly applied to an underground passage constructed by trenching down from the surface, building the arching or other form of structure and then refilling over the top with soil; but a passage so constructed, although indistinguishable from a tunnel when completed, is more correctly termed an "aqueduct," a "covered way" or "subway" (depending on its use) and the operations "cutting" and "covering," instead of tunnelling. Making a small tunnel, afterwards to be converted into a larger one, is called driving a heading, and in mining operations small tunnels are termed galleries, drifts and adits. If the passage leading underground is vertical it is called a shaft; if inclined from the vertical it is called a slope, or inclined shaft; if the shaft or slope is begun at the surface the operations are known as sinking; and if worked upwards from a previously constructed heading or gallery the operations are called risings or stopes (*See* COAL AND COAL MINING; MINING, METALLIFEROUS)

Tunnels may be driven through earth, which usually requires timbering during excavation (and there are many systems of timbering) or the use of a shield; or in rock, which may or may not require timbering, depending on the firmness. (*See* Plate, figs. 2 and 3) In earth, and often in rock some form of permanent lining is necessary and it is sometimes formed of closely spaced heavy timbers but more often of some type of masonry. Tunnels may be excavated either above or below water level, and in the former case excavated in free air, but, in the latter, where in earth, modern practice usually requires the use of compressed air.

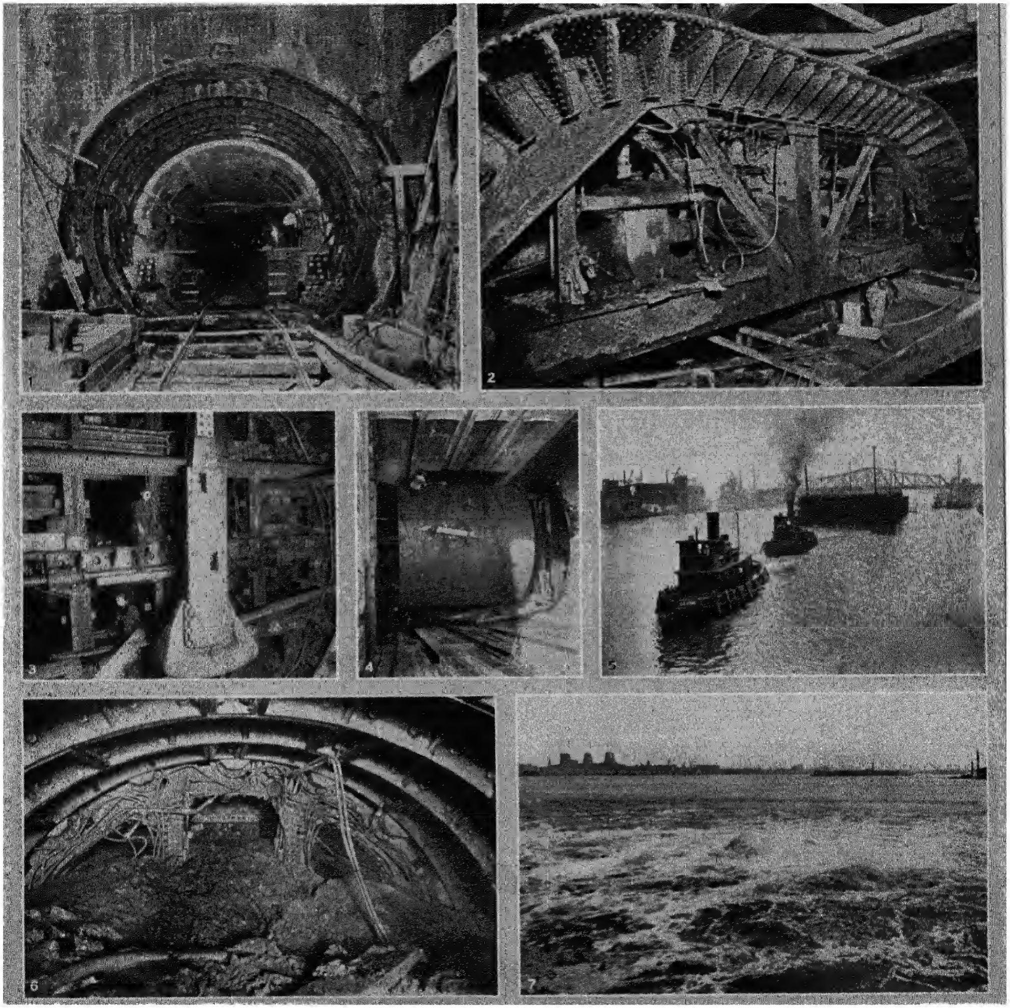
Tunnelling has been effected by natural forces to a far greater extent than by man. In limestone districts innumerable swallow-holes, or shafts, have been created by sinking rain water following joints and dissolving the rock, and from the bottom of these shafts tunnels have been made by the water to the sides of hills in a manner strictly analogous to the ordinary method of executing a tunnel by sinking shafts at intervals and driving headings therefrom Many rivers thus find a course underground In Asia Minor one of the rivers on the route of the Mersina railway extension pierces a hill by means of a natural tunnel The Mammoth Cave of Kentucky, the caverns at Carlsbad, New Mexico, and the Peak caves of Derbyshire are due to natural tunnelling

Mineral springs bring up vast quantities of matter in solution. It has been estimated that the Old Well spring at Bath has discharged since the beginning of the 19th century solids equivalent to the excavation of a 6 ft. by 3 ft heading, 9 m long; and yet the water is perfectly clear and the daily flow is only the 150th part of that pumped out of the great railway tunnel under the Severn Tunnelling is also carried on to an enormous extent by the action of the sea

Subaqueous Demolitions.—The most gigantic subaqueous demolition hitherto carried out by man was the blowing up in 1885 of Flood rock, a mass about 9 ac in extent, near Long Island sound, N Y. To effect this gigantic work by a single instantaneous blast a shaft was sunk 64 ft. below sea-level, from the bottom of which 4 m of tunnels or galleries were driven so as completely to honeycomb the rock The roof rock ranged from 10 to 24 ft. in thickness, and was supported by 467 pillars 15 ft square; 13,286 holes, averaging 9 ft in length and 3 in. in diameter, were drilled in the pillars and roof. About 80,000 cu yd. of rock were excavated in the galleries and 275,000 remained to be blasted away The holes were charged with 110 tons of "rackarock," a more powerful explosive than gunpowder, which was fired by electricity. The sea was lifted 100 ft. over the whole area of the rock

Early Examples of Tunnelling.—With so many examples of natural caves and tunnels in existence it is not to be wondered at that tunnelling was one of the earliest works undertaken by man, first for dwellings and tombs, then for quarrying and mining and finally for water-supply, drainage and other requirements of civilization. A Theban king on ascending the throne began at once to drive the tunnel which was to form his final resting place, and persevered with the work until death. The tomb of Mineptah, at Thebes, was driven at a slope for a distance of 350 ft. into the hill, when a shaft was sunk and the tunnel projected a farther length of about 300 ft., and enlarged into a chamber for the sarcophagus. Tunnelling on a large scale was also carried on at the rock temples of Nubia and of India and to some extent by the Aztecs in America, and the architectural features of the entrances to some of these temples might be studied with advantage by the designers of modern tunnel portals.

Flinders Petrie has traced the method of underground quarrying followed by the Egyptians opposite the Pyramids. Parallel galleries about 20 ft. square were driven into the rock and cross galleries cut, so that a hall 300 to 400 ft. wide was formed, with a roof supported by rows of pillars 20 ft. square and 20 ft. apart. Blocks of stone were removed by the workmen cutting grooves all round them, and, where the stone was not required for use, but merely had to be removed to form a gallery, the grooves were



TUNNEL EXCAVATING AND CONSTRUCTION

1. View of tunnel from bottom of steel caisson shaft, showing cast iron walls of tunnel lining with conduits for electric cables. Old Slip—Clark Street, East River tunnel, New York city
2. Roof shield used in excavating two-track tunnel for subway in dry sand. Flatbush Avenue, Brooklyn, N.Y.
3. Shield of the Holland tunnel, New York city, showing tail end of shield and part of temporary rings in shaft
4. Looking down in a completed caisson shaft, sealed against soil and water pressure at the bottom, the shield being placed in position to start tunnel excavation, Montague Street, Brooklyn
5. Four track pontoon section being towed to site for sinking
6. Interior of tunnel, back of shield, after a "blowout"
7. Surface of water made rough by compressed air escaping from tunnel excavating under East River, New York city

wide enough for a man to stand up in. Where granite, diorite and other hard stone had to be cut the work was done by tube drills and by saws supplied with corundum, or other hard gritty material, and water—the drills leaving a core of rock exactly like that of the modern diamond drill.

As instances of ancient tunnels through soft ground and requiring masonry arching, reference may be made to the vaulted drain under the south-east palace of Nimrod and to the brick arched tunnel, 12 ft. high and 15 ft. wide, under the Euphrates. In Algeria, Switzerland and wherever the Romans went, remains of tunnels for roads, drains and water-supply are found. Pliny refers to the tunnel constructed for the drainage of Lake Fucino as the greatest public work of the time. It was then by far the longest tunnel in the world, being more than 3·5 m. in length, and was driven under Monte Salviano, which necessitated shafts no less than 400 ft. in depth. Forty shafts and a number of cuniculi, or inclined galleries, were sunk and the excavated material was drawn up in copper pails, of about 10 gal. capacity, by windlasses. The tunnel was designed to be 10 ft. high by 6 ft. wide, but its

FIG. 1.—EARLY MINING METHODS IN "DE RE METALLICA" (1566) BY GEORG AGRICOLA
A. Shaft, B, C, D. Drifts, E. Tunnel, F. Tunnel mouth

actual cross-section varied. It is stated that 30,000 labourers were occupied 11 years in its construction. With modern appliances and a small percentage of the men, such a tunnel could be driven from the two ends without intermediate shafts in far less time.

No practical advance was made on the tunnelling methods of the Romans until gunpowder came into use. Old engravings of mining operations early in the 17th century show that excavation was still accomplished by pickaxes or hammer and chisel, and that wood fires were lighted at the ends of the headings to split and soften the rock in advance. (*See* fig. 1.) Crude methods of ventilation by shaking cloths in the headings and by placing inclined boards at the top of the shafts are also on record. Before the advent of the railroad, tunnels were built for canals at many locations and some were of very early date. On the introduction of railways tunnelling became one of the ordinary incidents of a contractor's work. Probably upwards of 4,000 railway tunnels have been excavated, including in this list some of the longest tunnels in the world, such as the Mont Cenis, Saint Gotthard, Simplon and Loetschberg in the Alps; the Hoosac, Moffat and Cascade in mountains of the United States; and the Connaught at Rogers pass in Canada. On mountain railways, tunnels often form a large percentage of the length; on the Mexican railway in a distance of 66 m. there are 21 tunnels; on the Southern Pacific 11 tunnels in 25 m., including a spiral tunnel. There are also several long spiral tunnels on the Canadian Pacific railway at the Kicking Horse pass. The longest single tunnel, however, is the Shandaken tunnel, 18·1 m. in length, built by the City of New York (1917–24) as an extension of the Catskill aqueduct system for water-supply, in Greene county, N.Y.

TUNNELLING UNDER RIVERS AND HARBOURS

Through Tunnelling Methods.—In 1818 Marc Isambard Brunel took out a patent for a tunnelling process, which included a shield, and which mentioned cast iron as a surrounding wall. His shield foreshadowed the modern shield, which is substituted for the ordinary timber work of the tunnel, holds up the surrounding earth during excavation, affords space within its shelter for building the permanent lining, overlaps this lining in telescope fashion and is moved forward by pushing against the front ends. The advantages of cast iron lining are that it has great strength in small space as soon as the segments are bolted together, and its joints can be caulked water-tight.

First Use of Shield.—In 1825, Brunel began, and completed in 1843, after several suspensions of operations, the Thames tunnel between Rotherhithe and Wapping. It was constructed for a highway, but was never used for that purpose. It was sold in 1866 to and has since been used by the East London railway, which operates its trains through it. This early tunnel, built of brick, in the form of two arches with frequent openings between them, has a length of 1,200 ft., and required an excavation opening 27 ft. in width, which is still one of the widest ever built under such conditions. Brunel employed a peculiar form of shield, made of timber, in several independent sections. Part of the ground penetrated was almost liquid mud, and the cost of the tunnel was about £433 per linear foot. In 1830 Lord Cochrane (afterwards the 10th earl of Dundonald) patented the use of compressed air for shaft sinking and tunnelling in water-bearing strata. Water under any pressure can be kept out of a subaqueous chamber or tunnel by introducing sufficient air of a greater pressure, and men can breathe and work therein—for a time—up to a pressure exceeding four atmospheres. To confine the compressed air it is necessary to provide a substantial bulkhead across the workings. To pass men and materials through the bulkhead there is a mechanical device called a lock, which is a large steel tube, with doors at each end, both of which open inward toward the working chamber, and both of which can never be opened at one time because of the difference in air pressure between that in the working chamber and that back of the bulkhead. Valves are provided to admit compressed air to the lock from the working chamber, and also to exhaust it from the lock to back of the bulkhead, in order to manipulate the doors.

The Severn tunnel 4·33 m. in length, for a double line of railway, was begun in 1873 and finished in 1886. Hawkshaw, Son and Hayter were the engineers, and T. A. Walker the contractor. At the lowest part the depth of water was 59 ft. at low water and 104 ft. at high water, and the thickness of sandstone over the brickwork was 45 feet. Under a depression in the bed of the river on the English side there is a cover of only 30 ft. of marl. Much water was met with throughout. In 1879 the works were flooded for months by a land spring on the Welsh side of the river, and on another occasion from a hole in the river bed at the Salmon pool. This hole was filled with clay and the work completed beneath. The total amount of water raised

at all the pumping stations was about 27,000,000 gal. in 24 hours.

The length of the railway tunnel under the Mersey between Liverpool and Birkenhead, is 1 m. between the pumping shafts on each side of the river. From each a drainage heading was driven through the sandstone with a rising gradient towards the centre of the river This heading was partly bored out by a Beaumont machine to a diameter of 7 ft. 4 in and at a rate attaining occasionally 195 ft per week. All of the tunnel excavation, amounting to 320,000 cu yd., was done by hand labour, as heavy blasting would have shaken the rock The minimum cover is 30 ft. between the top of the arch and the bed of the river Pumping machinery is provided for 27,000,000 gal. per day, which is more than double the usual quantity of water Messrs Brunlees and Fox were the engineers and Messrs Waddell the contractors for the work which, taking six years, was completed in 1886

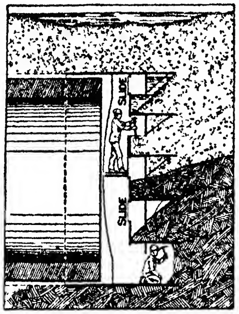


FIG 2—BAKER'S PNEUMATIC SHIELD

Some 30 m of brick-lined waterworks tunnels have been built under the Great Lakes since 1864, mostly in clay, without the use of shields, although in the later ones compressed air was utilized A large portion of one of the tunnels at Cleveland, O, 9 ft interior diameter, was built at the rate of 17 ft per day at a cost of about $18 per foot During this work three explosions of inflammable gases occurred in which 19 men were killed and others were injured Later a fire at the shaft in the lake caused the death of ten men Work was thereafter completed under the direction of George H Benzenberg Less serious accidents, principally explosions of marsh gas, occurred in many of the other tunnels

In 1869 P W Barlow and J. G. Greathead built the Tower footway under the Thames, using for the first time a cast iron lining and a shield which embodied features of Brunel's design

First Tunnel in Compressed Air.—Compressed air was first used in tunnel work by Hersent, at Antwerp in 1879, in a small drift with cast iron lining In the same year compressed air was used for the first time in any important tunnel by D C Haskin, in the famous first Hudson River tunnel, from Hoboken, N J, to Morton street, New York city This tunnel was to be of two tubes, each 16 ft wide by 18 ft high In June 1880 the northerly tube had reached 360 ft from the Hoboken shaft The compressed air blew a hole through the soft silt of the roof at this spot, and the water entering drowned the 20 men With British capital and largely under the direction of British engineers (Sir Benjamin Baker and E. W Moir), the northerly tunnel was extended 2,000 ft. to about three-fourths of the way across but in 1891, the tunnel was allowed to fill with water and it so remained for ten years Both tubes were completed in 1908, under the direction of Charles M Jacobs, engineer In the meantime, two others were started crossing under the Hudson from beneath the Pennsylvania railroad station in Jersey City to Cortlandt street, New York, and connecting tubes on the New Jersey side paralleling the Hudson river These tunnels which form parts of the Hudson and Manhattan railroad system, were put in operation in 1910 under electric traction by third rail (*See* TRACTION, ELECTRIC)

The use of compressed air in the first Hudson tunnel, and of annular shields and cast iron lining in constructing the City and South London railway (1886–90) by Greathead, became widely known and greatly influenced subaqueous and soft-ground tunnelling thereafter The pair of tunnels for this railway, from near the monument to Stockwell, from 10 ft 2 in to 10 ft 6 in interior diameter, were constructed mostly in clay and without the use of compressed air, except for a comparatively short distance through water-bearing gravel In this gravel a timber heading was made, through which the shield was pushed The reported total cost was £840,000. Other tunnels, lined with cast-iron segments and constructed by means of annular shields and the use of compressed air, were constructed after the City and South London work was well advanced.

The St Clair River tunnel (Joseph Hobson, engineer) from Sarnia to Port Huron, Mich., was built in 1889–90, through clay, and for a short distance through water-bearing gravel. It is 1·14 m. in length and 21 ft external diameter. This tunnel was the first one completed in America in which were used all the essential elements for successful subaqueous work; *i.e.*, a shield, compressed air and cast-iron rings.

In 1890–93 a shield-driven vehicular tunnel was constructed in sand and gravel across the Clyde in Glasgow, Scotland. It consists of three parallel cast iron tubes with an internal diameter of 16 ft, the centre one being a footway and the outer tubes for vehicles in each direction The footway is reached by inclined ramps and stairs, but the vehicles are lowered and raised by elevators in shafts of 76 ft inside and 80 ft outside diameter. The distance between shafts is 700 feet The cost was £287,000. This tunnel was not a financial success because of competition by a municipal ferry and its use, though interrupted, was resumed

In 1891 the tunnel of the Ravenswood Gas Co in New York city was started by Jacobs and Davies, engineers, crossing beneath the East River and Blackwell's island from between 70th and 71st streets in Manhattan, to Ravenswood in Long Island city. It was expected to be a rock tunnel throughout and the section was to be 8 ft 6 in high and 10 ft 6 in wide, to provide room for two 3 ft and one 4 ft gas mains. Soft ground was encountered and great difficulty was found because of the depth and water pressure Compressed air was adopted, the pressure at times reaching as high as 46 lb per square inch Eventually, it was necessary to line the soft ground sections with cast iron rings of 10 ft 2 in internal diameter The work was completed in 1894

The notable Blackwall tunnel, under the Thames about 6 m below London bridge (Sir Alexander Binnie, engineer, and S Pearson and Sons, contractors), was built in 1892–97, through clay and 400 ft of water-saturated gravel. The tunnel is about 3,116 ft long, the external diameter 27 ft and the internal diameter 24 ft 3 inches The shield, 19 ft 6 in. long, contained a bulkhead with movable shutters, as foreshadowed in Baker's proposed shield (fig 2) There are a roadway 16 ft wide for vehicles and two footwalks 3 ft wide The maximum grade is 2·78%.

Numerous tunnels of small diameter have been constructed by the use of shields under the Thames and Clyde for electric and cable ways, several for sewers in Melbourne and under the Seine at Paris for sewer siphons

The Rotherhite tunnel, under the Thames, about 2·25 m below London bridge, provides for a vehicular roadway 16 ft wide and two footwalks 4 ft. 8 in wide It has a length of 4,863 ft between portals, of which about 1,400 ft. are directly under the river The exterior diameter of the tunnel is 30 ft. and the interior 27 feet The maximum grade is 2·7% It is constructed of cast iron rings and concrete lining, and a shield and compressed air were used It was begun in 1904 and finished in 1908 Maurice Fitzmaurice was the engineer of design and construction, and Price and Reeves the contractors. The top of the main tunnel excavation in the middle of the river was only 7 ft. from the bed of the Thames, and a temporary blanket of filled earth, usual in similar cases, was prohibited owing to the close proximity of the docks

The East Boston tunnel, built in 1901, was the first important example of a shield-built monolithic concrete arch, and extends from the Boston subway to East Boston It is 1·4 m. long, 3,400 ft being under the harbour. One mile was excavated by tunnelling with roof shields about 29 ft. wide, through clay containing pockets of sand and gravel. The shields reacted against iron bars set in the concrete and moved forward on the masonry side walls The engineer was H A. Carson, and the contractors the Boston Tunnel Construction Company and Patrick McGovern.

A number of tunnels of marked importance, of the subaqueous shield-driven type, operated solely with electric cars (*see* TRACTION, ELECTRIC) in addition to the Hudson and Manhattan tun-

nels already mentioned, have been built under the East and Hudson rivers at New York. They are divided into two groups: those built as parts of the Pennsylvania-Long Island railroad systems, and those forming parts of the rapid transit system built by the City of New York.

Of the rapid transit tunnels, the first two tubes, of 15 ft. 6 in. interior diameter and 4,150 ft. long, penetrate gneiss, sand and gravel directly under the East river, between the Battery, in Manhattan, and Joralemon street, Brooklyn. They were begun in 1902,

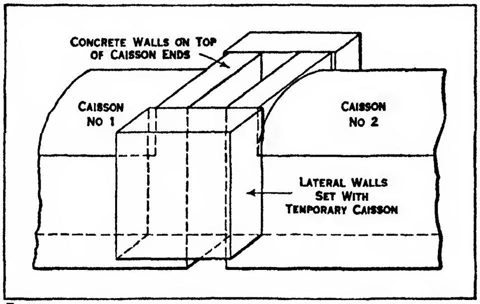


FIG 3 —PERSPECTIVE SHOWING MANNER OF ENCLOSING SPACE BETWEEN TUNNEL CAISSONS FOR THE MÉTROPOLITAIN UNDER THE SEINE AT PARIS

with Wm. Barclay Parsons (and later George S Rice) as chief engineer, and were finished in Dec 1907, under the direction of Walton I Aims and D. L. Hough of the New York Tunnel Company, contractors Two other tubes, also of the same size, built (also through gneiss, sand and gravel) between 1905 and 1907 by the Degnon Contracting Company, with R. A Shailer as the contractors' engineer, extend from 42nd street, Manhattan, to Long Island City These tubes were built as an independent line, but were bought and merged with the rapid transit system, under the operating contracts of 1913 Under these contracts four other tunnels each consisting of two tubes, were also driven beneath the East river from Whitehall street, Manhattan, to Montague street, Brooklyn; Old Slip, Manhattan, to Clark street, Brooklyn; 14th street, Manhattan, to North 7th street, Brooklyn; and from 60th street, Manhattan, to Long Island city They are of larger size At the 60th and 14th street tunnels the tubes in part are above the original river bed and were built in an artificial but permanent bed of clay protected by rip-rap of stone On both the Joralemon and Whitehall street tunnels blow-outs of compressed air occurred during construction which carried workmen through to the river surface, and in each case one man survived without injury (*See* Plate, fig 6) The chief engineer for the city was Alfred Craven, and, later, Daniel L Turner The work was done between 1914–20 Under contracts let by the city for a proposed independent rapid transit system for municipal operation (Robert Ridgway, chief engineer for the board of transportation, City of New York), two other tube tunnels are in process of construction (1928) under the East river: Fulton street, Manhattan, to Cranberry street, Brooklyn; and Fifty-third street, Manhattan, to Long Island City. The 53rd street tunnel is also being built in part in an artificial river bottom of clay filling A tunnel is also being built under the Harlem river, from Manhattan to the Bronx, at 145th street The greatest shield progress, that on the Whitehall-Montague street tunnel, was 95 ft. in a week of six working days. A pressure of 48 lb. was used in the 60th street tunnel

Four somewhat larger tubes, measuring 23 ft. on the outside diameter were built under the East river in 1904–09 for the Pennsylvania and Long Island railroads. Alfred Noble was chief engineer, S Pearson and Son, contractors, and E. W. Moir was general manager for the contractors. Blowouts were prevented by placing clay blankets (sometimes 25 ft. thick) on the river bed, which could be carried up to 20 ft. depth of water in the slips and back of the pierhead lines, and by filling the pores of the sand and gravel at the face of the shield with dry blue lias lime or applying plastic clay. Under the Hudson river, two tubes of the same size as those under the East river were built for the Pennsylvania trains to New Jersey

In 1914 a highway tunnel, started in 1907 and very similar to that at Glasgow, was completed in sand beneath the Elbe river at Hamburg, Germany. Access is here also obtained by elevators, in shafts 1,471 ft between centres. The shafts are 72 ft inside and 84 ft outside diameter and each contains four elevators for vehicles and two for foot passengers. The lift is 78 feet Each of the two tubes between shafts provides for a single roadway 6 ft. wide and two foot-walks 4 ft. wide. The tubes are of cast iron 19·7 ft external diameter and the clear width inside is 14 8 feet. The lining is concrete faced with decorative tiles

The new (1920) water-supply intake tunnel at Cleveland, O, extends out 2·8 m, below the surface of Lake Erie, at a depth of 95 ft below the surface and 40 to 50 ft below the lake bottom It was driven with a shield and compressed air in soft clay and sand. The air pressure for most of the work varied from 15 to 25 lb. per square inch. The tunnel has an internal diameter of 10 ft and is lined with concrete blocks 11 in thick

The notable Holland tunnels connect Canal street, New York, with Twelfth street, Jersey City, passing beneath the Hudson river The tunnels are named in honour of Clifford M Holland, the first chief engineer, who died on Oct 27, 1924, two days before the meeting of the tubes beneath the river Mr Holland was succeeded by Milton H Freeman and the latter on his death by Ole Singstad The tunnels consist of two tubes 1 61 m in length between the portals Except for the land approaches, they consist of circular cast iron rings, 29 ft in exterior diameter They are solely for motor-propelled vehicular traffic and each tube provides for two lines of traffic in one direction only, with a roadway width of 20 feet. The tubes beneath the river were driven with shields under compressed air (*See* Plate, fig 3) The maximum grade, with traffic, is 4% and against traffic, 3 6%, both on the New York side of the river The roadways are paved with granite blocks, and the clear headroom is 13 ft. 6 inches The interior

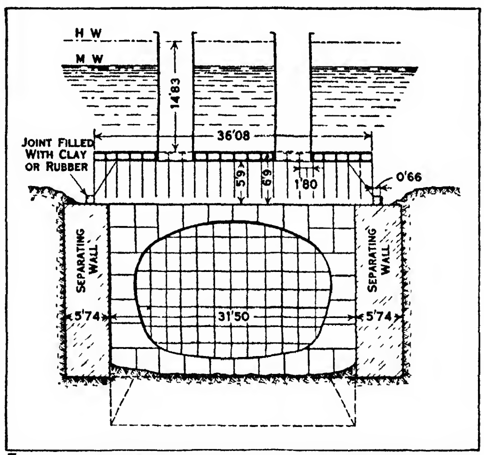


FIG 4 —TRANSVERSE SECTION OF COFFER-DAM SUPERIMPOSED OVER JOINTS BETWEEN CAISSONS IN TUNNELS FOR THE MÉTROPOLITAIN UNDER THE SEINE

walls are covered with glazed ceramic tile and the tubes are brilliantly lighted by electricity The entrance and exit portals are separated at each end by two city blocks and large plazas are provided to prevent traffic congestion. Artificial ventilation is provided. The tunnels have fire fighting equipment, water lines, sand boxes, telephones, traffic signals, wrecking equipment, etc A footwalk is provided for policing and inspection, but the tunnels are not open to pedestrians. Power for the equipment is obtained from two independent sources on each side of the river and three independent cables from each source of supply. Each

cable has a capacity sufficient to carry the full load. It was estimated that the tunnels would have a traffic capacity of 1,900 vehicles per hour for each tube About 52,000 vehicles have used the tunnels in a single day, without reaching their capacity. Construction began on July 1, 1919, and the tunnels were opened to traffic on Nov. 11, 1927. The cost of construction and real estate was about $48,000,000, of which the States of New York and New Jersey paid equal amounts. Tolls are collected.

The River Mersey vehicular tunnel, between Liverpool and Birkenhead, England, lies about parallel with and a little north of the Mersey railway tunnel, built in 1880–86 It is the largest circular tube tunnel in the world, having an outside diameter of 46 ft 3 in and inside diameter of 44 ft This tunnel is lined with cast iron plates and concrete The main roadway is at about the centre of the tube and provides for four lines of traffic on a width of 36 ft and two foot-walks of about 4 ft each Over this roadway, with a clearance of 17 ft, is the exhaust air ventilating duct, occupying the top of the tube Below the main roadway, in the central part of the bottom of the tube, there is a roadway for two lines of traffic, with a width of 21 ft and clear height of 17 feet On each side of the lower roadway the space is used for the fresh air supply ducts. Mechanical ventilation is required as the tube is for motor and steam-driven cars At the deepest point, the tunnel is 170 ft below high water The length between shafts is 76 ft less than 1 m. and the total length of the tunnel, including two branches on each side of the river for entrance and exits, is 2·93 miles. The maximum grade is 3·33%. The estimated capacity, at 15 m per hour spaced 100 ft apart, is 3,000 vehicles per hour, requiring about 9 minutes for passage The cast iron required for lining is over 110,000 tons and the concrete lining 150,000 cubic yards The estimated cost is £5,000,000 Work was started on the shafts in Jan. 1926 and completion is expected in 1931. The work is done under the Mersey Tunnel Act, of 1925, modified by an act of 1927 The cost is to be contributed one-half by the Ministry of Transport, one-fourth by tolls and the remaining portion by Liverpool and Birkenhead in the proportion of their rateable values Basil Mott and J A Brodie are the engineers, with B H. M Hewett in charge, and the contractors for shafts, drifts and the enlargement of the tunnel were Edmund Nuttall, Sons and Co Ltd

Tunnels have been proposed for undersea connection between England and France, beneath the English channel; even between Alaska and Siberia and beneath the entrance to the Mediterranean at Gibraltar, but aside from the great cost, due to great length and depth, questions of national military defence arise

SINKING TUBES, CAISSONS, COFFER-DAMS, ETC.

In 1845, De la Haye, in England, doubtless having in mind the tedious and difficult work of the Thames tunnel, proposed to make tunnels under water by sinking large tubes on a previously prepared bed and connecting them together. Since then many inventors have proposed similar schemes In 1866 Belgrand sank twin-plate iron pipes, 3 28 ft. in diameter and 512 ft long, under the Seine at Paris for a sewer siphon, and there have since been numerous examples of sunk cast iron subaqueous water-pipes

First Subaqueous Trench Tunnel.—It is believed that the first tunnel of this class, large enough for men to move upright in, was by H A. Carson, assisted by W Blanchard and F D Smith (in 1893–94), in the outer portion of Boston harbour, for the metropolitan sewer outlet. The later tubes were about 9 ft. exterior diameter, in sections each 52 ft long weighing about 210,000 lbs, made of brick and concrete, with a skin of wood and watertight bulkheads at each end A trench was dredged in the harbour bed and saddles were accurately placed to support the tubes. The latter, made in cradles above the water alongside a wharf, were lowered and towed ½ to ¾ m to their final positions After sufficient water had been admitted they were lowered to their saddles by travelling shears on temporary piles The temporary joints between consecutive sections were made by rubber gaskets between flanges which were bolted together by divers. The later operations were backfilling the trench over the pipes and, in each section, pumping out the water, removing its bulkheads and making good the masonry between consecutive bulkheads, this masonry being inside the flanges. This work, about 1,500 ft. in length, was done without contractors, by labourers and foremen under the immediate control of the engineers and was found perfectly sound.

The double-track railroad tunnel at Detroit, made in 1906–09, for the Michigan Central railroad, was built under the direction of an advisory board consisting of W. J Wilgus, chairman, H. A.

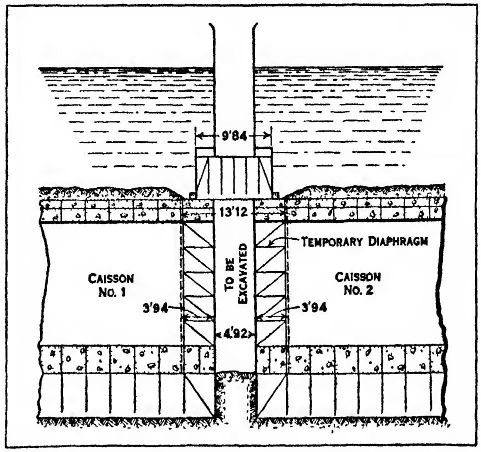


FIG 5—LONGITUDINAL SECTION OF COFFER-DAM SHOWN IN FIG 4

Carson and W S Kinnear, chief engineer The tunnel is 1·5 m. long, with a portion of 0 5 m directly under the river A trench was dredged with a depth equal to the vertical dimension of the tunnel below the river bed and about 70 ft. below the river surface and grillages were accurately placed in it to support the ends of thin steel tube forms, inside of which concrete was to be moulded and outside of which deposited These tubes, each about 23 ft in diameter and 262 5 ft. long, were in pairs (one tube for each track) and were joined together at intervals of 12 ft. by thin steel diaphragms surrounding the tubes The planking, to limit the concrete, was secured to the outside edges of the diaphragms. The tubes were made tight, bulkheaded at their ends, floated into place, sunk by admitting water, set on the grillages and the ends of successive pairs connected together by bolts through rubber gaskets and flanges

The second (1913–15) tunnel crossing of the rapid transit system at New York beneath the Harlem river from Lexington avenue, in Manhattan, to Mott avenue, in the Bronx, consists of four tubes 1,080 ft long The general design and method of construction were modifications of those used in the Michigan Central railroad tunnel at Detroit. The tunnel was built in five sections, 199 to 220 ft. in length A trench was dredged with a width of 81 ft. and side slopes of 45°. The sections (770 tons) were erected on timber falsework and, to launch them, flat boats were run beneath the sections at low tide and the rising tide lifted them from the falsework. The ends of the tubes were provided with timber bulkheads to make the tubes float, and when free from the falsework they were towed by a tug into the river, where the flat boats were scuttled and sunk by opening valves provided for the purpose The tubes then floated on their own bottoms and were towed to the tunnel site and sunk on the timber caps provided for their support in the river (*See* Plate, fig. 5) The water was then pumped from the tubes and they were lined with concrete. The tunnels were completed without the use of compressed air for any part of the work Alfred Craven was chief engineer for the Public Service Commission and the contractor was the Arthur McMullen and Hoff Company.

The vehicular tunnel beneath the Detroit river, from Detroit, Mich., to Windsor, Canada, was started in 1928. It consists of one tube, 0·95 m. long, between portals, with an inside diameter

of 28 ft. 4 inches. The portion beneath the river, 2,500 ft long, is to be built by the subaqueous trench method as in the case of the Michigan Central tunnel at Detroit, and the second Harlem River tunnel, at New York. The land portions, 1,000 ft. and 500 ft in length are shield-driven. The estimated cost is $10,000,000 Because of the international character of this tunnel, it is necessary not only to provide for collection of tolls but for customs and immigration inspection, which requires unusual plaza facilities at both ends of the tunnel Parsons, Klapp, Brinckerhoff and Douglas are engineers and Porter Brothers, contractors.

The largest diameter tunnel built by the subaqueous trench method is the Oakland-Alameda estuary tube, in California. It is a single tube, 0 67 m. in length between portals, of which 2,436 ft is made up of 12 sections of tubes, each 203 ft. long, sunk in a dredged trench, with a depth of water over the tubes of 42 feet. The tube sections present the novelty of being made of reinforced concrete, 37 ft external diameter, with a shell thickness of 30 in. and they are enveloped with a membrane of three-ply waterproofing. They were cast in forms in a dry dock at San Francisco, then floated to position and sunk The roadway is 23 ft wide for vehicles, two lines of street railway tracks and also foot-walks protected by railings The cost is estimated at $4,500,000 or about one-half the estimated cost if done by the shield method. C E. Posey is chief engineer

Tunnelling by Sinking Caissons.—The first New York rapid transit tunnel under Harlem river, built in 1904–05, is an example of tunnel caissons built under water and in part of the work a portion of the permanent tunnel was itself made to serve as the roof of the caisson The tunnel has two tubes, each about 15 ft in interior diameter, the portion beneath the river being 400 ft long, with a surrounding shell of cast iron itself surrounded by concrete The outside width of concrete is about 33 feet Its top is 28 ft below high water and about 3 ft below the bed of the river The method of construction was devised by McMullen and MacBean, the contractors, who dredged a trench in the river to within 7 or 8 ft of the required depth They then enclosed a space of the width of the tunnel, from shore to mid-stream, with 12 in sheet piling, which was evenly cut off some 2 ft above the determined outside top of the tunnel On top of this piling was sunk and tightly fitted a flat temporary roof of timber, 3 ft thick in sections, which was covered with about 5 ft of dredged mud. An air lock was provided in the roof and the water was expelled from this subaqueous chamber by compressed air, after which the remaining earth was easily taken out, and the cast iron and concrete tunnel walls were then built in the chamber For the remaining part of the river the foregoing process was varied by cutting off the sheet piling at mid-height of the tunnel and making the upper half of the tunnel, which was built above and lowered in sections through the water, serve as the roof of the chamber in which the lower half of the tunnel was built in compressed air

Subaqueous tunnels are usually started from shafts near the margins of the streams and, when in soft ground, the shafts are sunk by the use of caissons under compressed air The caissons remain as part of the permanent construction and from them the shields are started. It may therefore be said that nearly all tunnels of this class are built in part by caissons (*See* Plate, figs 1 and 2)

The tunnels of the Métropolitain railway of Paris (F Bienvenue, engineer-in-chief) under the two arms of the Seine, between Place Chatelet and Place Saint Michel, were made by means of compressed-air caissons sunk beneath the river bed, L Chagnaud being the contractor. They were built of plates of sheet steel and masonry, with temporary steel diaphragms in the ends, filled with concrete, making a cross wall with a level top about even with the outside top of the tunnel and about 2 ft. below the bottom of the Seine. The caissons were sunk on the line of the tunnel so that adjacent ends and the walls just described, were nearly 5 ft apart with (at that stage) a core of earth between them Side walls joining the end walls and thus enclosing the earth core on four sides (fig. 3) were next made by the aid of temporary small caissons sunk through about 26 ft. of earth under the river. The tops of the side walls were made even with the end walls. A steel rectangular coffer-dam (figs. 4 and 5) was sunk to rest with rubber or clay joint on these surrounding walls. The coffer-dam had shafts reaching above the surface of the water, so that the earth core was easily taken out in free air, after removing the water The adjacent chambers under the caissons were then connected together Three caissons, of a total length of 396 ft were used under the large arm and two, of an aggregate length of 132 ft under the smaller arm of the Seine Construction was started in 1905 and operation was begun in Jan. 1910; the cost of the tunnel was 2,134 francs per linear foot

At San Diego, Calif, a tunnel 1,200 ft long was constructed in 1928 by the caisson method The tunnel has a cross section of 11 by 12 ft, and forms the intake for cooling water for a power plant

Tunnels Built in Coffer-Dams.—The first subaqueous highway tunnel in the United States was that at Washington street, beneath the Chicago river, in Chicago. It is not properly a tunnel, having been built in a coffer-dam. It was constructed in 1866–69 and has two roadways each 11 ft. wide and 13 ft high, and a footway 10 ft wide and 10 ft. high. It has twice been rebuilt to provide a deeper waterway, the original depth being only 14 feet. After the great fire of 1871, it formed the only means of communication between the west side and the business district pending the reconstruction of the bridges In 1869–71 a similar roadway tunnel was constructed at La Salle street and in 1889–94 one at Van Buren street, both beneath the Chicago river These also required rebuilding at later dates to provide deeper waterways All these tunnels are now used for surface cars only

TUNNELLING BY THE FREEZING METHOD

Tunnelling by freezing the water contained in the soil, and then excavating through the frozen material in a manner similar to rock, has often been proposed The method has been used for sinking shafts with a fair degree of success in a number of cases Siberian miners have for years taken advantage of low temperatures to penetrate saturated ground to reach mineral deposits F H Poetsch applied the method in 1883 in sinking a shaft in Saxony, for the Archibald mine.

While fairly successful as applied to shafts, the method has rarely been used for driving tunnels and then not with entire success In 1884–86, in Stockholm, Sweden, a tunnel for pedestrians was driven in part by the freezing method by Captain Lindmark The length of the tunnel was 758 ft and it passed beneath a ridge dividing two parts of the city The cross section was 12 ft 8 in high and 13 ft. 2 in wide and the material was coarse gravel with large stones and some clay It contained water and had very little cohesion The material was frozen by using a dry air (Lightfoot) machine delivering 25,000 cu ft. of air per hour The temperature of the air at the machine was $-55°$ C. Only about 80 ft. of the tunnel was constructed by this method, the balance of the soil being of firmer material

TUNNELLING THROUGH MOUNTAINS

Where a great thickness of rock overlies a tunnel through a mountain it may be necessary or advisable to do the work wholly from the two ends without intermediate shafts The problem largely resolves itself into devising the most expeditious way of excavating and removing the rock Experience and modern mechanical devices, such as compressed air drills, and mucking and loading machines, have led to speed and economy.

The Hoosac tunnel, in Massachusetts, on the line of the Fitchburg railroad, was the first prominent tunnel in America, and for many years the longest, being 4 73 m. long It was begun in 1855 and finished in 1876, after many interruptions It was memorable for the original use in America of compressed air drills and nitroglycerin, mechanical drilling being adopted in 1866

In 1857 the first blast was fired in connection with the Mont Cenis work in the Alps, in 1861 machine drilling was introduced and in 1871 the tunnel was opened for traffic. It is located between Modane, France and Bardonecchia, Italy It is a single tunnel 7·98 m. long, with a "horseshoe" section 26 ft 3 in by 24 ft. 7 inches The material penetrated was granitic and the

average progress 7·7 lin ft. per 24 hours The approximate cost was £75 per linear foot. With the exception of about 900 lin.ft. the tunnel is lined throughout with brick or stone During the first four years, by hand labour, the average progress was not more than 9 in per day on each side of the Alps, but with compressed air drills the rate towards the end was five times greater.

In 1872 the St Gotthard tunnel was begun and in 1881 the first locomotive ran through it It lies between Goschenen and Airolo, in Switzerland It is 9 3 m in length and of the same dimensions as the Mont Cenis The material also was granitic and the average progress 18 lin ft per 24 hours The approximate cost was £48 per linear foot Mechanical drills were used from the beginning Tunnelling was carried on by driving in advance a top heading about 8 ft square, then enlarging this sideways and finally sinking the excavation to invert level (*See* details in fig 6) Air for working the rock-drills was compressed to seven atmospheres by water turbines of about 2,000 horse-power The two inclines leading to the summit, which total about 36 m, are 28% tunnel, including seven spirals forming almost complete loops within the mountains, in order to gain altitude and distance

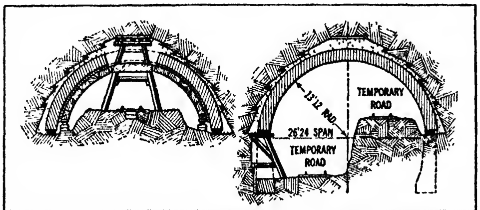


FIG 6 —METHOD OF EXCAVATION OF ST GOTTHARD TUNNEL

The driving of the Arlberg tunnel was begun in 1880, and the work was completed in little more than three years It is a single tunnel, 6 36 m long, between Innsbruck and Bludenz, in the Tirol. It is 25 ft 3 in wide and the average progress in 24 hours was 27 2 linear feet The approximate cost was £36 per linear foot The main heading was driven along the bottom of the tunnel and shafts were opened to the upper heading 75 to 210 ft apart, from which smaller headings were driven right and left The tunnel was enlarged to its full section at different points simultaneously in lengths of 24 ft, the excavation of each occupying about 20 days and the masonry 14 days Ferroux percussion air drills and Brandt rotary hydraulic drills were used, the performance of the latter being especially satisfactory After each blast a fine spray of water was injected, which assisted the ventilation materially. In the St Gotthard tunnel the discharge of the air drills was relied on for ventilation In the Arlberg tunnel over 8,000 cu ft of air per minute was thrown in by ventilators To keep pace with the miners, 900 tons of excavated material had to be removed, and 350 tons of masonry introduced daily at each end of the tunnel, which necessitated the transit of 450 wagons The cost per linear foot varied according to the thickness of masonry lining and the distance from the mouth of the tunnel For the first 3,000 ft from the entrance the prices per linear foot were £3 16s for the lower heading; £2 11s for the upper one; £10 3s for the unlined tunnel, £15 for the tunnel with a thin lining of masonry, and £41 8s with a lining 3 ft thick at the arch, 4 ft at the sides and 2 ft 8 in at the invert

The Simplon tunnel was begun in 1898 and completed in 1905 It lies between Brigue, Switzerland and Iselle, Italy It has a length of 12·3 m and is over 30% longer than the St Gotthard The greatest depth below the surface is 7,005 feet. A novel method was introduced by driving two parallel headings (56 ft. apart, connected at intervals of 660 ft by oblique galleries), which greatly facilitated ventilation and resulted in increased economy and rapidity of construction, while also insuring the health of the men One of the headings was enlarged at once to 16 ft. 5 in wide by 19 ft 6 in high, for a single track railroad, but the second was left to be enlarged and similarly used at a later date (This was undertaken in 1918, during the World War, and completed a few years later) Had one wide tunnel been made instead of two narrow ones, it would have been difficult to maintain its integrity; even with the narrow cross section employed, the floor was forced up at points in the solid rock from the great weight above, and had to be secured by building heavy inverts of masonry. About 2·5 m from the portal at Iselle, the "Great Spring" of cold water was struck It yielded 10,564 gal. per minute at 600 lb pressure per square inch, and reduced the temperature to 55·4° F, the lowest point recorded. A spring of hot water was met on the Italian side which discharged into the tunnel 1,600 gal. per minute with a temperature of 113° F. The maximum flow of cold water was 17,081 gal per minute, and of hot water 4,330 gal. per minute These springs often necessitated a temporary abandonment of the work Water-power from the Rhone at the Swiss and from the Diveria at the Italian end provided the power for operating all plants during construction of most of the work. The material penetrated was gneiss, mica-schist, limestone and disintegrated mica-schist. The average progress per 24 hours was 35 lin ft and the approximate cost £49 7s per linear foot Among the able engineers connected with this work must be mentioned Alfred Brandt, a man of remarkable energy and ability, whose drills were used with much success He died early in the work of injuries received from falling rock

A group of tunnels—the Tauern, Barengraben, Wocheiner and Bosruck—was undertaken by the Austrian Government in connection with new Alpine railroads to increase the commercial territory tributary to the seaport of Trieste, which at one time was greater than Hamburg

The Loetschberg tunnel, in the Alps of Switzerland, between Kandersteg and Gopperstein, is 9 04 m long and the maximum grade 0 38% It is a double track railway tunnel, and its construction was begun in Oct 1906 and completed in Sept 1911 It was originally planned to be 8 5 m in length and straight It passed beneath the ancient glacial gorge now filled with detritus and occupied by the Kander river, but at a great depth and it was supposed it would be in solid granite After driving the heading for nearly 2 m it broke through into the gorge which was filled with sand, boulders and water under great pressure In the space of a few moments about 8,000 cu-yd of the material was carried into the heading Twenty-five men, the drills and all equipment were lost beyond hope of recovery It was bulkheaded off and the line bent to throw it farther into the mountains and beneath the gorge and was then successfully completed, the length being increased one-half mile The tunnel is operated electrically, using 15,000 volts, single phase, alternating current of 16 cycles.

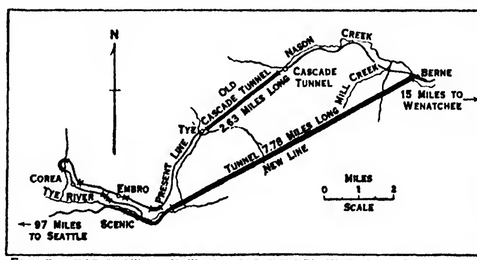


FIG 7 —MAP SHOWING NEW AND OLD TUNNEL IN THE CASCADE MOUNTAINS, STATE OF WASHINGTON, U S A

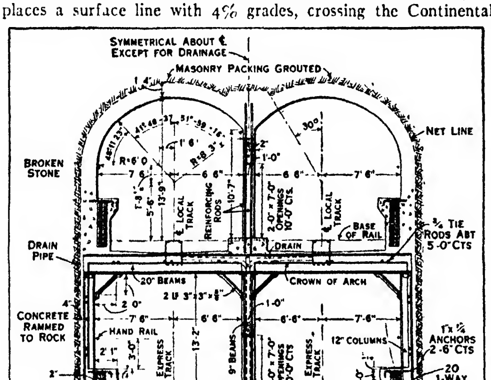
The Connaught tunnel at Rogers pass on the Canadian Pacific railway, pierces the Selkirk range of the Canadian Rockies It is 5 m long and replaces a surface line 540 ft higher up Its construction saves 5 m of distance and replaced 5 m of snow sheds in a distance of 13 miles. It is a double track tunnel, operated electrically and has a maximum grade of 2·2%. It was built between 1913 and 1916 and was the first American tunnel in which a parallel pioneer tunnel was used Progress on the pioneer heading reached as high as 817 ft. in 30 days.

Much important tunnel construction has been done in Japan by the Japanese government railways Probably the most notable

is the Tanna tunnel, between Atami and Mishima, which was started in 1918 and is not yet (1928) completed, as extraordinary difficulties have been encountered. The tunnel is 4·89 m in length and passes under two mountains and the valley between them. The maximum depth below the surface is 1,300 ft. and below the valley 600 feet It is partly in soft ground and partly in rock. The rock is andesite. Several methods of excavation have been tried but difficulty with water prevails. At the Atami side, 17 cu ft per second at a pressure of 240 lb per square inch enters the work, and at the Mishima side 48 cu ft. per second. The actual cost of construction up to the present (1928) has been $500 00 per linear foot

The Liberty vehicular tunnels penetrate the south hills at Pittsburgh, Pa., and connect with the Liberty bridge, over the Monongahela river They consist of two parallel tunnels, 59 ft. between centres, each 26 ft. 7 in. wide, and 1·1 m long Each tunnel provides a single line of street railway track not installed and two lines of vehicular traffic on a roadway 21 ft wide There is also a foot-walk, 4 ft. wide, in each tunnel. The tunnels are lined with concrete 24 in thick. The alignment is straight and the grade continuous at the rate of 0 392% The work was begun in 1919 and completed about three years later The total cost was about $6,000,000 For tunnels of their size, unusually rapid progress was made in excavating which was due largely to a bonus system of paying the workmen Eleven hours' pay was allowed for 9 ft. advance of excavation and 12 hours' for 10 ft, whether consumed or not. There was also sharp rivalry between the forces in the two tunnels, and the men completing their shift first were allowed to display an American flag at the entrance, the following day, while their competitors were compelled to display a black flag. The average rate of advance per day in the tunnels was over 10 ft for a period of several months.

The Moffat tunnel, on the Denver and Salt Lake railroad, replaces a surface line with 4% grades, crossing the Continental



BY COURTESY OF N Y CITY BOARD OF TRANSPORTATION

FIG 8 —TYPICAL FOUR TRACK TUNNEL IN ROCK

Divide, about 50 m. west of Denver, Colo. At the time of construction it was the longest railroad tunnel in America. It lies at an elevation of 9,200 ft. above sea-level, as compared with 11,660 on the surface line at the summit of the Divide. The work was begun in 1923 and the first train was run through in Feb. 1928. The work consists of two parallel tunnels, 75 ft. apart, one for a single track railroad, 16 ft. by 24 ft. and one for a water tunnel, 8 ft. by 8 ft., which may be used for the future water-supply of the City of Denver. The work was done by the Moffat Tunnel Commission, and paid for by a bond issue by a district of the State in the vicinity and the City of Denver The railroad tunnel is leased to the Denver and Salt Lake railroad The length of the tunnel is 6 1 m and the cost including the water tunnel was about $15,470,000. The grades of the railroad tunnel rise from the ends toward the centre, on rates of 0 3% from the east and 0 9% from the west The construction of both tunnels at one time was taken advantage of to use the water tunnel as a pioneer heading, with cross connections to the main railroad tunnel at intervals of about 1,500 ft, as was done in the Simplon tunnel and the Connaught tunnel at Rogers pass, which offered advantages in speed and ventilation Chloride of lime dumped in one of the lakes, 1,400 ft. above, was found in the tunnel water two hours later

The new Cascade tunnel of the Great Northern railway, between Berne and Scenic, in the State of Washington, is 7 79 m long. (*See* fig 7) It is the fifth longest railway tunnel in the world and the longest railway tunnel in America The alignment is straight and the grade 1·565% downward to the west from Berne. Work was started in Dec. 1925. The tunnel was driven from the two portals and a shaft, 622 ft deep, 2·41 m from the east end, by the centre heading method, to allow radial drilling A pioneer tunnel, 66 ft to one side and parallel with the main tunnel, was also driven, from which cross-drifts were driven at 1,500 ft. intervals This provided a number of points of attack and insured proper ventilation and drainage The pioneer heading has a width and height of 10 ft. and was advanced 984 ft. in one month The pioneer heading was holed through in May 1928, and the main tunnel was completed during the same year and put in operation Jan 12, 1929 The power used in construction was 2,300 volts, 60-cycle, 3-phase current The total compressor capacity was 10,450 cu ft of free air per minute Haulage in the headings was by 6-ton, 250-volt trolley locomotives, and for the full section 20-ton trolley locomotives The locomotives were equipped with gathering reels, which allowed their working 500 ft beyond the suspended trolley. The line speed of the skip hoists at the shaft was 900 ft per minute A total force was employed of about 1,800 men and, because far distant from any settlement, complete camps with cottages, schools, recreation halls, stores and shops were provided, equipped with water-supply, electric lights, sewers and modern plumbing J R W. Davis is chief engineer for the Great Northern railway, and the contractor was A Guthrie and Co The line through the tunnel is to be operated electrically The estimated cost is $16,000,000 (*See* TRACTION, ELECTRIC)

The electric railway from Eiger glacier to near the summit of the Jungfrau includes a tunnel 1 5 m long, 11 ft. 10 in wide and 12 ft 6 in high, with a midway station having arches through the side from which a large part of northern Switzerland can be seen From the Jungfrau terminus, at an elevation of 13,428 ft., the summit, 242 ft higher, may be reached by an elevator

Among other important rock tunnels may be mentioned the Albula, through a granite ridge of the Rhaetian Alps, for a single-track narrow-gauge railroad, 3 6 m long; the Giovi, 6 m long, north of Genoa, Italy; tunnels on the Midland railway, near Totley in Derbyshire, over 3 5 m long, largely in shale and at Cowburn, over 2 m long, in shale and harder rock, each 27 ft wide and 20·5 ft high inside; the Arthur Pass tunnel in New Zealand, begun in 1908, 5·3 m long, for a single track, narrow gauge railway; the Suram, on the Trans-Caucasus railway, for double track, 2·47 m long, through soft rock; the Graveholz tunnel, on the Bergen railway, in Norway, 3 3 m long (the longest in northern Europe); the tail-race tunnel for the Niagara Falls Power Company, being 1 3 m long, 19 ft. wide and 21 ft. high, through argillaceous shale and limestone, costing about $1,250,000, the Tequixquiac outlet to the drainage system for the City of Mexico, 6·2 m long, costing $6,760,000; the first Cascade tunnel, Washington, part of the Great Northern railway system, 2 63 m long and saving 9 m in distance (now replaced by a still longer tunnel, 7 79 m); the Gunnison, 5·8 m. long, irrigating 147,000 ac. in Colorado; the double track railway tunnel of the Canadian Northern railway, under Mount Royal in Montreal, Canada, 3·5 m. long; and the double track Musconetcong tunnel of the

Lehigh Valley railroad, a little less than 1 m. long and costing $5,000,000, holed through in 21 months (June 1928). An example of a small tunnel of considerable length is the Strickler tunnel It supplies water to Colorado Springs, from Pike's peak of the Rocky Mountains, in Colorado. It is 1·22 m long and the cross-section is only 4 by 7 feet

For many reasons, including both safety of the work and interest charges on the capital investment, speed in tunnel construction is desirable, and such work is always pushed as fast as possible. During the World War, the Northern railway of France built the Marseille-en-Beauvaisis tunnel, a single track railway tunnel, paralleling a similar one in operation and 60 ft from it, at the rate of 16 ft per day It is 1,200 ft long, in badly fissured chalk formation and is lined with concrete It was begun May 21, 1918, the headings met June 28 and it was in operation Aug. 4, a period of 75 days

TUNNELLING IN TOWNS

Where tunnels have to be carried through soft soil in proximity to valuable buildings special precautions have to be taken to avoid settlement. An early successful example of such work is the tunnel driven in 1886 for the Great Northern Railway Company, under the metropolitan cattle market, London This was done by the crown-bar method, the bars being built in with solid brickwork. The subsidence in the ground was from 1 to about 3½ inches Several buildings were tunnelled under without any damage.

The District subway of Glasgow, Scotland, consists of a double tube line in the form of a loop, connecting Partick and the northern districts with the centre of the city. It has a length of 6 5 m, and consists in large part of circular tubes, 11 ft internal diameter, built as tunnels, lined with cast iron and driven with a shield and compressed air. The line crosses twice beneath the Clyde. Work was begun in 1891 and the line opened to traffic in 1897

London has now some 90 m. of tunnels for railways, mostly operated by electric traction (*See* TRACTION, ELECTRIC) Most of those which have been constructed since 1890, comprising some 50 m of double tube railways, have been tunnelled through clay by the use of cylindrical shields and have linings of cast iron plates. The tubes are generally small, from 10 to 12 ft in inner diameter, but shields about 23 ft in diameter were used in constructing the stations on the Central London railway, and one 32 ft. 4 in. in diameter and only 9 ft 3 in long was used for a short distance on the Clapham extension of the City and South London railway. The first of the London tube railways to be built was 3 5 m., of the City and South London, from the Bank under the Thames to Stockwell, begun in 1886 and completed in 1900.

Paris has an extensive system of underground railways some 60 m in length, portions of which were built as tunnels, and a considerable number of which were constructed under the engineering direction of F Bienvenue The first line was built in 1898, from Porte Maillot to Porte de Vincennes, and other lines followed at later dates. Instead of using completely cylindrical shields and cast iron walls, as in London, roof-shields (*boucliers de voute*) were employed for the construction of the upper half of the tunnel, and masonry walls were adopted throughout. In general, the upper half of the tunnel was executed first and the lower part completed by underpinning.

In the case of the tunnelling near important buildings in Boston, in 1896, with a roof-shield 29 ft. 4 in in external diameter, the vertical side walls were first made in small drifts, the roof-shield running on top of these, and the core of earth was taken out later and the invert or floor of the tunnel put in last. Each hydraulic press of the shield reacted against small continuous cast iron rods imbedded in the brick arch.

In some large sewerage tunnels in Chicago the shields were pushed from a wall of oak planks, 8 in. thick, surrounding the brick walls of the sewer. The same method was employed in constructing the portion of the Dorchester tunnel, a part of the Boston subway system, beneath Fort Point channel The length of this section was 3,060 ft the external diameter 24 ft 2 in. and the thickness of the wood 9 inches

The Pennsylvania railroad tunnels crossing New York city under 32nd and 33rd streets are of unusual size and excavated through mica schist. Owing to the close proximity of large buildings and other structures, special methods were adopted for mining the rock to lessen the vibrations from explosions.

Quite long sections of the rapid transit system beneath the streets in New York have been built in tunnels. There are about 3 m. of double tube, shield-driven tunnels in Brooklyn. Shorter sections also were built in Manhattan. A portion of the line under Flatbush avenue was built in sand with a roof shield of unusual size rolling on the completed side walls, as in the case of the Boston subway. A number of the rock tunnels disclose an exceptional size On the Lexington avenue line, four tracks, two on each of two levels, are in one tunnel excavation, about 32 ft high and wide. (*See* fig. 8.) The upper level is carried on steel beams supported by columns at the side and centre The concrete roof is formed of two arches carried by columns. The central portion is known as an "umbrella" section, which it resembles Beneath St Nicholas avenue and Fort Washington avenue five of the subway stations are constructed in tunnel, four of which contain two tracks and two platforms within a single arch having a clear span of 48 feet The width of excavation required was 57 ft and the height 30 feet. In one case the arch carries a mezzanine platform the entire length of the station, supported by hangers from the roof arch alone

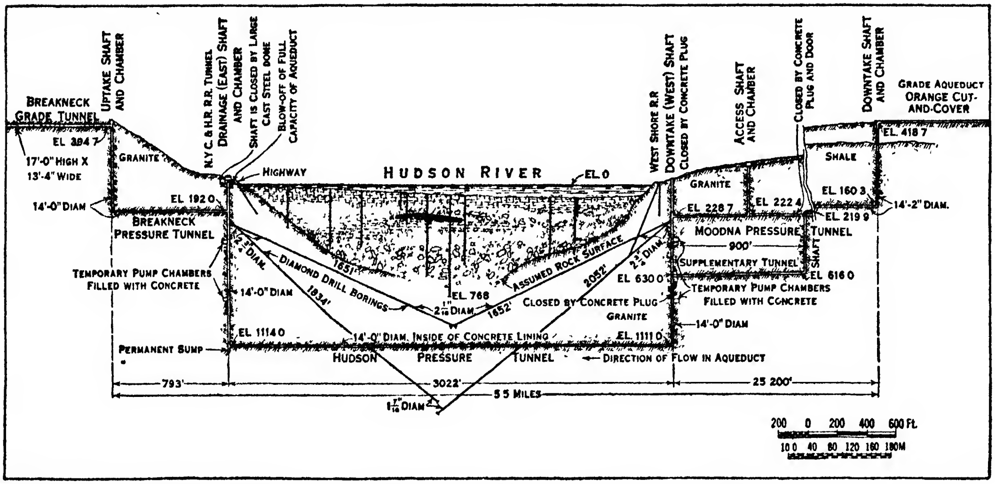
TUNNELS FOR CONVEYING WATER

From very early days, water has been conveyed in aqueducts formed by tunnelling, and some early examples have been mentioned Generally such tunnels were of small cross-section, but many of them were of great length. They also generally followed the grade of the flowing water and where valleys were encountered they were crossed by aqueducts of stone arches, of which examples still exist. Examples of modern tunnelling in connection with water-supply may be found in many sections of the world Where necessary to obtain water for the supply of large cities it sometimes must be brought from great distances and the sources of supply are generally in mountainous districts.

Both the largest and longest aqueduct tunnels are those supplying water to the City of New York They also present the novelty of sinking to great depths below the hydraulic grade line and rising again to that line to pass beneath river gorges, which are crossed at many points and also to pass beneath the entire length of Manhattan island. This introduces an internal or bursting pressure in the tunnel, which is called "a pressure tunnel"

The Croton aqueduct, from the Croton dam to the gate house at 135th street, constructed 1885–90, forms, in its completed state, a tunnel 31 m long and includes an inverted siphon or pressure tunnel, passing beneath the Harlem river. A number of short sections were built in open excavation and then covered over.

The Catskill water-supply system, which extends from the Catskill mountains to New York city, a distance of about 160 m, consists in large part of true tunnels and includes both the largest tunnels for such purpose, and the longest tunnels for any purpose in the world. All are concrete lined. There are 25 tunnels on the hydraulic grade, with a total length of 32 m, including the tunnel beneath the Shandaken mountains, 18·1 m long, about 40 m. south-west of Albany, N.Y It has a "horseshoe" section 11 ft. 6 in high by 10 ft 3 in wide and is the longest continuous true tunnel in the world for any purpose Seven shafts were used in constructing this tunnel There are also seven pressure tunnels crossing beneath river valleys, including that beneath the Hudson river from Storm King to Breakneck mountain, at a depth of 1,114 ft. below sea-level. It is 14 ft internal diameter and 3,022 ft between the shafts on either side of the river. (*See* fig. 9) The total length of the Catskill aqueduct pressure tunnels exclusive of the city aqueduct tunnels is 17 m. and they are from 14 ft. to 17 ft. 6 in. in diameter. The city aqueduct tunnel extends from Hillview reservoir, beneath the Harlem river and nearly the entire length of Manhattan island and the East river, to shafts in Brooklyn, a distance of 18 miles. It is the second longest tunnel in the world, and the longest carrying water under pressure. To provide



BY COURTESY OF N Y CITY BOARD OF WATER SUPPLY

FIG 9 —CROSS-SECTION OF THE HUDSON RIVER CROSSING OF THE CATSKILL AQUEDUCT, LOOKING DOWN-STREAM, SHOWING THE LOCATION OF THE TUNNEL AND THE DIAMOND-DRILL BORINGS MADE TO EXPLORE THE ROCK TO DETERMINE ITS LOCATION

resistance to the bursting pressure of the water and also watertightness, it is placed in the rock from 200 to 750 ft below the surface of the streets beneath which it was built It was driven from 25 shafts, averaging 4,000 ft apart The work of constructing the Catskill aqueduct system, including the reservoirs, the city tunnel and the Shandaken tunnel, occupied from 1905 to 1926.

In 1920, a tunnel 4 5 m long, 9 ft wide and 9 5 ft. high was begun in the Alps of Switzerland, to convey water to an hydroelectric plant The Nevada irrigation tunnel is 4·1 m long and has a cross-section 9 by 9 feet. It was completed in May 1928 at a cost of $1,500,000

TUNNELS FOR CANALS OR WATERCOURSES

Tunnels for the diversion of streams or canals are of very early date South of Seleucia, in Turkey in Asia, a river flows through a tunnel 20 ft wide and 23 ft. high, excavated 1,600 years ago through rock so hard that the chisel marks are still discernible In 1766 a tunnel 9 ft wide, 12 ft high and 1 63 m long was begun on the Grand Trunk canal, England, and completed 11 years later; and this was followed by many others.

The largest of its kind is the recently completed (1927), Rove tunnel, connecting the Port of Marseilles, France, by canal with the river Rhone. It is 72 ft wide (width of water 60 ft) and 50 ft high inside and 4 53 m long. The cross-sectional area is about six times that of the average double track railway tunnel Its construction occupied 15 years, and its cost was about 135,000,000 francs, paid by the French Government, the chamber of commerce and the City of Marseilles The entire cost is to be returned by tolls The quantity of material excavated was greater than any other tunnel in Europe, about 2,250,000 cu yd, or 25% more than the great Simplon tunnel It is lined with masonry, has a tow path 6 ft. wide on each side in the form of a series of small arches and has a large masonry portal at each end This tunnel is 1 7 m longer than a similar canal tunnel between the Marne and the Rhine.

VENTILATION OF TUNNELS

Ventilation of Steam Railway Tunnels.—The simplest method for ventilating a railway tunnel is to have numerous wide openings to daylight at frequent intervals If these are the full width of the tunnel, at least 20 ft. in length, and not farther apart than about 500 ft., a tunnel can sometimes be naturally and adequately ventilated. Such arrangements are, however, frequently impracticable, especially in long and deep tunnels, and then recourse must be had to mechanical means Not only long tunnels, but often those relatively short, require artificial ventilation when on a steep gradient, as the smoke and gases have a tendency to travel up the grade with the locomotive, which is then working at full capacity Natural ventilation depends for its action upon the difference of temperature within the tunnel or ventilation shaft, and the outer air In winter the draft is upward and in summer often downward In the spring and autumn there are often periods when there is little difference in temperature and, in consequence, little circulation of air Most steam railway tunnels are poorly ventilated, except where the difference in elevation of the ends or the prevailing winds, creates a natural draft through them The need for ventilation is far greater with steam locomotion than with electric motors

The first application of mechanical or fan ventilation to railway tunnels was made in the Lime street tunnel of the London and North Western railway, at Liverpool, which has since been replaced by an open cutting At a later date fans were applied to the Severn and Mersey railway tunnels

Where possible, the principle ordinarily acted upon, where mechanical ventilation has been adopted, is to exhaust the vitiated air at a point midway between the portals of a tunnel, by means of a shaft with which is connected a ventilating fan of suitable power and dimensions. In the case of the tunnel under the Mersey river such kind of shaft could not be provided, owing to the river being overhead, but a ventilating heading was driven from the middle of the river (at which point entry into the tunnel was effected) to each shore, where a fan 40 ft in diameter was placed In this way the vitiated air is drawn from the lower point of the railway, while fresh air flows in at the stations on each side to replenish the partial vacuum

The principle was that fresh air should enter at each station and "split" each way into the tunnel, and that thus the atmosphere on the platforms should be kept pure. In the Mersey tunnel there are five fans; two are 40 ft in diameter by 12 ft. wide and two 30 ft in diameter by 10 ft. wide, one of each size being erected at Liverpool and at Birkenhead respectively. In addition there is a high speed fan, 16 ft in diameter, in Liverpool, which throws 300,000 cu ft. per minute The ventilation of this tunnel was satisfactory up to a train schedule of 300 trains per day, or one each way every five minutes As the traffic increased the air shaft became coated with soot several inches thick and arrangements were made to instal electric power.

The central point of the Severn tunnel lies toward the

Monmouthshire bank of the river and ventilation is effected from that point by means of one fan placed on the surface at Sudbrooke Monmouth, at the top of a shaft which is connected with a horizontal heading leading to the centre of the tunnel. This fan, which is 40 ft in diameter by 12 ft in width, removes from the tunnel some 400,000 cu ft per minute, and draws in an equivalent volume of fresh air from the two ends

About 1896 an excellent system was introduced by Signor Saccardo, an Italian engineer, which to a great extent minimized the difficulty of ventilating long tunnels under mountain-ranges where

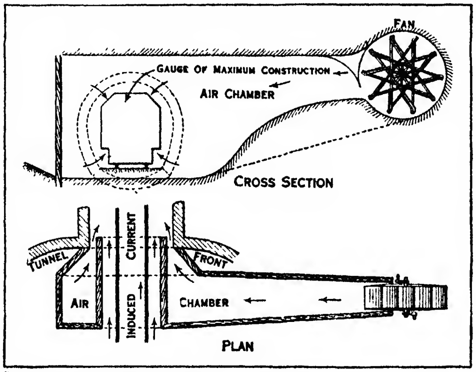


FIG 10—DIAGRAM ILLUSTRATING THE SACCARDO SYSTEM FOR VENTILATING TUNNELS

shafts are not available This system, which is not applicable to tunnels in which underground stations exist, is based upon the principle of the ejector, and is illustrated in fig 10, which represents its application to the single-line tunnel through the Apennines at Pracchia This tunnel is one of 52 single line tunnels, with a gradient of 1 in 40, on the main line between Florence and Bologna, built by Thomas Brassey There was a great deal of traffic which had to be worked by heavy locomotives Before the installation of a ventilating system, under any condition of wind, the state of this tunnel, about 9,000 ft. in length, was bad, but when the wind was blowing in at the lower end at the same time that a heavy goods or passenger train was ascending the gradient the condition of affairs became very much worse The engines, working with the regulators full open, often emitted large quantities of both smoke and steam which travelled concurrently with the train The goods trains had two engines one in front and the other at the rear, and when, from the humidity in the tunnel, due to the steam, the wheels slipped and possibly the train stopped, the state of the air was indescribable A heavy train with two engines, conveying a royal party and their suite, arrived on one occasion at the upper exit of the tunnel with both enginemen and both firemen insensible, when a heavy passenger train came to a stop in the tunnel, all the occupants were seriously affected

In applying the Saccardo system, the tunnel was extended for 15 or 20 ft. by a structure either of timber or brickwork, the inside line of which represented the line of maximum obstruction of the tunnel, and this was allowed to project for about 3 ft into the tunnel (fig 10) The space between this line and the exterior constituted the chamber into which air was blown by means of a fan Considering the length of tunnel, it might at first be thought there would be some tendency for the air to return through the open mouth, but nothing of the kind happened The whole of the air blown by the fan, 164,000 cu.ft. per minute, was augmented by the induced current yielding 46,000 cu ft per minute, making a total of 210,000 cu ft; and this volume was blown down the gradient against the ascending train so as to free the driver and men in charge of the train from the products of combustion at the earliest possible moment Prior to the installation of this system the drivers and firemen had to be clothed in thick woollen garments, pulled on over their ordinary clothes, and wrapped round and round the neck and over the head.

The Saccardo system was installed in 1899 at the St. Gotthard tunnel with most beneficial results. The ventilating plant is situated at Goschenen at the north end of the tunnel and consists of two large fans operated by water-power The quantity of air pressed into the narrow mouth of the tunnel is 413,000 cu.ft. per minute at a velocity of 686 ft., this velocity being much reduced as the full section of the tunnel is reached After installation, a sample of the air taken from a carriage contained only 10 19 parts of carbonic acid gas per 10,000 volumes.

In the Simplon tunnel (12 3 m long), where electricity is the motive power, mechanical ventilation was installed at the time of construction at each end of the tunnel, both for construction purposes and to serve as permanent equipment It is based on a different principle than the Saccardo system A steel sliding door is arranged at each entrance to be raised and lowered by electric power. After the entrance of a train the door is lowered and fresh air forced into the tunnel from the same end at considerable pressure by fans Since completion of the second tunnel following the World War an additional ventilation plant has been built at the north end of the tunnel

The Moffat tunnel in Colorado (6·1 m long) is ventilated by a mechanical plant based on the principle of forced or induced draft created at one end of the tunnel A building was erected at the east portal which forms an extension of the tunnel and provides a fan chamber on each side. A vertical lift gate is provided to close the portal Two fans are provided, which differ for experimental reasons. Each has a diameter of 9 ft and width of 6 feet The motors are of 750 and 500 h p with capacities of 450,000 and 350,000 cu ft. per minute, at velocities of 14 and 10 m per hour, respectively Only one fan is operated, the other held in reserve. The ventilation is by forced draft for east bound trains and induced draft for west bound trains, which forces the smoke back along the train The results are very satisfactory

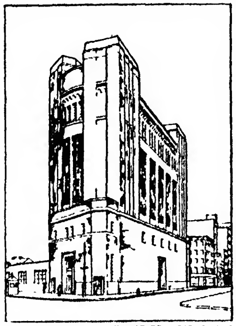
Other railway tunnels partially or completely ventilated by mechanical draft are the Giovi tunnel, in Italy, Hoosac tunnel, in Massachusetts, East Mahanoy tunnel, in Pennsylvania, Big Bend tunnel, in West Virginia, Elkhorn tunnel, in West Virginia, and the Gallitzen tunnel, in Pennsylvania

Volume of Air Required for Ventilation of Railway Tunnels.—The consumption of coal by a locomotive during the passage through a tunnel having been ascertained, and 29 cu ft of poisonous gas being allowed for each pound of coal consumed, the volume of fresh air required to maintain the atmosphere of the tunnel at a standard of purity of 20 parts of carbon dioxide in 10,000 parts of air is ascertained as follows The number of pounds of fuel consumed per mile, multiplied by 29, multiplied by 500 and divided by the interval in minutes between the trains, will give the volume of air in cubic feet which must be introduced into the tunnel per minute

Ventilation of Tunnels for Electric Traction.—The introduction of electric traction has simplified the problem of ventilating intra-urban railways laid in tunnels at a greater or less distance below the surface, since the absence of smoke and products of combustion from coal and coke renders necessary only such a quantity of fresh air as is required by the passengers and staff. For ventilation the shallow tunnels which form the underground portions of the Metropolitan and District railways in London, open staircases, blow-holes and sections of uncovered track are relied on When the lines were worked by steam locomotives they afforded notorious examples of bad ventilation, the proportion of carbonic acid gas amounting to from 15 or 20 to 60, 70 and even more parts in 10,000 Since the adoption of electricity as the motive power the atmosphere of the tunnels has very much improved Samples taken from the cars in 1905 after the adoption of electricity gave as low as 11·27 parts in 10,000.

When deep level "tube" railways were first constructed in London, it was supposed that adequate ventilation would be obtained through the lift-shafts and staircases at the stations, with the aid of the piston action of the trains which, being of nearly the same cross-section as the tunnel, would, it was supposed, drive the air in front of them out of the openings at the stations they were

approaching, while drawing fresh air in behind them at the stations they had left. This expectation, however, was disappointed and it was found necessary to employ mechanical means. On the Central London railway, which runs from the Bank of England to Shepherd's Bush, a distance of 6 m., the ventilating plant installed in 1902 consists of a 300 h.p electrically driven fan, which is placed at Shepherd's Bush and draws in fresh air from the Bank end of the line and at other intermediate points. The fan is 5 ft. wide and 20 ft in diameter, and makes 145 revolutions a minute, its capacity being 100,000 cu ft. a minute. It is operated from 1 to 4 A M. and, the openings at all the intermediate stations being closed, it draws fresh air in at the Bank station The tunnel is thus cleared out each night, during the period when trains are not operated, and the air is left in the same condition as it is outside. The fan is also worked during the day from 11 A M to 5 P M, the intermediate doors being open In a number of the later tube railways in London—such as the Baker street and Waterloo, and the Charing Cross and Hampstead lines—electrically driven exhaust fans are provided at about half-mile intervals, these each extract 18,500 cu ft of air per minute from the tunnels and discharge it from the tops of the station roofs



BY COURTESY OF N Y STATE BRIDGE AND TUNNEL COMMISSION

BUILDING FOR THE HOUSING OF THE MACHINERY BY WHICH FRESH AIR IS FORCED INTO THE HOLLAND TUNNEL AND USED AIR WITHDRAWN

The Boston system of electrically operated subways and tunnels is ventilated by electric fans capable of completely changing the air in each section about every 15 minutes Air admitted at portals and stations is withdrawn midway between stations

In the southerly 5 m of the first rapid transit subway at New York, constructed between 1900 and 1904, which is a four track structure of rectangular section, having the area of 650 sq ft and built as close as possible to the surface of the streets, ventilation by natural means through the open staircases at the stations was at first relied upon The results were satisfactory as regards the proportions of carbonic acid gas found in the air, but when intensely hot weather prevailed the tunnel air was sometimes 5° hotter still, due to the conversion of electric energy into heat Ventilation chambers were added on each side of the subway at points between stations, and the condition became much improved. These chambers are beneath the sidewalks and covered by gratings, and they have been incorporated in the construction of all subways built later In addition, a partition wall separates trackways for trains running in opposite directions and the piston action of the trains induces a satisfactory circulation of the air.

Ventilation of Vehicular Tunnels.—The need of mechanical ventilation of vehicular tunnels is a development of the last generation due to the advent of vehicles propelled by internal combustion engines The exhaust from such engines contains smoke and gases, which are irritating to the eyes and also contains a considerable percentage of carbon monoxide, a highly poisonous gas. The first studies of the need of ventilation for vehicular tunnels were undertaken in connection with the construction of the Holland tunnel, at New York, because of its length and the large volume of traffic which was expected to use it At that time (1920) natural draft was relied upon for the ventilation of all such tunnels in operation, including the Blackwall and Rotherhithe tunnels, in London, which were by far the most important. The traffic in them, however, was only about 100 motor vehicles per hour for each tunnel, compared with an estimated traffic of 1,900 motor vehicles per hour in each tube of the Holland tunnel. Research studies and exhaustive tests were made for this tunnel with the co-operation of the U.S. Bureau of Mines to determine first, the amount and composition of exhaust gases from motor vehicles; second, the physiological effects of these gases and third, the friction losses and power required to handle large quantities of air through concrete ducts

In the Holland tunnel, the transverse system of ventilation was adopted. The fresh air is introduced continuously along each tube, from conduits provided for the purpose, and taken off at frequent intervals at opposite points. The air therefore travels a course transverse to that of the vehicles and there is a practically equal degree of purity at all points in the tubes Because carbon monoxide is lighter than air and the exhaust motor gases are warmer than the fresh air introduced in the tunnel and therefore tend to rise, the fresh air ducts are placed beneath the roadways and the exhaust ducts above the roadway ceiling but all in the same tunnel tube The fresh air is introduced in each roadway by continuous slots along each side above the floor, and the vitiated air is exhausted through louvers in the roof at 15 ft. intervals The entire tunnel atmosphere is completely changed every 1½ minutes or 40 times per hour, but so uniformly and gently that the current is hardly perceptible This eliminates the fire hazard incident to a longitudinal circulation of draught There are four ventilation shafts, one at each pierhead line and one about midway between the pierhead and portal on each side of the river The fans are located in the shaft buildings and there are 84 in all, one-half blowers and one-half exhausters.

The Liberty tunnels were the first long vehicular tunnels in which artificial ventilation was used The method adopted is the longitudinal draft system, based on Saccardo's, with modifications by C S Churchill. The flow of air in each tunnel is with the traffic, and is induced from a shaft near the centre of each tunnel. Each shaft is divided into two compartments, one of which is used to exhaust the air which enters at the portal from the first half of the tunnel, and the other to blow fresh air into the tunnel at the centre and force it forward to the exit portal. Suitably designed nozzles at the centre of the tunnels, at the shafts, prevent the mixing of the air being introduced and ejected. The flow of air is continuous in each tube in opposite directions and wind pipes are provided at the exit of each tube to prevent interference with the ventilation by adverse winds The ventilating plant and fans are on the hilltop near the centre of the tunnels, at the shafts. The plant was designed to provide for a double line of motor cars in each tube, spaced 100 ft, moving at 15 m. per hour and a proportion of carbon monoxide at 6 parts in 10,000 at the point of exit, the average, therefore, being 3 parts in 10,000 This required the supplying of 280,000 cu ft of air per minute in each tube at a velocity of 6 m per hour. (*See* also TRACTION, ELECTRIC, TRANSPORT; AQUEDUCTS; etc) (R Ry)

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TUNNY (*Thunnus thynnus*) the largest fish of the mackerel family, reaching a length of over 10 ft. and a weight of 1,500 lb It is robust in form, bluish above, grey spotted with silver below The tunny is found in all warm seas, and periodically approaches the coasts, it feeds on other fishes It is excellent as food. In the Mediterranean especially, the fishing is extensive.

The sport of catching tunny or "tuna" with rod and line from motor-boats originated at Avalon, Calif., and has spread to New Zealand and Europe At Avalon the Tuna Club regulates the weight of rod and strength of line, and the capture of a large fish may occupy several hours.

TUNSTALL (or TONSTALL), **CUTHBERT** (1474–1559), English prelate, natural son of Thomas Tunstall of Thurland Castle, Lancashire, seems to have studied at Oxford, at Cambridge and at Padua Having held several livings in quick succession, he became chancellor to William Warham, archbishop of Canterbury,

in 1511 He was employed on diplomatic business by Henry VIII. and Wolsey, being sent to Brussels in 1515 and to Cologne in 1519, while he was at Worms during the famous Diet of 1521. In 1516 he had been made master of the rolls; in 1521 he became dean of Salisbury; in 1522 bishop of London, and in 1523 keeper of the privy seal. For Henry VIII he negotiated with Charles V after his victory at Pavia in 1525 and he helped to arrange the Peace of Cambrai in 1529 In 1530 he succeeded Wolsey as bishop of Durham Tunstall adhered firmly to the traditional teaching of the Church, but after some slight hesitation he accepted Henry as its head and publicly defended this position In 1537 the bishop was appointed president of the new council of the north, but although he was often engaged in treating with the Scots he took part in other public business and attended parliament, where in 1539 he participated in the discussion on the bill of six articles Although he disliked the religious policy pursued by the advisers of Edward VI and voted against the first act of uniformity in 1549, he continued to discharge his public duties without molestation until after the fall of the protector Somerset; then in May 1551, he was placed in custody. A bill charging him with treason was introduced, but the House of Commons refused to pass it, he was, however, deprived of his bishopric in October 1552 On the accession of Mary in 1553 he was released and was again bishop of Durham, but during this reign he showed no animus against the Protestants When Elizabeth came to the throne he refused to take the oath of supremacy, and he would not help to consecrate Matthew Parker as archbishop of Canterbury He was placed under arrest at Lambeth, where he died on Nov. 18, 1559

Among Tunstall's writings are *De veritate corporis et sanguinis domini nostri Jesu Christi in eucharistia* (1554), and *De arte supputandi libri quattuor* (1522). The bishop's correspondence as president of the council of the north is in the British Museum.

TUNSTALL, market town, in Staffordshire, England Pop (1921) 22,740 It is one of the towns which amalgamated in 1910 to form the municipal borough of Stoke-on-Trent (*q v.*) which in 1925 became a city The town is of modern growth. The Victoria Institute (1889) includes a library and schools of art and science The neighbourhood is full of collieries, ironworks and potteries Kidsgrove, Chatterley and Talk-o'-th'-hill are large neighbouring villages. There are brick and tile works in Tunstall

TUPELO, a city of north-eastern Mississippi, U S A, on the west fork of the Tombigbee river; the county seat of Lee county It is at the intersection of Federal highways 45 and 78, and is served by the Frisco and the Mobile and Ohio railways Pop (1920) 5,055 (41% negroes), estimated locally at 6,500 in 1928. It is the seat of a military institute

TUPIAN (Tupi), a group of tribes of South American Indians, occupying at the time of the first European contact a narrow and probably continuous strip of the Brazilian coast, from the vicinity of Rio de Janeiro northward nearly to the mouth of the San Francisco river. The original home of this stock probably lay in southern Matto Grosso and Paraguay

The Tupi tribes were everywhere sedentary or semi-sedentary agriculturalists, hunters and fishermen, but on the Atlantic coast fish was almost the staple food As a rule they wore very little clothing, made much use of feather ornaments and decoration, and wore small labrets in the lower lip They lived in large communal houses of light construction, although some had the walls of wattle and daub, and protected their often large villages by means of palisades Their weapons were the bow and club, but they made no use of poison on their arrows They were skilled canoemen, and their vessels carried as many as 60 men The Tupi tribes were warlike, and strongly organized for war, and commonly ate their prisoners The dead had their burial in large pottery urns The language of the coastal Tupis was adopted by the Jesuit missions as a lingua franca throughout a large part of Brazil, and this in time grew into the still considerably used *lingua geral*.

See C F P von Martius, *Beiträge zur Ethnographie und Sprachenkunde Amerikas*, etc (Leipzig, 1867); H von Ihering, *The Anthropology of the State of S Paulo, Brazil* (São Paulo, 1906).

TUPPER, SIR CHARLES, Bart. (1821–1915), British colonial statesman, son of the Rev. Charles Tupper, D.D., was born at Amherst, Nova Scotia, on July 2, 1821, and was educated at Horton Academy He afterwards studied for the medical profession at Edinburgh University, where he received the diplomas of M.D. and L.R C S. In 1855 he was returned to the Nova Scotia Assembly for Cumberland county In 1862 he was appointed governor of Dalhousie College, Halifax; and from 1867 till 1870 he was president of the Canadian Medical Association. Tupper was a member of the executive council and provincial secretary of Nova Scotia from 1857 to 1860, and from 1863 to 1867 He became prime minister of Nova Scotia in 1864, and held that office until the Union Act came into force on July 1, 1867, when his government retired He was a delegate to Great Britain on public business from the Nova Scotia government in 1858 and 1865, and from the Dominion government in March 1868. Tupper was leader of the delegation from Nova Scotia to the Union conference at Charlottetown in 1864, and to that of Quebec during the same year, and to the final colonial conference in London, which assembled to complete the terms of union, in 1866–1867 He was sworn a member of the privy council of Canada, June 1870, and was president of that body from that date until July 1, 1872, when he was appointed minister of inland revenue This office he held until February 1873, when he became minister of customs under Sir John Macdonald, resigning with the ministry at the close of 1873. On Sir John's return to power in 1878, Tupper became minister of public works, and in the following year minister of railways and canals Tupper was the author of the Public Schools Act of Nova Scotia, and had been largely instrumental in moulding the Dominion Confederation Bill and other important measures Sir Charles represented the county of Cumberland, Nova Scotia, for thirty-two years in succession—first in the Nova Scotia Assembly, and subsequently in the Dominion parliament until 1884, when he resigned his seat on being appointed high commissioner for Canada in London

Shortly before the Canadian Federal elections of February 1887, Tupper re-entered the Conservative cabinet as finance minister By his efforts the Canadian Pacific railway was enabled to float a loan of $30,000,000, on the strength of which the line was finished several years before the expiration of the contract time. He resigned the office of finance minister in May 1888, when he was reappointed high commissioner for the Dominion of Canada in London. Tupper was one of the British plenipotentiaries to the Fisheries Convention at Washington in 1887. When the Dominion cabinet, under Sir Mackenzie Bowell, was reconstituted in January 1896 Tupper accepted office, and in the following April he succeeded Bowell in the premiership. On both patriotic and commercial grounds he urged the adoption of a preferential tariff with Great Britain and the sister colonies. At the general election in the ensuing June the Conservatives were severely defeated, and Tupper and his colleagues resigned, Sir Wilfrid Laurier becoming premier. At the next general election, in 1900, Tupper, long the Conservative leader, sustained in his own constituency of Cape Breton his first defeat in forty years

See his *Recollections of Sixty Years* (1914); and E. M. Saunders. *Life and Letters of Sir Charles Tupper* (2 vols., 1916).

TUPPER, MARTIN FARQUHAR (1810–1889), English writer, the author of *Proverbial Philosophy*, was born in London on July 17, 1810, the son of a doctor of Huguenot descent He was educated at Charterhouse and at Christ Church, Oxford. He was called to the bar at Lincoln's Inn, but never practised He began a long career of authorship in 1832 with *Sacra Poesis* and in 1838 he published *Geraldine, and other Poems*, and for fifty years was fertile in producing both verse and prose; but his name is indissolubly connected with his long series of didactic moralisings in blank verse, the *Proverbial Philosophy* (1838–67) which for about 25 years enjoyed an extraordinary popularity. The first part was, however, a comparative failure, and N. P. Willis, the American author, took it to be a forgotten work of the 17th century. He died at Albury, Surrey, on Nov. 29, 1889.

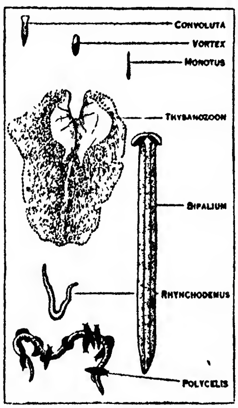
TURA, COSIMO (1430–1498), founder of the Ferrarese school of painting, was born at Ferrara and in his youth appears

to have visited Padua and Venice. He spent most of his life at Ferrara, where he was court painter to the dukes Bono and Ercole. Between 1465 and 1467 he decorated the library of the Picos of Mirandola with allegorical figures. These works, now destroyed, were described at length by Lilius Gregorius Giraldus (*Ferrarensis Historiae Poetarum,* Basle 1580). The decorations of Duke Borso's chapel at Belriguardo have also perished. In 1469 he painted the organ shutters in the cathedral of Ferrara These two panels, representing an "Annunciation" and a "St. George slaying the Dragon" are still extant The Berlin museum has one of the most important works of the master, "The Virgin and Child Enthroned and saints" Another notable work is the "Madonna and Child enthroned surrounded by six angels playing on musical instruments" (National Gallery, London). This painting was the central panel of an altarpiece of which the lunette representing "the Pietà" is in the Louvre, and one of the wings representing "a monk kneeling and two saints" is in the Colonna collection, Rome Other notable works are the "St Jerome" (National Gallery, London), the "Pietà" in the Correr Museum, Venice, and a madonna at Bergamo

See E. Gardner, *The Painters of the school of Ferrara* (1911).

TURBELLARIA (Planarians), a class of flat-worms or Platyhelminthes (*q v*) in which the body is unsegmented and covered with a ciliated epidermis, and an alimentary canal is generally present. Almost all the group are free-living.

General Morphology.—The body is either subcylindrical or flattened and leaf-like or ribbon-like. In length the species range from a fraction of a millimetre to some 20 centimetres In many forms there is a flat creeping (ventral) surface At or near the anterior end there may be a pair or more of tentacles, and a pair of eyes, or numerous eye-spots. The margins of the body, in some of the leaf-like aquatic forms, are very mobile and capable of forming fin-like membranes, with which the animals swim after the manner of a skate The dorsal surface of the body is often pigmented, and the colours and markings, especially in terrestrial forms, may be very striking and brilliant. In certain aquatic species a green or brown colour is produced by the presence in the tissues of symbiotic green or brown algae



AFTER VON GRAFF IN PARKER AND HASWELL, "TEXT BOOK OF ZOOLOGY" (MACMILLAN)

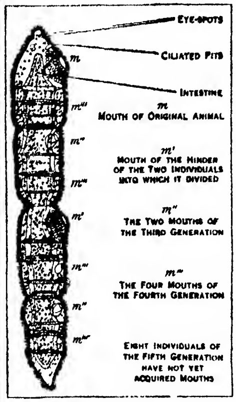
FIG 1 —EXTERNAL APPEARANCE OF VARIOUS TYPES OF TURBELLARIA

The upper three are small aquatic Rhabdocoelida. *Thysanozoon* is a marine Polyclad; the next two are terrestrial Triclads, and the bottom, a common fresh-water Triclad. All are shown feeding on a dead earthworm

The epidermis consists of a single layer of ciliated, glandular cells These cells secrete a mucoid slime and often also solid, fusiform, refringent rods known as "rhabdites." Below the epidermis is a basement membrane, and below this various layers of muscle-fibres (circular, longitudinal and sometimes also diagonal). As in the other classes of Platyhelminthes, the internal organs are embedded in parenchymatous tissue, though in some of the more highly specialized forms a slight space (schizocoel) surrounds the alimentary canal

The mouth is very variable in position. In some forms it is placed anteriorly, but more often it lies towards the middle, or even behind the middle, of the ventral surface. It leads, usually through a muscular pharynx with more or less mobile and protrusible margins, into a digestive organ which, in some cases (Acoela), is a solid syncytial mass, but more often forms a hollow sac. This sac-like gut may be simple, lobate or branched, but as a rule, has no opening to the exterior except the mouth

The nervous system consists of paired anterior ganglia lying ventrally to the gut, and giving off various lateral, dorsal and ventral fibres which are interconnected by other fibres. Tactile organs are generally distributed over the skin, and may take the form of special hair-like cilia Other sensory organs also occur in the form of statocysts, ciliated cephalic pits or grooves, and eyes. The eyes may be mere groups of specialized retinal cells surrounded by pigment, or more complex structures provided with a lens. An excretory system of the platyhelminth type, with flame-cells, is usually present The external opening may be single or paired, ventral or terminal, or there may be multiple excretory pores on the dorsal surface Almost all the Turbellaria are hermaphrodite, and the reproductive organs are usually complex The ducts of the male and female organs generally open separately, on the ventral surface and towards the posterior end of the body, the male pore being the more anterior.



FROM LANKESTER, "TREATISE ON ZOOLOGY" (A & C BLACK LTD)

FIG 2 —RHABDOCOELAN TURBELLARIAN (MICROSTOMA LINEARE) UNDERGOING THE PROCESS OF REPRODUCTION BY DIVISION

Classification.—To draw up a natural systematic arrangement of the Turbellaria is a matter of considerable difficulty An arrangement based primarily on the characters of the digestive apparatus, and due largely to von Graff and Lang, has for many years been looked upon as the standard system, and has been adopted, with slight modifications, in many well-known text-books of zoology Recently in consequence partly of the great increase in the number of known forms, there has been a tendency among specialists to consider this simple classification an unnatural one, and somewhat drastic changes have been proposed, notably by Poche (*Arch f. Naturg*, 1926). The older classification, which, up to the present, has been generally followed, is given here.

Order I Rhabdocoelida. Intestine, when present, a simple, straight or irregular sac. Female gonads compact Small forms (marine or fresh-water) with cylindrical, or more seldom flattened, body.

Tribe 1 Acoela. Digestive organ consists either of scattered cells among the parenchyma or of a syncytial mass without a lumen. Excretory organs of the usual type absent A median statocyst present above the brain. Testes follicular. Ovaries paired. Marine forms, including the families Proporidae and Convolutidae

Tribe 2. Rhabdocoela. Digestive organ consists of a straight gut, typically with a lumen, and usually separated from the general parenchyma by a partial cavity (schizocoel) Excretory organs present. Statocyst usually absent. Testes generally paired and compact. Vitellaria may or may not be distinct from the ovaries Sexes exceptionally separate (*Microstoma*) Marine and fresh-water forms, including a large number of families and genera (Prorhynchidae, Mesostomatidae, etc). A few forms (*Graffilla, Anoplodium,* etc) parasitic in marine invertebrates.

Tribe 3. Alloeocoela An irregular or branching intestine present, distinct from the parenchyma, but schizocoel greatly reduced. Excretory organs present Testes follicular Vitellaria and ovaries may or may not be distinct Almost all species marine, but a few in fresh water. Includes the family Plagiostomidae.

Order II. Tricladida. Intestine consists typically of three main branches, one median and anterior, two posterior, each of which gives off a series of caeca Mouth behind middle of body A single genital pore present Generally elongate and flattened or subcylindrical forms, including the families Bdelluridae, Procerodidae (marine), Planariidae (fresh-water), Geoplanidae, Bipaliidae (terrestrial) and several others

Order III. Polycladida Intestine consists of a central sac giving off laterally a number of branching caeca Genital pores typically separate. Flattened and generally leaf-like marine forms

Tribe 1. Acotylea. Without a ventral sucker Mouth at or behind middle of body. Genital pores near posterior end Tentacles, if present, dorsal. Includes the families Planoceridae, Leptoplanidae, etc

Tribe 2 Cotylea A sucker present behind the genital pores

Mouth at or in front of middle of body, with genital pores just behind it. Tentacles, if present, marginal. Includes the families Pseudoceridae, Euryleptidae, etc.

The group Temnocephaloidea (consisting of *Temnocephala* and certain other peculiar genera epizoic upon fresh-water cray-fish, tortoises, etc.) has sometimes been given the rank of a fourth order, and looked upon as connecting the Turbellaria with the Trematoda (*q v*).

In the classification proposed by Poche, to which reference has been made above, the three main groups are Acoela (order Proporidea), Rhabdocoeloinei (orders Planariidea, Catenulidea, Rhabdocoela, Temnocephalidea) and Polyclada (order Planocer-idea) The Acoela are thus removed from the Rhabdocoelida, and the remainder of the latter, with the Tricladida and Temnocephaloidea of the old system, included in one large group

Occurrence and Habits.—Most Turbellaria are aquatic They are abundant on the seashore and in fresh water, where they lurk among weeds or under stones, and in the crannies of rock-pools The marine forms usually emerge from their hiding-places only during high tide to feed. These worms creep with a curious gliding movement, aided by their cilia, or swim actively. Some of the small fresh-water planarians may often be seen creeping upside-down on the surface-film of the water Many species of triclads are terrestrial. These occur in damp localities and chiefly in tropical or subtropical countries, though a few are known in temperate latitudes They are somewhat slug-like in form and habits A few Turbellaria are parasitic. These are marine, and are found in such animals as sea-urchins, holothurians and molluscs The free-living forms are almost all carnivorous, feeding either on microscopic organisms or on worms, molluscs and insects The protrusible pharynx is used either to engulf the prey whole or to pierce it and suck up its juices after it has been enveloped in a coating of mucus.

Development and Life-history.—The development of most of the Turbellaria is direct (*i.e.,* without metamorphosis). In certain polyclads, however, the embryo develops into a swimming larva ("Muller's larva") provided with eight ciliated lobes, and somewhat resembling the trocho-sphere larvae of certain annelids In the Rhabdocoela the eggs are generally enclosed in shells, each being provided with a number of separate yolk-cells. In the Acoela and Polycladida the ova themselves may contain yolk-granules, and the eggs are usually laid in clumps surrounded by a gelatinous envelope The ova of triclads are laid, several together, surrounded by amoeboid yolk-cells, in a cocoon, and only a certain proportion of them develop, the others being used as food-material by the survivors.

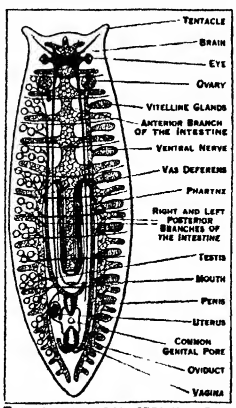


FIG. 3.—GENERAL STRUCTURE OF A TRICLADID TURBELLARIAN. THE THREE-BRANCHED INTESTINE IS CHARACTERISTIC OF THIS GROUP

A form of asexual multiplication occurs in certain rhabdocoels (Microstomidae) and triclads. In the former the body becomes constricted in the middle and forms two complete animals, each of which again subdivides, and so on, until a whole chain of individuals is formed, head to tail, eventually breaking up into separate organisms. In some of the triclads spontaneous fragmentation may occur, with regeneration of the parts to form complete animals. But even forms which at one season reproduce in this manner, do so at another by means of eggs. In certain rhabdocoels (e.g., *Mesostoma*) two distinct types of eggs are produced according to the season. During warm weather the eggs laid are thin-shelled "summer eggs" which develop rapidly, while thick-shelled "winter eggs," whose contents remain longer in a resting condition, are laid in cold weather. In other cases the eggs are apparently similar at all seasons, but develop more rapidly in warm water than in cold Thus in shallow pools subject to sudden and frequent changes of temperature, the population increases rapidly during warm weather, while during cold spells the survival of the race is assured. (*See* PLATYHELMINTHES.) (H. A. B.)

TURBERVILLE (or TURBERVILE), **GEORGE** (1540?–1610?), English poet, second son of Nicholas Turberville of Whit-church, Dorset, belonged to an old Dorsetshire family, the D'Urbervilles of Thomas Hardy's novel, *Tess.* He became a scholar of Winchester college in 1554, and in 1561 was made a fellow of New college, Oxford In 1562 he began to study law in London, and gained a reputation, according to Anthony à Wood, as a poet and man of affairs. He accompanied Thomas Randolph in a special mission to Moscow to the court of Ivan the Terrible in 1568. Of his *Poems describing the Places and Manners of the Country and People of Russia* (1568) mentioned by Wood, only three metrical letters describing his adventures survive, and these were reprinted in Hakluyt's *Voyages* (1589). His *Epitaphs, Epigrams, Songs and Sonets* appeared "newly corrected with additions" in 1567 In the same year he published translations of the *Heroycall Epistles* of Ovid, and of the *Eglogs* of Mantuan (Gianbattista Spagnuoli, called Mantuanus), and in 1568 *A Plaine Path to Perfect Vertue* from Dominicus Mancinus. The *Book of Falconry or Hawking* and the *Noble Art of Venerie* (printed together in 1575) may both be assigned to Turberville. He probably died before 1611.

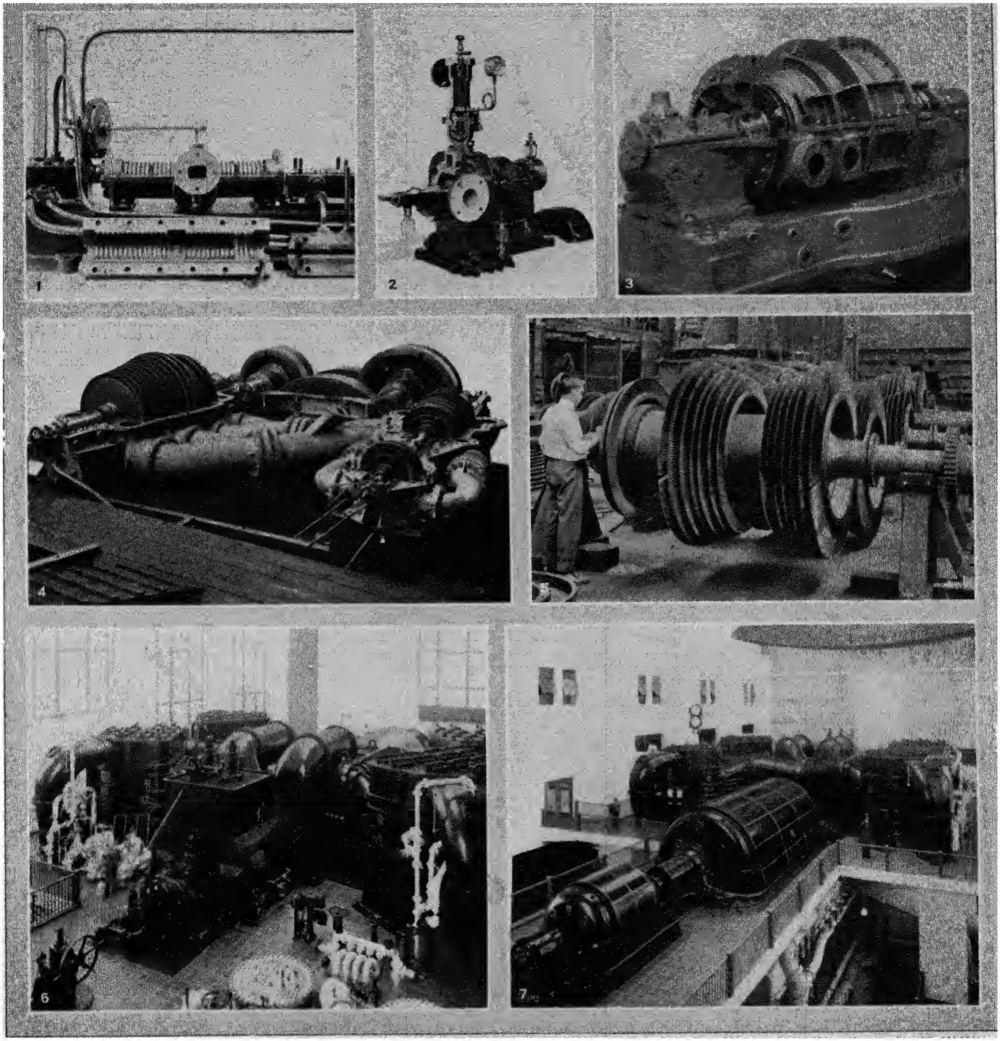
TURBET I HAIDARI, a town in the province of Khurasan in Persia, situated at an elevation of 4,400 ft, about 76 m S of Meshed, on the motor road to Duzdab, via Qain and Birjand A centre of many roads, the town is surrounded by a dilapidated bastioned wall, but the better houses are found outside In the north-east are the ruins of an old citadel, or the Ark of Ishaq Khan; but the principal feature of the town is its bazaar formed of four dome-vaulted streets radiating from a larger central dome Before the famine of 1871, Turbet i Haidari was populous, but the population was, it seems, reduced by 20,000. The town had recuperated before the World War owing to increased trade between Russian Turkistan and Afghanistan; since then there has been a decline and the latest estimate (1900) gives a population of 5,000 only, chiefly of Turki Qarai stock, who were settled there by Timur in the 14th century, but many of the merchants and artisans are Yazdis The surrounding district is very fertile and much wheat and barley are sent to other parts The chief trading activities are wool-buying, silk production (now greatly declining), carpet buying from the Baluch nomads round about, and the making of copper utensils

The town, formerly known as Zavah, derives its name from the *turbeh,* or tomb, of a holy man named Qutb ud Din Haidar, the founder of the ascetic sect of dervishes known as Haidaris, who died *c.* 1230 and is buried in a domed building just outside the town.

TURBINE: STEAM. A turbine is a rotary motor in which the shaft is rotated steadily in its bearings, not by means of cranks as for example in a reciprocating engine (*q.v.*), but by a current of water, air, steam or any other fluid. Thus a steam turbine is a "prime mover" which generates motive power in the same manner as the familiar country-side "wind mill," which is used for grinding corn or pumping water. Instead of a current of air being used to rotate the shaft by means of "sails" as in a "windmill," a current or blast of steam issuing from a number of fixed nozzles, is employed to rotate the shaft of a steam turbine by means of "vanes," "buckets" or "blades."

The relatively small power obtainable from the wind with a reasonable sail area, and the discontinuity of the breeze, render the windmill of comparatively little economic importance, but with the steam turbine on the other hand, the matter is very different. Not only is there the convenience of uniform rotary motion applied to a shaft direct, but also the powerful and unfailing steam blast generated with coal or oil fired boilers, and the enormous power output obtainable from a turbine of very moderate dimensions.

The economic value of the steam turbine has, therefore, been



BY COURTESY OF (1) SIR CHARLES A. PARSONS, K.C.B., F.R.S., (2, 3) THE SCIENCE MUSEUM, LONDON, (4, 5) THE MARINE ENGINEERING AND SHIPPING AGE, (6, 7) THE GENERAL ELECTRIC COMPANY (U.S.A.)

DEVELOPMENT OF THE STEAM TURBINE

1. Parsons' original 10 h.p. steam turbine with top of casing removed. Built in 1884, this type, by the utilization of Parsons' principle of "pressure compounding," opened up an unlimited field of utility for the steam turbine. The original is in the Science Museum, London
2. De Laval steam turbine built in 1889, after several years of preliminary research. Sectional view reveals the single wheel, about 5 in. in diameter, which rotated at approximately 30,000 revolutions per minute
3. Model of Rateau steam turbine built in 1896. Section shows internal construction
4. Engine of S.S. "Scythia," and the double, reduction geared turbine unit with top housing removed to show turbine rotors and gears. It is designed to develop 6,250 h.p. at the shaft
5. Turbine rotors in process of assembly at a large plant
6. General Electric 94,000 kilowatt tandem compound turbo-generator set at the Long Beach station of the Southern California Edison Company, Los Angeles. This view shows the high-pressure unit in the foreground with the low-pressure unit towards the rear, connection from one to the other being effected by means of the two steam headers shown
7. The turbo-generator of fig. 6 viewed from the generator end. The space underneath the unit houses the auxiliary equipment

the incentive to its development to the utmost, and its evolution has been carried out in the face of all obstacles,—a story worthy of an epic of mechanical engineering—for many years almost entirely owing to the efforts of the Hon. Sir Charles A. Parsons, O.M., K.C B., etc., and his associates and in more recent years by a host of other workers as well.

General Mechanical Features.—In the steam turbine, in which a pure twist or driving torque is the only force applied to the shaft, the entire mechanism may be described under the following six headings

(1). The system of "blading" by means of which the motive power is produced. The term "blading" (as distinct from "blades") is used to denote collectively the fixed nozzles and the rotating "vanes" or "blades"

(2). The rotating shaft, or "rotor," which carries the rotating elements of the blading, and collects and transmits the driving torque.

(3). The casing, which carries the nozzles or fixed elements of the "blading," balances or provides the reaction to the driving torque (*see* torque tube in a motor car), and embodies the supports or bearings for the rotor

(4). The speed regulating mechanism

(5). The lubricating system for the bearings

(6). The coupling between the rotor and the apparatus intended to be driven by it

The blading may consist of a set of fixed nozzles (*see* fig 1) directing high-velocity steam jets on to "vanes" or "blades" mounted round the rim of the wheel If there were no blades or other obstructions in front of the steam jets, the latter would travel forward in a straight line. The curved surfaces of the blades, however, forcibly deflect the jets from the free path, the blades themselves receiving in consequence an "impulse" in the direction opposite to the deviation which they produce Hence the name "impulse turbine" applied to a turbine of this kind The steam jets in passing through the blade passages and doing work on the wheel, will be continuously slowed down and will leave the moving blades with a velocity much less than the initial

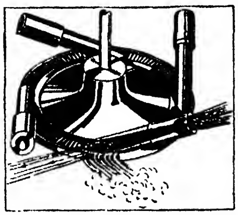


FIG. 1—DE LAVAL WHEEL AND NOZZLES SHOWING DEVIATION OF THE STEAM JETS BY THE BUCKETS

Special Difficulty of the Problem.—Such a very simple arrangement (the counterpart of the well-known Pelton water wheel for utilizing waterfalls) although widely adopted for small powers, is not applicable to large powers

The underlying reason for the unsuitability of the simple steam-wheel as compared with the water wheel is to be found from a comparison of the physical properties of steam and water Water is an in-elastic fluid; that is, it has practically the same density (weight per cubic foot) at all pressures, and in a water turbine, the water jet velocity generated by a given fall in pressure is determined from the static head corresponding to that pressure. If h is the height of a column of water, the difference of pressure between the top and the base of the column is that due to the weight of the water in the column pressing on an area equal to the sectional area at the base. Denoting this sectional area by A then hA=the volume of the water, the weight of the column ρh A, and p, the pressure per unit area at the base, $=\rho h$ where ρ is the density or weight per unit volume.

The jet velocity due to such a head of water is the same as that acquired by a body falling freely through the height h under gravity viz, $\sqrt{2gh}$ thus $V^2=2gh=2g\left(\frac{p}{\rho}\right)$. Each pound of water coming in at the top of the column and discharged at the base with velocity V has lost potential energy gh and gained an equivalent amount of kinetic energy $\frac{1}{2}V^2$. This is the energy per pound which would be available for use in a water turbine.

The static head of water corresponding to a pressure of 265 lb. per sq. inch would be 610 feet and the velocity due to this head 198 feet per second

With a fluid of less density, a longer column would be required in order to have the same pressure at the base. In other words the same pressure would then correspond to a greater static head. Considering steam at, say, 265 lb per sq. inch and a temperature of 700° F, the density of the steam is $\frac{1}{160}$ of that of water and it would therefore require at that density a column 160 times the height to give the same pressure, or $160\times610=97,600$ ft. But this is not all. Steam, in contrast with water, is a highly elastic fluid, and the effective head in steam would be even greater than 97,600 ft., because of the expansion in volume which takes place as the pressure falls. During this process, successive decrements of pressure, associated with successively decreased density, contribute increasing amounts to the static head (figure 2c.). As a consequence of the expansion the fluid cools down considerably, and the actual head is therefore the height of a column of steam at varying density (and temperature); the pressure at any point of the column is that due to the weight of the steam above it and the density at that point is the density corresponding to such pressure. Such a column of steam with a pressure at its base of 265 lb. per sq inch and a pressure at the top of $\frac{1}{2}$ lb. per sq. inch (measured from zero pressure or an absolute vacuum) would have a height of 365,000 feet (It should be noted that pressures measured from zero pressure [or an absolute vacuum] are designated absolute pressures A pressure below atmospheric is expressed either as an absolute pressure or as a vacuum, by which is meant the defect below atmospheric pressure Thus if the barometer reading is 30″ of mercury then a perfect vacuum would be called a vacuum of 30″ of mercury; and a vacuum of, say, 28″ of mercury is less than a perfect vacuum by the pressure corresponding to 2″ head of mercury.) This therefore is the value of the effective static head of steam when allowed to expand between these pressures

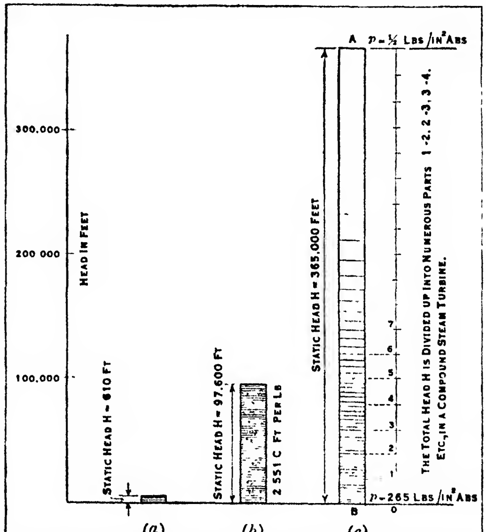


FIG 2—COMPARISON OF WORKING "HEAD" FOR A WATER TURBINE AND A STEAM TURBINE RESPECTIVELY

Thus the static head h of an expanding fluid can be considered as the height of a column of the fluid at its natural density, that is to say, of a density diminishing from the base upwards just in the same manner as the atmospheric pressure decreases with altitude.

The potential energy gh is then available as before (*i e*, as in the water turbine) for conversion into kinetic energy $\frac{1}{2}V^2$ of the resulting steam jets. The velocity corresponding to a head of 365,000 feet, however, is 4,800 feet per second, and it can easily

be understood therefore that a construction suitable for utilizing the energy of water jets with a speed of 198 feet per second is not suitable for steam in which the available energy per pound corresponds to a jet speed of 4,800 feet per second

Figure (2) is a diagrammatic comparison of the effective static heads above considered, shown as columns of fluid having a pressure of 265 lb per sq inch at the base (a) shows the height of such a column of water, (b) that of a fluid at the uniform density which steam has at 265 lb per sq inch pressure, and (c) that for steam at its natural density.

Actually, of course, the head of steam for a steam turbine is not obtained by means of a vertical column, but by generating steam under pressure in a boiler

This does not alter matters, however, for imagine a steam boiler, generating steam at 265 lb. per sq inch absolute, to be connected to the base of the column (c) in figure (2) Then evidently the steam will rise up the column, falling gradually in pressure and temperature just as it would do in a turbine, and at an altitude of 365,000 feet it would leave the top of the column as exhaust steam at ½lb/in² absolute (assuming the external atmosphere absent) Where has the energy originally in the high pressure steam gone? Clearly it is in the gravitational potential energy of the steam raised to the top of the column. In whatever manner the head is generated, the stored energy per pound of fluid is the same. This energy, namely Sum $\frac{p}{\rho_1}$ has been calculated for steam from an experimental knowledge of its properties, and is tabulated for the use of engineers. it is, however, usual to express it in heat units instead of mechanical units, the two being strictly equivalent (*See* THERMODYNAMICS)

Table I gives the theoretical values for the velocity attainable by allowing high pressure steam to escape through a suitably shaped orifice or nozzle, to a place at lower pressure

TABLE I—*Theoretical Velocity of Efflux of a Steam Jet*

Steam pressure lb/in.² abs (dry saturated)	Velocity into atmosphere Ft/sec	Velocity into vacuum of 28" mercury (baro 30") Ft/sec
10		2,677
15		2,900
30 .	1,002	3,263
50 .	2,108	3,510
75 .	2,425	3,671
100 . .	2,645	3,804
125 .	2,777	3,905
150 . .	2,900	3,983
175 .	3,000	4,050
200 .	3,075	4,100
250	3,207	4,190

The Simple Steam "Windmill" of de Laval.—The practical difficulty in utilizing such high velocity steam jets efficiently in a "simple" steam turbine will soon be apparent Simple mathematical theory shows, and experiment confirms, that the proportion of energy in a jet of steam which can be converted into useful work on the turbine shaft, depends mainly on the relation which is made (by the designer) to exist between the linear velocity C_1 of the "vanes" or "blades," and U that of the jets impinging on them In other words, the efficiency of a turbine depends mainly on the ratio called the "velocity-ratio," $\frac{U}{C_1}$, usually denoted by the symbol α. Figure 3 shows a curve (A) of the "blading" efficiency obtainable from a "simple" turbine of the type shown in figure (1). Losses due to windage, eddies and friction in the turbine itself, and to friction of bearings, etc, will absorb some of the power developed, so that the "brake" efficiency at the driving end of the shaft will be considerably less.

Here it may be noted that the expression "efficiency of a turbine" must be carefully understood, as it is liable to misinterpretation. If the energy of the steam jet is, say A units of work and out of this the turbine usefully delivers B units to the coupling at the driving end, then the brake efficiency of the turbine is $\left(\frac{B}{A}\right)$. A however, may have very different values, according to the steam conditions. The more favourably chosen the steam conditions are, the greater fraction A may be made of the total latent energy E in a lb. of coal or oil fuel. In

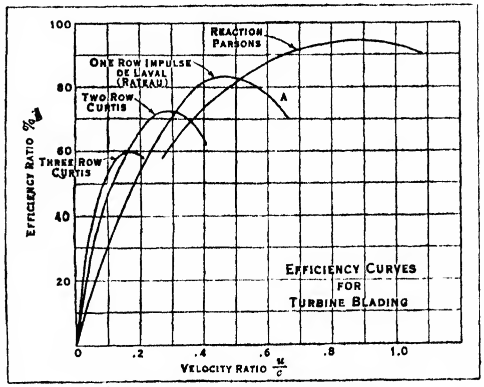


FIG. 3.—CURVES OF EFFICIENCY BLADING

other words, the net efficiency of the whole plant (boilers and turbine) is $\frac{A}{E} \times \frac{B}{A} = \frac{B}{E}$. The important point to be realized is that whilst $\frac{B}{A}$ may be and generally is, in a large modern turbine, about 85%. on the other hand $\frac{A}{E}$ does not even in the very best plants exceed about 36 0% so that the overall efficiency is about $(0{\cdot}36 \times 0{\cdot}85) \times 100 = 30{\cdot}5\%$ from fuel to brake horse power. This comparatively low figure is not due to imperfections in the plant owing to incorrect design, but to a fundamental law of thermo-dynamics which places a limitation on the thermo-dynamic efficiency of any engine, however perfect, designed to convert the heat of fuel into motive power For further information upon this aspect of the problem of the utilization of the heat energy in fuel, *see* THERMODYNAMICS

To resume, it will become apparent from fig 3 that the best efficiency for this type of blading is obtained at a "velocity-ratio" of about 0·45, that is to say, when the velocity of the blades is about half the velocity of the steam jets Referring to Table I. it will be observed that with an ordinary boiler pressure of, say, 175 lb/in.² absolute, and a final exhaust pressure of 1 lb/in² absolute, the jet velocity is of the order of 4,000 feet per second. If the blade velocity is to be 0 45 of this, it will be about $(0{\cdot}45 \times 4{,}000) = 1{,}800$ ft. per sec

The centrifugal forces on a turbine wheel and blades operating at this mean blade velocity will be very great, and the consequent centrifugal stresses also A rim speed of 1,800 feet per sec. would be that of a 10" wheel revolving at 41,000 revolutions per minute. The maximum stress in a disc at this speed would be of an order which is not practicable so that a turbine consisting of a single wheel can only have a poor velocity ratio, and is only suitable for small outputs for which efficiency is of secondary importance The speed of revolution is necessarily high, and such turbines have therefore to be coupled to the machines they drive through some form of speed-reducing gear, usually of the mechanical type, with double helical gear wheel teeth.

The "simple" type of steam turbine or steam "windmill" was first perfected by the great Swedish Engineer Gustav C. P. de Laval in 1887 after several years of preliminary work. It ranks as a great achievement inasmuch as, within the limitations just described, it is a perfectly practical solution of the problem, worked out moreover in days when reliable data on the proper-

ties of steam were practically non-existent.

Velocity Compounding of Steam Turbines.—If the mean blade speed of a simple steam "windmill" such as the de Laval, is less than about half the circumferential velocity of the steam jets, the latter will not be slowed down sufficiently in the space following the moving blades, and some of their energy will be wasted. In other words, the velocity of the steam will not be

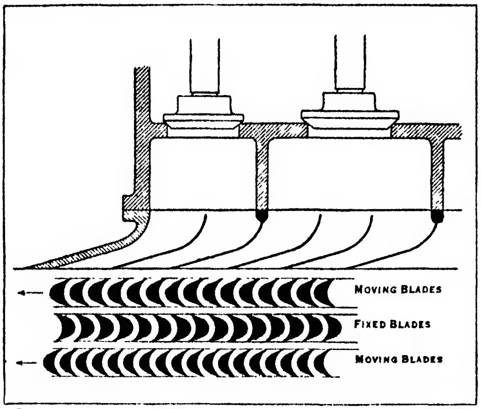


FIG 4.—VELOCITY COMPOUNDING—NOZZLES AND MOVING BLADES

a minimum In order to provide means for recovering the energy in the residual velocity, about the year 1898, Curtis developed in the United States of America a system known as "velocity compounding" In this arrangement he fitted additional guide blades to re-direct the steam on to further rows of moving blades. Figure 4 illustrates a series of such additional rows The characteristic feature is that the fall in steam pressure is confined to the nozzles, the steam flowing through the remaining blades at constant pressure, but with ever diminishing velocity, because of the energy absorbed by the wheel and transmitted to the turbine coupling. It might be supposed these rows could be made sufficiently numerous to extract the whole energy economically in a single pressure stage, *i e*, that pressure compounding would be unnecessary Unfortunately, however, reversal of the direction of the motion of steam at high velocity is accompanied by loss of energy and this, together with frictional losses, soon imposes a limit to the number of reversals which can be efficiently employed. The "two-row" Curtis wheel has been employed widely but the 3-row Curtis wheel is so inefficient that it is now seldom used except in small auxiliary turbines or sometimes in marine astern turbines where efficiency is less important

Parsons' Master Principle of "Pressure Compounding."—The application of steam turbines on these lines could never, owing to the limitations described above, become general, and the master invention which has opened up an unlimited field of utility was supplied in 1884 by Sir Charles A Parsons.

The high efficiency already attained by water turbines (*q v*) operating under very moderate "heads" of water, made it seem to him possible that if a number of "simple" one wheel steam turbines were placed in series on the same shaft, one turbine exhausting its steam into another, and so on, it would be practicable to divide up the energy of expansion of the steam over a number of such "elementary" turbines so that the effective "head" of steam (in other words, the amount of expansion) in each would be small.

Thus, since the velocity of efflux of the steam jets in each "simple" turbine of the series would be correspondingly reduced, the latter would operate under conditions more analogous to the water turbine, that is with moderate and practical blade speeds, in conjunction with high "velocity-ratio" and high efficiency.

This fundamental concept was subjected to practical test by Parsons in a turbine of his own design at Gateshead-on-Tyne, England, in 1884, and has since proved to be the only solution. In fact, this principle of "pressure-compounding" or using several "simple" turbines in series is an essential feature of *all* modern steam turbines of large output and high economy, because it permits reasonable blade velocities to be adopted, without sacrifice of efficiency (Parsons' original 10 h p steam turbine and dynamo may be seen in the Science Museum, South Kensington, London)

Application of Parsons' Principle.—The application of this principle may best be grasped by considering its application (at

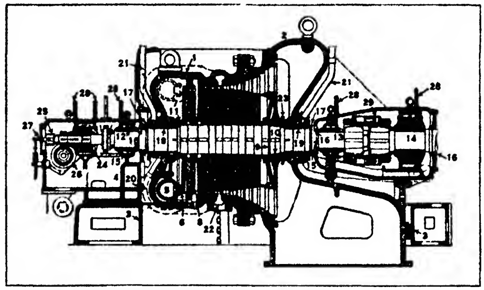


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FIG 5 —MODERN COMPOUNDED DE LAVAL TURBINE BY RATEAU

1. Cylinder casing, 2 Exhaust end of casing; 3. Bedplate; 4. Bearing casing; 5. Steam inlet belt; 6. Nozzle ring; 7. Diaphragms; 8. Bladed wheels; 9. Shaft collar; 10. Distance piece; 11. Locking nut; 12. No. 1 bearing; 13. No. 2 bearing; 14. No. 3 bearing; 15, 16. Oil baffles; 17. Oil throwers; 18 No 1 gland; 19. No. 2 gland; 20. Leak off pipe from 18; 21. Vapour pipe; 22 Steam extracting belt; 23. Locking nut; 24. Segmental thrust and adjusting block; 25. Shaft runaway governor; 26. Worm and wormwheel for driving speed-regulating governor; 27. End gauge; 28 Oil temperature thermometer; 29. Flexible claw coupling

a later date) to the simple turbine of de Laval Figure 5 gives a diagram of a modern turbine of this kind, associated chiefly with the name of Rateau, who developed it from about the year 1896 The turbine consists of a series of de Laval wheels or steam "windmills" all mounted on the same shaft, each wheel being placed in a compartment. High pressure steam is admitted to the first wheel of the series through suitable nozzles (Figure 6.) In the partition dividing the first wheel from the second wheel there is a second set of nozzles so proportioned as to maintain a suitable back pressure in No 1 compartment and not allow the steam to escape from it too freely By thus limiting the drop of pressure from boiler pressure to that in the first compartment, the steam velocity generated in the first set of nozzles can be adjusted to any desired value and consequently also the resulting jet velocity.

The passages which form the exhaust or exit ports from the first wheel are actually nozzles delivering the steam in the form of jets on the second wheel of the series. In the succeeding wheels the same procedure is followed over and over again, the initial steam pressure being thus reduced by appropriate steps until finally the exhaust at exit pressure is reached in the last wheel From a correct knowledge of the properties of steam and of the losses which occur due to friction and eddies, it is possible to choose the proportions of the nozzles so that every wheel of the series operates at a proper velocity-ratio

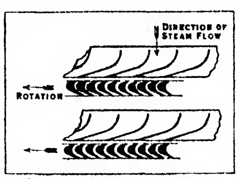

FIG 6 —DE LAVAL (RATEAU)

Difficulties Attending Pressure Compounding.—There are certain unavoidable losses encountered in the practical utilization of the Parsons principle of pressure compounding.

It will be seen from fig. 5 that there are places in a "compound" turbine where serious leakage can take place, viz round the periphery of the shaft where it passes through the "diaphragms" separating one wheel from another, and also at each end of the shaft where it passes into the outer atmosphere

The necessary surface speeds in successful steam turbines are so high that generally speaking leakage cannot be entirely stanched

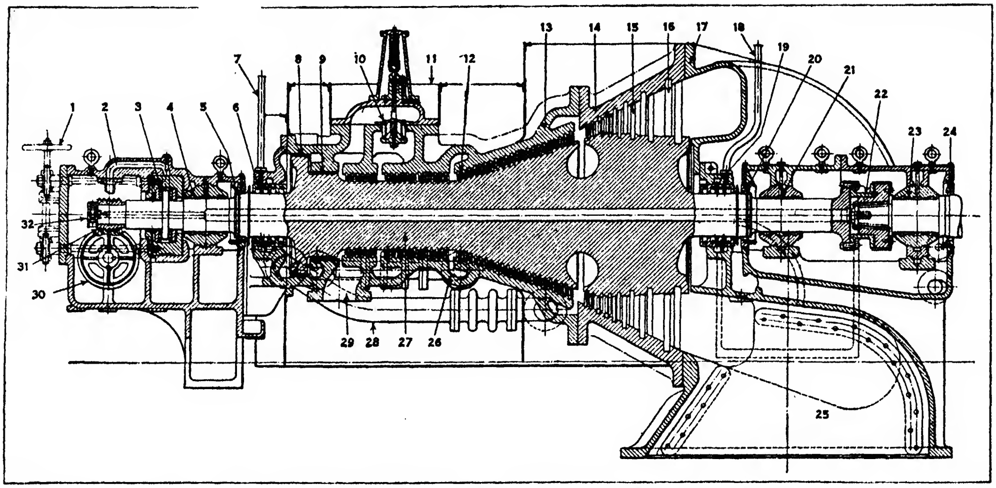

FIG. 7.—LONGITUDINAL SECTION THROUGH SINGLE CYLINDER REACTION TURBINE
1. Handwheel for cylinder thrust block adjusting gear; 2. Oil discharge from thrust to worm wheel; 3. Thrust block; 4. No. 1 bearing; 5. Oil baffles; 6. Carbon segment neck; 7. Vapour pipe; 8, 9. Dummy pistons; 10. Overload byepass D.B. Valve (operated from steam chest); 11. Cylinder cleaning; 12. Reaction blading "End tightened" type with large radial clearance; 13. Cast steel centre portion of cylinder; 14. Cast iron portion of cylinder; 15. Reaction blading "ordinary" (radial clearance type); 16. Reaction blading "Ordinary" (special twisted); 17. Cast-iron exhaust portion; 18. Vapour pipe from no. 2 gland; 19. Carbon segment neck gland No. 2; 20. Oil baffles; 21. No. 2 bearing; 22. Flexible claw coupling; 23. No. 3 bearing; 24. Oil baffles; 25. Cylinder exhaust; 26. Equalising pipe from No. 1 dummy to blading; 27. Turbine shaft; 28. Equalising pipe from No. 2 dummy to blading; 29. Main steam inlet; 30. Worm for driving governor; also tachometer and oil pump through bevel gearing; 31. Worm driving No. 29; 32. Shaft governor

by any form of packing which involves actual rubbing contact, on account of the great frictional heat that would be generated. It follows therefore, that such leakage, if it cannot be altogether suppressed, must be reduced to a minimum by the use of fine working clearances. Thus all compound turbines, of whatever design, have fine clearances in certain parts, such fine clearances being essential to steam economy.

The early pioneer work of Sir Charles Parsons was carried out against considerable obstacles. For 13 years after 1884, no notice whatever of his efforts was taken on the continent of Europe.

In dealing with the problem of the reduction of steam leakage, Parsons originated two principles, namely, that where the relative motion between two surfaces is very great and it is desired to limit the fluid or gaseous leakage between them as between the rotating shaft and the fixed casing,

(1) One of the surfaces should be provided with thin edges or so-called "contacts";

(2) Both surfaces must be serrated, *i.e.*, given an interrupted contour in the direction of the pressure gradient.

The first is necessary in order to make it possible to limit the leakage area through which steam can escape, that is to say, to enable the two surfaces to be run close up to one another at suitable points, without danger of irreparable damage, in the event of accidental contact.

The second is necessary in order to limit further the leakage by compelling the steam to flow in a tortuous path.

In another well-known form of packing, which is said to have been originated much later in Germany, rings of graphite or carbon are placed round the shaft. Each ring is cut up into several segments, and all are held together by a "garter" spring. A pin projects into the fixed turbine casing on one side in order to prevent the carbon ring being carried round with the rotating shaft. The carbon ring does not actually seal the shaft against all leakage; if it pressed sufficiently hard on the shaft to do so it would rapidly become overheated, as explained above. In practice, the length of the individual segments is made such that when they are pressed together butt and butt by the garter spring they are just clear of the shaft, and a thin film of leakage steam separates them from actual contact.

Parsons' Compound Reaction Steam Turbine.—Although Parsons' master principle of pressure compounding has since its introduction been applied to all types of modern efficient turbines, there is another distinctive feature of design which he introduced in 1884 and which renders his steam turbine different from all others, with the one exception of the Ljungstrom (1912). This feature (*see* fig. 7) is the use of blades which give a nozzle shape to the spaces between them in both the fixed and rotating elements of the turbine (fig. 8). In the modern "reaction" turbine, in fact, the efficiency of the "blading" is practically equal to that of well-formed nozzles. It has therefore a higher intrinsic efficiency than "impulse" blading, because in the latter there are losses due to friction in the moving blades in addition to the losses in the nozzles.

As will be made evident later, in a Parsons reaction turbine, the function of the fixed nozzles is to bring the steam jets smoothly into the moving nozzles and the turbine is driven or rotated almost entirely by the reaction of the steam jets issuing from the moving nozzles. Hence the name "reaction turbine." This reaction is analogous to that of machine guns. The moving blades themselves in a reaction turbine represent the guns which receive a continuous backward "kick" or "reaction" from the shots fired from them, causing them to recoil in the opposite direction.

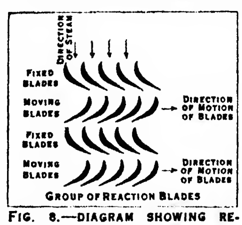

FIG. 8.—DIAGRAM SHOWING REACTION BLADING

Features of Reaction Blading.—A further source of leakage occurs in the reaction turbine from the fact that the rotating blades are themselves nozzles, so that there is a drop of pressure in them just as occurs in the fixed nozzles or "guides." Steam will therefore tend to leak past the clearances of each. To minimize this, many makers prefer to use the Parsons practice of 1906, in which the tips of the blades are thinned down almost to a fine edge, so that fine radial clearances can be used without risk of serious damage in case of accidental contact (*see* figs. 9, 10).

The most modern form of Parsons reaction blading however is shown in fig. 10. This is known as "end-tightened" or axial-clearance reaction blading. It will be seen that the clearance in the radial direction is large, giving mechanical safety. The blades are fitted with shrouding having an overhanging sharp edge in close proximity to the roots of the blades of the adjacent row. The axial clearances between the edge of the shrouding and the blade-roots are adjustable by endwise motion of the rotor, and because of the positive nature of the control of the end-position of the "rotor" by the thrust block, the axial clearances can be made small with greater safety.

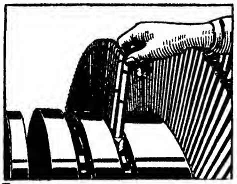

FIG 9 —RADIAL CLEARANCE—REACTION BLADING

Another feature of reaction blading, due to the pressure drop over the moving blades, is the evident existence of an unbalanced steam thrust on every row of the latter. There is also a steam pressure gradient along the rotor so that this also contributes to a resultant steam thrust on the rotor and its blading of considerable magnitude in a direction down the turbine, *i.e*, towards the exhaust end. This resultant thrust may amount to several tons and may be too heavy to carry entirely on the thrust bearing Parsons therefore uses dummy pistons to balance the end thrust by receiving steam pressure in the opposite direction. One such piston could be made to balance the whole, but in order to ensure proper control of the end pressure at all loads and under all conditions it is usual to use two or more dummy pistons, each connected to that portion of the rotor blading which it balances, by means of large bore equalizing pipes. Sometimes the low pressure dummy piston is omitted and the residual end thrust carried by the thrust bearing This practice saves the steam leakage past the low pressure piston and thus improves the economy.

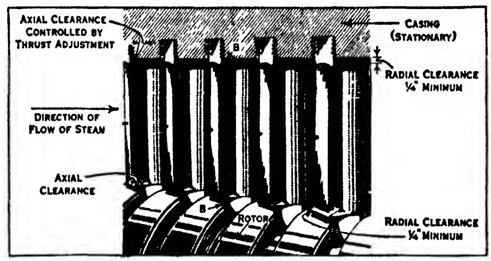

FIG. 10.—END-TIGHTENED REACTION BLADING

Ljungstrom Compound Reaction Steam Turbine.—With few exceptions, modern turbines are built as axial-flow turbines with horizontal shafts In the Ljungstrom turbine, a constructional peculiarity is that the steam is made to flow radially outwards In addition, instead of having alternate rows of fixed and moving blades, the guide nozzles are themselves allowed to rotate, but in the opposite direction, so that it is the same in effect as if the casing of a Parsons turbine were allowed to revolve in a direction opposite to that of the shaft or rotor The blades are attached in concentric rings to two discs, mounted on shafts with a common horizontal axis, revolving in opposite directions, and driving separate dynamos.

Differences Between Impulse and Reaction Turbines.—The names "impulse" and "reaction" turbines mentioned above, are more popular than scientific, and it is important to possess a clear idea of the fundamental constructional difference in design which places a turbine in one or other category.

A comparison of the longitudinal section of a modern axial-flow horizontal impulse turbine (fig. 5) with that of a similar modern reaction turbine (fig. 7) shows that speaking generally the former is characterized by the presence of definite compartments or cells in which each row of blades revolves, while in the latter the compartments are virtually non-existent. This difference, however, is a matter of expediency for the particular type of blading adopted, and is not a matter of fundamental design. There is no theoretical reason why impulse blading should not be arranged on a barrel like the reaction blading in fig 7, or why reaction blading should not be arranged with diaphragms and wheels like the impulse blading in fig. 5. This is an important point to be borne in mind.

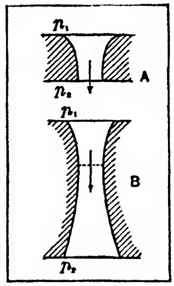

FIG 11 —(A) CONVERGENT NOZZLE PASSAGE AND (B) WITH DIVERGENT OR TRUMPET-SHAPED MOUTHPIECE ADDED

It is not enough merely to say: "this turbine has nozzles in diaphragms followed by a row of buckets, therefore it is an impulse turbine," and "that turbine has no diaphragms but has nozzles in both fixed and moving elements, therefore it is a reaction turbine" The further question arises: "What are the essential characteristics of nozzles, and in what way do buckets or vanes or blades differ from them?"

The fundamental constructional difference lies in the shape of the steam passages or paths between the blades or vanes which are used. The nozzles used in steam turbines to produce the propelling steam jets are always the same in principle, although they may differ considerably in their proportions. There is, that is to say, always a narrowing or "convergent" passage connecting a region of higher steam pressure with a region of lower steam pressure, the change in cross section of the passage (fig 11a) being made gradual in order to obtain high efficiency of conversion of pressure-energy into kinetic or velocity energy

The nozzle may have a divergent extension or "mouthpiece" as in fig. 11b and in turbine design has to be "skewed" at an angle to the plane of the wheel, as in figs. 12a and 12b, but in every case the primary intent is to create a drop in pressure over the two sides of the boundary plate containing the nozzles, and to utilize that pressure drop to produce a steam jet. Having obtained the requisite steam jets, however, the buckets or blades on the rotating wheels are made with the fundamental distinction corresponding to "impulse" or "reaction" design respectively If the blade-passages of the rotating wheels are "parallel" or nearly parallel (*i e.*, non-convergent) as in fig 13 the blading is of the "impulse" type, *i e*, nozzles followed by buckets. If they are passages of diminishing cross-sectional area (*i.e.*, convergent) the blading is of the "reaction" type, fig. 8.

Velocity Diagrams.—As a further aid to an understanding of these fundamental differences, study may be made of a useful graphic representation of the velocity and trajectory of the steam jets in their passage through the nozzles and blades.

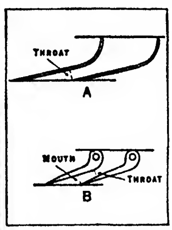

FIG. 12 —(A) SKEWED CONVERGENT AND (B) DIVERGENT NOZZLES

Figure 14a is what is known as a "velocity diagram" for impulse blading, in which "U," the mean circumferential velocity with which the blades are moving in front of the nozzles, is represented by BA OA is the velocity "C," of the steam jet issuing from the nozzles. It will be seen that the blades are running away from the steam jets, so that if it were possible for an observer to be stationed at B (*i e*, going round with the blades) he would see the steam jets apparently coming in the direction OB. OB is, in fact, the relative velocity of approach with which the steam impinges on the blades, and the blade inlet angle at B would be made suitable to receive the steam approaching the blades in this direction.

Passing over the blade-surfaces, the steam jets are deflected out of their paths OA, and shoot off the tails of the blades with velocity CD relative to the blades, which, if frictional losses are neglected, is equal to the relative velocity of entry OB. But as the blades are themselves moving with velocity "U" or ED, the actual path taken by the steam jets at exit, relative to the fixed turbine

casing, will be CE.

It was mentioned previously that the best velocity-ratio for this type of blading is about 0·45; in other words the steam-jet velocity OA must be rather more than twice the mean blade-velocity BA. When this is the case, as will be seen from the diagram the steam finally leaves the wheel with axial velocity CE, which is evidently the minimum, for if it left in the direction C'E' (fig. 14b), it would evidently be greater. When CE is a minimum it is evident that the maximum energy has been extracted from the steam jets, and this occurs when $\frac{U}{C_1}$ is slightly less than one-half.

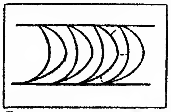

FIG. 13.—IMPULSE BLADING—PRACTICALLY NON-CONVERGENT.

In Parsons' reaction blading, on the other hand, the best velocity ratio is about unity, that is to say, the mean blade-speed has to be nearly equal to the velocity of the steam jets. Thus OA (fig. 15a) represents the steam velocity. Circumferentially, this is equal to BA, the velocity with which the blades are running away from the steam-jets. To an observer at B therefore (moving round with the blades), the steam jets would appear to approach along OB, which is parallel to the axis of the turbine. Now this apparent or relative velocity of approach OB of the steam jets is quite small and further, being axial in direction, exerts no driving force on the moving blades. Hence the statement made that the function of the fixed nozzles is to bring the steam into the moving nozzles smoothly and without shock. Figure 15b shows the diagram when the velocity-ratio is too low.

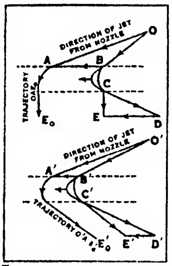

FIG. 14.—VELOCITY DIAGRAMS FOR DE LAVAL OR RATEAU BLADING
(A) Correct velocity
(B) Underspeeded

With either type of blading ("impulse" or "reaction") the ideal condition for theoretical maximum efficiency is reached when the steam leaves the moving blades with a relative circumferential velocity ED equal to the mean blade-speed BA, so that in relation to the turbine casing itself the actual velocity is a minimum, and the maximum energy has been extracted from the steam jets.

Combined Types of Turbines.—The velocity-compounded wheel of Curtis is frequently used for the first pressure stage of a turbine of which the succeeding stages are either of the compound impulse or of the compound reaction type. A two-row Curtis wheel displaces three or four de Laval wheels in series, or alternatively seven or eight pairs of nozzle rings of the Parsons reaction type. Although it has an inherently lower efficiency than single-row de Laval wheels or than reaction blading, its use has been justified by some designers on the grounds that at the high-pressure end of a turbine the efficiency of the latter is considerably reduced by steam leakages or windage losses, or both so that the net efficiency of the two-row Curtis is not much inferior.

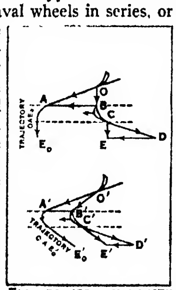

FIG. 15A, 15B.—VELOCITY DIAGRAMS FOR PARSONS' REACTION BLADING
(A) Correct velocity
(B) Underspeeded

Recently, however, in land turbines there has been a return to the use of the Parsons principle alone, the whole turbine, that is to say, being built up of simple pressure stages only (either of the de Laval or of the Parsons type), without any velocity-compounding.

The large number of such stages required for high efficiency led Parsons as long ago as 1899 to divide up the casing into two separate "cylinders" or separate turbines, coupled together in line and driving the same dynamo. Parsons used three separate cylinders in series on the steam-flow for the triple-shaft steam yacht "Turbinia" in 1897 (to be seen in the Science Museum, South Kensington, London).

In modern land practice for the generation of electricity on a large scale in central power-stations, the two-, or even three-cylinder turbine is widely used and in some continental examples even four separate cylinders have recently been adopted as a means of securing the highest efficiency, having regard to the ever increasing initial steam pressures and temperatures that are now being favoured.

Present Position of the Steam Turbine.—Essentially a high-speed prime-mover, the steam turbine in the early days of its development was unsuited to drive machinery which must run at a moderate or low speed of revolution. Such machinery might be grouped under the following headings:—

(1). Direct current dynamos.
(2) Paper mills, Jute mills, Textile mills.
(3). Screw propellers for marine propulsion.

The development by Parsons in 1910 of the small double-helical speed-reducing gears of de Laval, so as to be suitable for transmitting large powers, has permitted complete freedom of choice with regard to speeds, so that the steam turbine can now be applied to the driving of anything in which continuous rotary motion is required. The design of the earlier marine installations was largely a matter of compromise between the high speed of revolution required for the turbine and the much lower speed which was more suitable for the propeller. Since the introduction of mechanical gearing, the marine turbine has tended to become assimilated in type to the land turbine, the same conditions for high thermal efficiency, namely, high velocity ratios, high steam pressures and temperatures, and lowest possible exhaust steam pressures being equally applicable.

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(R. Do.)

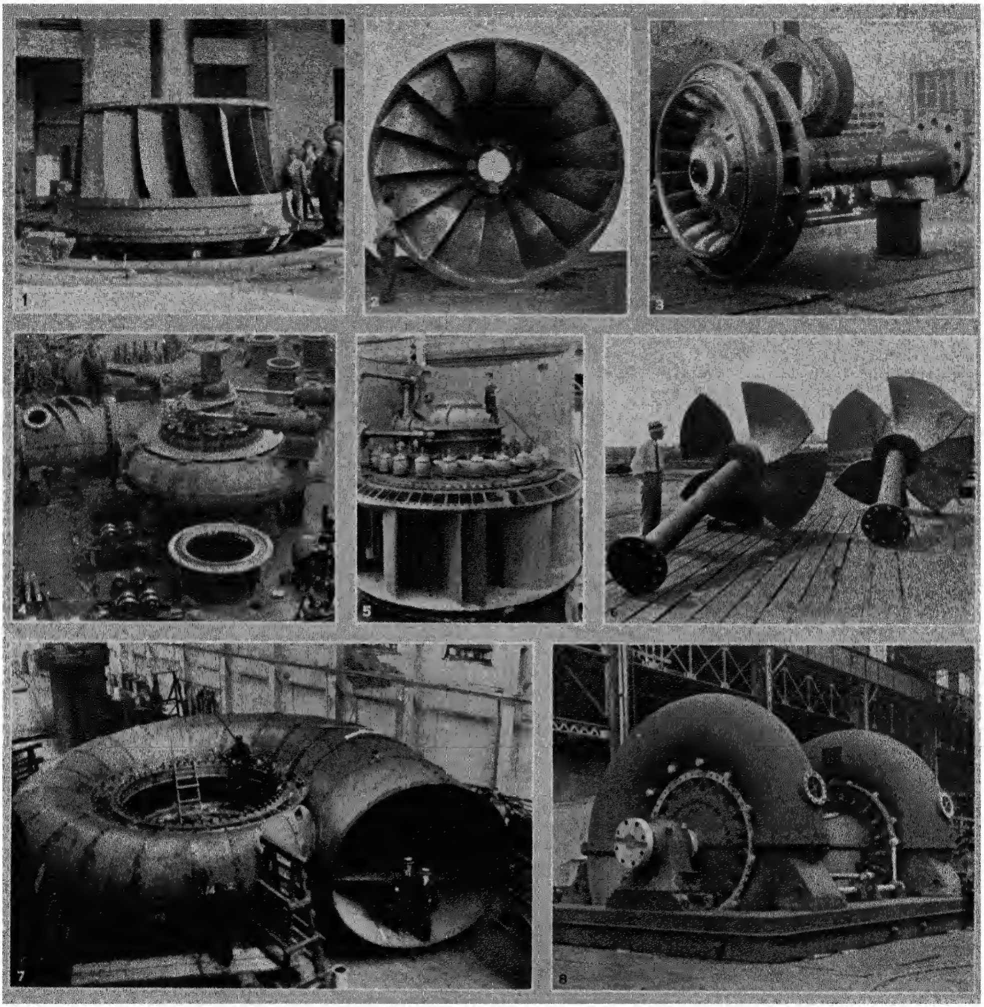
TURBINE: WATER.

Modern hydraulic turbines may be divided into two classes, impulse, and pressure or reaction turbines. Of the former the Pelton wheel, and of the latter the Francis turbine or one of its modifications, are the only types used in recent important installations.

In an impulse turbine, the whole head of the supply water is converted into kinetic energy before the wheel is reached. The water is supplied to the wheel through a nozzle which delivers a high velocity jet at atmospheric pressure on to the vanes or buckets mounted on the periphery of the wheel.

In the pressure or reaction turbine, the wheel or runner is provided with vanes into which water is directed by a series of guide vanes extending around the whole periphery. The water on leaving these guide vanes is under pressure, and supplies energy partly in the kinetic and partly in the pressure form. In its passage through the runner the pressure energy is utilized in increasing the relative velocity of flow between the vanes, and the water finally leaves the runner at the pressure obtaining in the discharge pipe or draft tube.

In the earliest of these turbines, the Fourneyron, the guide vanes were inside the runner, and the water flowed outward. This was followed by the Jonval turbine, in which the guide vanes are



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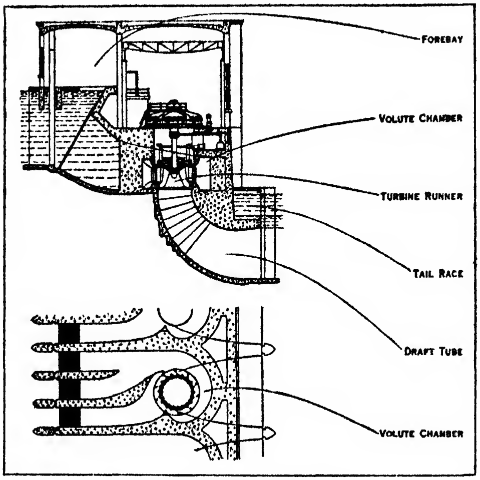
WATER TURBINE

1. Rotor for 35,000 h.p. medium-head turbine at Muscle Shoals, Alabama. Head, 92 feet. Speed 100 revolutions per minute. Built in 1925
2. Discharge end of medium speed turbine runner
3. Runner for 35,000 h.p., high-head turbine of the Southern California Edison Company. Head, 740 feet. Speed, 428 revolutions per minute. Built in 1923
4. Shop assembly of the turbine to which the runner of fig. 3 belongs, showing steel plate spiral casing
5. Shop assembly of turbine to which runner of fig. 1 belongs, with concrete spiral casing removed, showing stationary vanes
6. Propeller type, low-head, 4,800 h.p. runners of the West Florida Power Company's plant. Head, 32 feet. Speed, 150 revolutions per minute. Built in 1928
7. Shop assembly of a steel plate, spiral casing for a 22,000 h.p., medium-head turbine of the Rochester Gas and Electric Company, Rochester, N.Y. Head, 130 feet. Built in 1927
8. Twin horizontal medium-head 13,400 h.p. turbine with cast-iron spirals. Head, 180 feet. Speed, 1,875 revolutions per minute. Built in 1913

above the runner and the water flows axially into and through the wheel. Both types are now obsolete, and one or other modification of the Francis or inward-flow turbine, in which the guide vanes surround the outer periphery of the runner, is now in general use.

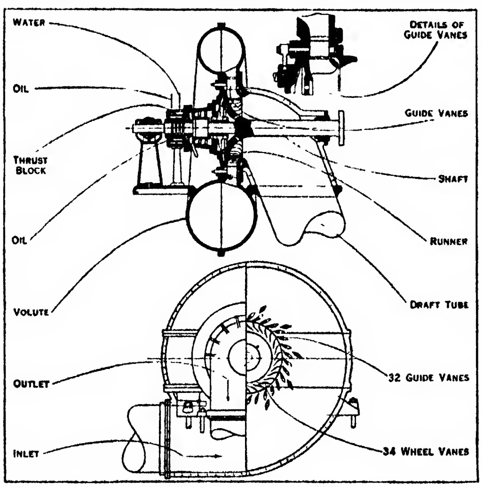
The supply of water to the runner depends upon the opening



FROM GIBSON, "HYDRO ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG 1—PLAN AND ELEVATION OF LOW HEAD FRANCIS TURBINE AND SETTING, VERTICAL SHAFT MACHINE WITH ELECTRIC GENERATOR ABOVE TAIL RACE LEVEL

between the guide vanes These are pivoted on stems which project through stuffing boxes in the turbine casing. Each stem carries a lever. These are all coupled to a regulating ring whose

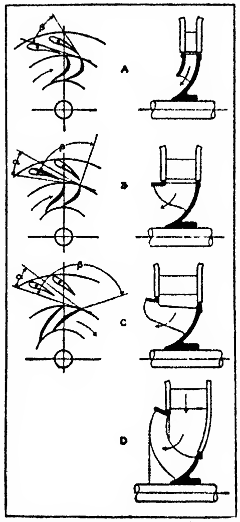


FROM GIBSON, "HYDRO-ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG 2.—DETAILS OF HIGH HEAD FRANCIS TURBINE WITH CAST IRON VOLUTE

position is regulated by the governing mechanism, so that all the guide vanes are opened or closed simultaneously.

In a low-head installation the turbine may be erected in the open forebay or supply canal. This method has the disadvantage that the guide-vane mechanism is submerged and cannot be inspected or repaired without draining the wheel pit, and in most recent installations, even of the low-head type, the guide-vane ring is surrounded by a spiral volute chamber, from which the pressure water is delivered with uniform velocity around the entire periphery of the guide ring For heads not exceeding about 100 ft, modern practice favours the moulding of the volute chamber in the concrete of the substructure (fig. 1). For higher heads, considerations of strength necessitate a metal casing, to which the water is supplied through a pressure pipe line (fig. 2). The turbine runner is usually of cast iron, although where corrosion or erosion is to be anticipated, it may be made of cast steel if large, and of phosphor bronze if small



FROM GIBSON, "HYDRO ELECTRIC ENGINEERING (BLACKIE & SON)

FIG 3.—TYPES OF TURBINE RUNNER

A. For high heads and comparatively low speeds. B. For medium heads and moderate speeds. C. For medium heads and high speeds. D. For low heads and high speeds

The general changes in the shape and proportions of the runner which have accompanied recent development of the low head high-speed turbine are indicated in fig. 3. The change has been generally in the direction of increasing the axial depth of the buckets, and at the same time of maintaining or increasing the ratio of the discharge area at exit to that at entrance. At the same time the width of the buckets in the direction of flow has been reduced. An extreme example is shown in fig. 3D, in which flow through the wheel itself is almost axial. In many recent low-head turbines the runners are of the propeller type They are characterized by the fewness of the vanes, as few as three or four in many cases, and are in appearance very like the ordinary ship's propeller.

The Draft Tube.—In order to avoid the flooding of the turbine house by any raising of the tail race level in time of floods it is usually necessary to instal the turbines at some higher elevation, and if the turbines were provided with open discharge pipes, freely discharging into the atmosphere, the proportion of head represented by the elevation above tail water level would be lost. By arranging the discharge, or draft tube, so that the outlet is always submerged, it becomes possible, however, to place the turbine above tail water level without loss of head The pressure at the point of discharge from the runner into the draft tube is now less than atmospheric by an amount which depends upon the elevation above tail water level.

The draft tube also, if well designed, serves a further purpose in that it enables a large proportion of the kinetic energy of discharge from the runner to be converted into pressure head, and so to be utilized. For this the tube must be designed with a gradually increasing diameter, so that the velocity is gradually reduced from v_1 to v_2 before discharge (fig. 1). The velocity of discharge from the draft tube should not exceed about 4 f s.

Hydraulics of the Reaction Turbine.—In the following discussion let ω = angular velocity of the runner in radians per second ($\omega = 2\pi N \div 60$ where N = revolutions per minute). $u = \omega r$ = velocity of wheel at point indicated by a suffix; v = absolute velocity of water; w = tangential component of v; f = radial component of v; v = relative velocity of water and vane; α = guide vane angle, β = wheel vane angle at entrance; γ = wheel vane angle at exit; Q = flow in c.f.s; W = weight of 1 cu.ft of water; suffix (2) refer to inlet to wheel vanes; suffix (3) refer to exit from wheel vanes

For entry without shock, the direction of the relative velocity

of water and vane at the entrance to the wheel must be parallel to the vane tips, and a consideration of the diagram of velocities (fig 4) shows that if the angles are correctly proportioned.

$$f_2 = w_2 \tan\alpha = (w_2 - u_2)\tan\beta, \quad \therefore\ u_2 = w_2\left(1 - \frac{\tan\alpha}{\tan\beta}\right).$$

$$f_3 = (u_3 - w_3)\tan\gamma, \quad 2v_r = f_2 \operatorname{cosec}\beta, \quad 3v_r = f_3 \operatorname{cosec}\gamma$$

$$\left.\begin{array}{r}\text{The change of the moment of momen-}\\ \text{tum in the wheel} = \text{turning moment}\end{array}\right\} = \frac{WQ}{g}(w_2r_2 - w_3r_3)\text{ ft lb}$$

$$\therefore\ \text{Work done per second on runner} = \frac{WQ}{g}(w_2u_2 - w_3u_3)\text{ ft. lb.}$$

In an ideal wheel, with no friction or eddy losses, neglecting changes of level in the wheel, we should have

$$\frac{p_2}{W} + \frac{v_2^2}{2g} = \frac{p_3}{W} + \frac{v_3^2}{2g} + \text{work done per pound between (2) and (3)}$$

The efficiency will be a maximum when the energy rejected in the discharge is a minimum, *i e*, when v_3 is a minimum, or when w_3 is zero, in which case $v_3 = f_3$ Assuming the wheel to be designed for this state of affairs,

$$\frac{p_2}{W} + \frac{v_2^2}{2g} = \frac{p_3}{W} + \frac{f_3^2}{2g} + \frac{w_2u_2}{g}.$$

Writing H as the head available to produce flow through the wheel, so that

$$H = \frac{p_2}{W} + \frac{v_2^2}{2g} - \frac{p_3}{W}, \text{ we have } H = \frac{f_3^2}{2g} + \frac{w_2u_2}{g},$$

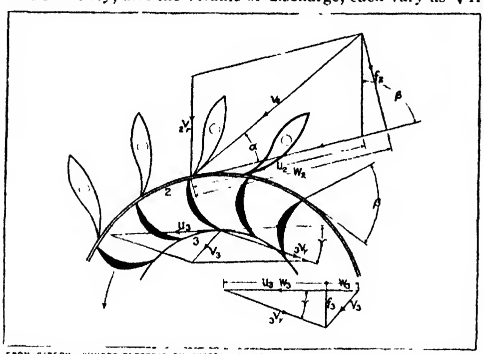
from which, writing $f_3 = f_2\dfrac{b_2r_2}{b_3r_3} = w_2\tan\alpha\,\dfrac{b_2r_2}{b_3r_3}$.

where b and r are the breadth and radius of the wheel, we get, on substitution,

$$w_2 = \sqrt{\left[\frac{2gH}{2 + \left(\frac{b_2r_2}{b_3r_3}\tan\alpha\right)^2 - 2\frac{\tan\alpha}{\tan\beta}}\right]}$$

$$\text{while } u_2 = w_2\left(1 - \frac{\tan\alpha}{\tan\beta}\right), \text{ and } Q = A_2f_2 = A_2w_2\tan\alpha$$

Thus in a wheel of given design, the peripheral speed for maximum efficiency, and the volume of discharge, each vary as $\sqrt{H}$,



FROM GIBSON, "HYDRO ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG. 4—VELOCITY DIAGRAM FOR ENTRANCE AND EXIT OF FRANCIS TURBINE

while the output of the turbine, being proportional to the product QH, varies as $H^{\frac{3}{2}}$.

$$\text{The hydraulic efficiency, } \eta = \frac{\text{work done per pound}}{H} = \frac{w_2u_2}{gH}.$$

By suitable adjustment of the vane angles α and β the, peripheral speed for a given head may be varied between wide limits. For high speeds the vane angle should be large As β is increased the value of f_2 and hence the volume of water passing a wheel of given size diminishes, so that to obtain the same output the size of the wheel must be increased. If, as is usually the case in low-head plants, a high rotative speed is required, the inlet area is increased by increasing the depth of the runner. Such a turbine has a comparatively large ratio of inlet area to discharge area, and the velocities of discharge are relatively high For high heads β may be between 60° and 90°, and, for medium and low heads, between 90° and 135°. Similarly, while the hydraulic efficiency decreases as α increases, the volume of flow increases with α, and the maximum output is obtained when the product of Q and η is a maximum For high efficiency α should be as small as mechanical considerations permit, generally between 12° and 18°.

In one modern turbine, the Kaplan, the wheel vanes are not fixed but are pivoted on a central drum, and their leading angle β can be adjusted while running so as to suit any variations in the working head or discharge In this way a very high efficiency may be maintained at all loads.

Specific Speed of a Turbine.—In order to afford a basis of comparison of turbines of different diameters and proportions operating under different heads, the term known as "specific speed" has been introduced This may be defined as the speed at which a runner would operate if reduced geometrically to such a size that it would develop 1 h p under unit working head The figures for specific speed given below refer to a unit head of 1 foot If the metre be adopted as the unit, these figures require to be multiplied by 4 45

If N be the number of revolutions per minute,
,, P ,, ,, horsepower of the turbine,
,, H ,, ,, working head in feet,

$$\text{the specific speed } N_S = \frac{N\sqrt{P}}{H^{\frac{5}{4}}}\text{ revs. per minute}$$

The specific speed of a reaction turbine may be varied by varying the diameter of the runner, the angle of the guide vanes and the angle of the wheel vanes. By modifying the design as indicated in the sketches of fig 3 it is possible, while maintaining high efficiencies at full load, to increase the specific speed from about 15, its minimum value with the type shown in fig 3A, to about 125 with the type shown in fig 3D Specific speeds as high as 150 are possible with some sacrifice in efficiency, and it is probable that further developments will see the value increased still farther These high specific speeds are extremely valuable for low-head installations since they enable the size and cost of the turbine and of the generator to be greatly reduced. In fact, many existing low-head installations would have been commercially impracticable but for the development during recent years of the high-speed turbine

High specific speeds are, however, attended by some disadvantages The part-gate efficiency in general falls off as the specific speed increases Also if the speed is unduly high it becomes very difficult to avoid very high local velocities and centres of low pressure in the runner, which invariably give rise to severe corrosion At the present stage of design, the maximum specific speeds to be used under normal circumstances with various heads are approximately as follows:

Head (feet)	20	40	60	80	100	150	200	300	400	600
Specific speed r p m	125	100	85	75	65	50	43	33	30	25

The reaction turbine may be built either as a horizontal or vertical shaft machine The latter type, having the weight of the rotating parts supported by a thrust bearing of the Michell or Kingsbury type, has been gaining in popularity of recent years

The Pelton Wheel.—This is usually built as a horizontal shaft machine and consists of a runner carrying a series of buckets around its periphery on which impinge one—or in exceptional cases two—high velocity jets from a nozzle or nozzles at the end of the supply pipe line (fig. 5). The buckets are spoon shaped and have a central sharp ridge which divides the impinging jet into

two halves which are deflected backwards by the buckets through about 165°. The modern Pelton wheel is always fitted with a circular nozzle, with an axial needle or spear for regulating the size of the jet The maximum diameter of jet as yet adopted is about 12 inches. The axial position of the needle in the nozzle is regulated by the governing mechanism in all important installations.

The Pelton wheel, being essentially a high head turbine, is usually supplied through a comparatively long pipe line, and any

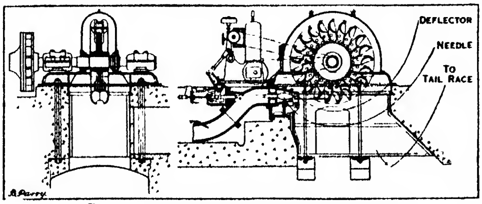


FIG 5.—PELTON WHEEL WITH SINGLE NOZZLE

rapid closing of the nozzle such as might occur if the load were suddenly thrown off, would set up severe surges of pressure in the pipe line which would not only prevent close speed regulation but might be dangerous. To prevent this, modern Pelton wheels are also fitted with a jet deflector, consisting of a curved plate pivoted between the nozzle and the buckets, which is operated by the governor and which when in action cuts into the jet and deflects it either wholly or partially into the tail race The governing mechanism is so arranged that when load is thrown off the wheel, the deflector at once comes into play, deflecting the jet from the buckets. The needle then begins to move slowly towards the closed position, and at the same time the deflector moves slowly back towards its idle position Ultimately both come to rest with the deflector just clear of the jet, and with the diameter of the latter so adjusted as to give the required supply of water to the wheel

Hydraulics of the Pelton Wheel.—If H be the pressure head behind the nozzle, in feet, the velocity of efflux is $C_1\sqrt{2gH}$ ft per second, where C_1, the coefficient of velocity, in a well-formed needle nozzle is approximately ·99 Calling this velocity V_1, the horsepower of the jet is equal to

$$\frac{62\cdot4aV_1^3}{550\times 2g}$$

where a is the area of the jet in square feet

Let u = peripheral speed of buckets at pitch circle, in ft per second.
,, V_2 = final absolute velocity of water leaving the buckets
,, ${}_1v_r$ = relative velocity of jet and bucket at entrance
,, ${}_2v_r$ = relative velocity of jet and bucket at discharge.
,, α = mean angle between jet and tangent at point of contact.
,, γ = total angle of deflection of buckets (fig. 6).

Then the initial velocity of jet in direction of tangent at point of impact $\Big\} = V_1\cos\alpha$.

The component, parallel to the tangent at discharge, of final velocity relative to bucket $\Big\} = {}_2v_r\cos\gamma$

∴ Absolute velocity in this direction at discharge $= u + {}_2v_r\cos\gamma$.

∴ Change of tangential momentum per second per pound

$$= \frac{1}{g}(V_1\cos\alpha - u - {}_2v_r\cos\gamma)$$

∴ Work done per pound of water per second

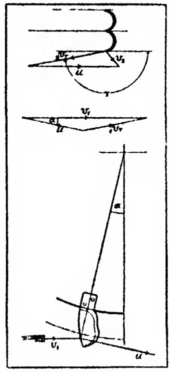
$$= \frac{u}{g}(V_1\cos\alpha - u - {}_2v_r\cos\gamma)\ \text{ft. lb}$$

∴ Efficiency $\quad = \dfrac{u}{gH}(V_1\cos\alpha - u - {}_2v_r\cos\gamma)$

The loss due to friction and eddies in the buckets $= \dfrac{{}_1v_r^2 - {}_2v_r^2}{2g}$ ft. lb. per pound, where ${}_1v_r^2 = V_1^2 + u^2 - 2V_1u\cos\alpha$

The loss due to rejection of kinetic energy in the discharge $= \dfrac{V_2^2}{2g}$ ft lb. per pound, where $V_2^2 = u^2 + {}_2v_r^2 + 2u{}_2v_r\cos\gamma$.

Tests show that in an average wheel ${}_2v_r$ may be as low as from ·5 to 6 ${}_1v_r$. In a well-designed bucket, however, having a ratio of bucket width to jet diameter not less than about 3 3, this ratio approximates to ·75 or even 8 If the angle of deflection were 180°, and if the buckets were frictionless, the value of the peripheral speed of the wheel for maximum efficiency would be $V_1\cos\alpha \div 2$, or approximately $V_1 \div 2$, since α is small When account is taken of the various losses and of the fact that γ is less than 180°, the best peripheral speed lies between 44 and $48V_1$



FROM GIBSON, "HYDRAULICS" (CONSTABLE & CO)
FIG. 6.—VELOCITY DIAGRAMS FOR PELTON WHEEL BUCKETS

Comparison of Impulse and Reaction Turbines.—The peripheral velocity of a Pelton wheel for maximum efficiency is slightly less than one-half the velocity of the jet (usually approximately $\cdot46\sqrt{2gH}$, where H is the head), while that of the reaction turbine varies from about $65\sqrt{2gH}$ to $1\cdot05\sqrt{2gH}$, depending on the design Because of this, the Pelton wheel is well adapted for very high heads, which may then be utilized with moderate speeds of rotation. On the other hand the relatively high speed of the reaction turbine enables reasonably high rotative speeds to be obtained with low heads

The Pelton wheel cannot well be designed to utilize efficiently more than two jets on a single wheel, and as the maximum practicable jet diameter is not large, the volume of water which can be handled and the output of the turbine become small under low heads The reaction turbine with its full peripheral admission on the other hand is well adapted for large volumes It is not suited for small powers under high heads, since the volume of water is then small, the waterways are of very small sectional area and easily become choked by floating debris, and the fluid friction losses become relatively high

The Pelton wheel cannot easily be adapted to the use of a suction or draft tube, and, where the tail-race level may vary appreciably, must be installed above the highest probable tail-water level with some sacrifice of head The efficiency of the reaction turbine is not so sensitive to changes of head as that of the Pelton wheel, but if operated under constant head and at constant speed, the efficiency of the Pelton wheel does not fall off so rapidly at part loads as that of the reaction turbine On the other hand, the modern reaction turbine has a slightly higher full-load efficiency, so that the average efficiency from half to full load is sensibly the same in a well-designed machine of either type The following table shows typical values of the part-load efficiencies of modern turbines of both types of large size, installed under equally favourable conditions.

Proportion of maximum discharge	·2	3	4	5	·6	7	8	9	1·0
Efficiency of reaction turbine	60	70	75	79	82	87	90	91	89
Efficiency of Pelton wheel	70	·78	·82	83	84	85	86	·85	83

The possibilities of accurate speed regulation are about equal in the two types

For large units the reaction turbine is generally preferable for heads up to 400 feet For heads above 750 ft the Pelton wheel is more suitable, while between these limits the choice depends largely upon local circumstances and on the power required The greater simplicity and accessibility of the parts requiring replacement due to natural wear and tear renders the Pelton wheel more

suitable when the supply is taken from a stream carrying an appreciable amount of grit.

The reaction turbine has been built in units capable of developing 65,000 H P The most powerful Pelton wheel yet constructed develops about 30,000 H.P., but these outputs could be largely extended if necessary

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TURBOT (*Prelta maxima*), a flat fish of the Mediterranean and the Atlantic coast of Europe, is distinguished by a large terminal mouth, eyes on the left side, a very deep body and a naked skin, with conical bony tubercles scattered on the eyed side The brill, a related species, is not so deep, and is scaly. The turbot is a valued food-fish, it feeds mainly on other fishes, it attains a weight of 30 lb It has a longer larval life than most flat fishes, and specimens nearly an inch in length, with an eye on each side, may be found swimming at the surface

TURDIDAE: *see* THRUSHES.

TURENNE, HENRI DE LA TOUR D'AUVERGNE, VICOMTE DE (1611–1675), marshal of France, second son of Henri, duke of Bouillon and sovereign prince of Sedan, by his second wife Elizabeth, daughter of William the Silent, prince of Orange, was born at Sedan on Sept 11, 1611 At the age of fourteen he went to learn war in the camp of his uncle, Maurice of Nassau, and began his military career (as a private soldier in that prince's bodyguard) in the Dutch War of Independence Frederick Henry of Nassau, who succeeded his brother Maurice in 1625, gave Turenne a captaincy in 1626. In 1630 Turenne left Holland and entered the service of France Cardinal Richelieu at once made him colonel of an infantry regiment. He still continued to serve at frequent intervals with the prince of Orange, who was the ally of France In 1635 Turenne served under Cardinal de la Valette in Lorraine and on the Rhine. The siege of Mainz was raised but the French army had to fall back on Metz from want of provisions In the retreat Turenne measured swords with the famous imperialist General Gallas, and distinguished himself greatly by his courage and skill The reorganized army took the field again in 1636 and captured Saverne (Zabern), at the storming of which place Turenne was seriously wounded. In 1637 he took part in the campaign of Flanders and was present at the capture of Landrecies (July 26) and in the latter part of 1638, under Duke Bernhard of Saxe-Weimar (1608–1639), he directed the assault of Breisach (reputed the strongest fortress on the upper Rhine), which surrendered on Dec. 17. He had now gained a reputation as one of the foremost of the younger generals of France, and Richelieu next employed him in the Italian campaign of 1639–40 under "Cadet la Perle," Henri de Lorraine, count of Harcourt (1601–1666). The favourable result of the complicated operations of this campaign was largely due to Turenne, who had by now become a lieutenant-general. He himself commanded during the campaign of 1641 and took Coni (Cuneo), Ceva and Mondovi. In 1642 he was second in command of the French troops which conquered Roussillon. At this time the conspiracy of Cinq Mars (*see* FRANCE: *History*) in which Turenne's elder brother, the duke of Bouillon, was implicated, was discovered.

The earlier career of Turenne was influenced by the relations of the principality of Sedan to the French crown, moreover his steady adherence to the Protestant religion was an element of difficulty in Turenne's relations with the ministers Cardinal Richelieu nevertheless entrusted him with the command in Italy in 1643 under Prince Thomas (who had changed sides in the quarrel). Turenne took Trino in a few weeks, but was recalled to France towards the end of the year. He was made a marshal of France (Dec 19) and was soon sent to Alsace to reorganize the "Army of Weimar"—the remnant of Duke Bernhard of Saxe-Weimar's troops—which had just been severely defeated at Tüttlingen (Nov. 24–25, 1643). He was thirty-two years old.

The work of reorganization over, Marshal Turenne began the campaign in June by crossing the Rhine at Breisach, but was almost instantly joined by an army under the duc d'Enghien (afterwards the great Condé), who, as a prince of the royal house, took the chief command of the united armies of "France" and "Weimar." The four famous campaigns which followed brought to an end the Thirty Years' War (*q v*) The chief event of the first of these was the desperately-fought battle of Freiburg against Count Mercy's Bavarians (Aug. 3, 5 and 9, 1644), after which Philipsburg was successfully besieged. Before the capitulation Enghien withdrew and left Turenne in command The marshal opened the campaign of 1645 with a strong forward movement, but was surprised and defeated by Mercy at Mergentheim (Marienthal) on May 2. Enghien was again sent to the front with the army of France and Turenne's army was greatly increased by the arrival of a Swedish force and a contingent from Hesse-Cassel. The Swedes soon departed, but Enghien was at the head of 20,000 men when he met the Bavarians in a battle even more stubbornly contested than Freiburg Mercy was killed and his army beaten at Allerheim near Nordlingen (Aug 3, 1645)

Ill-health forced Enghien to retire soon afterwards, and Turenne was for the third time left in command of the French army. He was again unfortunate against the larger forces of the imperialists, but the campaign ended with a gleam of success in his capture of Trier (Trèves). In the following year (1646) he obtained more decided successes, and, by separating the Austrians from the Bavarians, compelled the elector of Bavaria to make peace (signed March 14, 1647). In 1647 he proposed to attack the thus weakened army of the emperor, but was ordered into Flanders instead Not only was the opportunity thus lost but a serious mutiny broke out amongst the Weimar troops, whose pay was many months in arrear. The marshal's tact and firmness were never more severely tried nor more conspicuously displayed than in his treatment of the disaffected regiments, among whom in the end he succeeded in restoring order with little bloodshed. He then marched into Luxembourg, but was soon recalled to the Rhine, for in 1648 Bavaria had returned to her Austrian alliance and was again in arms Turenne and his Swedish allies made a brilliant campaign, which was decided by the action of Zusmarshausen (May 17), Bavaria being subsequently wasted with fire and sword until a more secure pacification was obtained

The peace of Westphalia (1648) was no peace for France, which was soon involved in the civil war of the Fronde (*See* FRANCE *History*) Few of Turenne's actions have been more sharply criticized than his adhesion to the party of revolt. The army of Weimar refused to follow its leader and he had to flee into the Spanish Netherlands, where he remained until the treaty of Rueil put an end to the first war of the Fronde The second war began with the arrest of Condé and others (Jan. 1650), amongst whom Turenne was to have been included; but he escaped in time and with the duchesse de Longueville held Stenay for the cause of the "Princes"—Condé, his brother Conti, and his brother-in-law the duc de Longueville. Love for the duchess seems to have ruled Turenne's action, both in the first war, and, now, in seeking Spanish aid for the princes In this war Turenne sustained one of his few reverses at Rethel (Dec 15, 1650); but the second conflict ended in the early months of 1651 with the collapse of the court party and the release of the princes

Turenne became reconciled and returned to Paris in May, but the trouble soon revived and before long Condé again raised the standard of revolt in the south of France. In this, the third war of the Fronde, Turenne and Condé were opposed to each other, the marshal commanding the royal armies, the prince that of the Frondeurs and their Spanish allies Turenne displayed the personal bravery of a young soldier at Jargeau (March 28, 1652), the skill and wariness of a veteran general at Gien (April 7), and he practically crushed the civil war in the battle of the Faubourg St Denis (July 2) and the reoccupation of Paris (Oct. 21). Condé and the Spaniards, however, still remained to be dealt with, and the long drawn out campaigns of the "Spanish Fronde" gave ample scope for the display of scientific generalship on the part of both the famous captains. In 1653 the advantage was with Turenne, who captured Rethel, St. Menehould and Muzon, while Condé's sole prize was Rocroy. The short

campaign of 1654 was again to the advantage of the French; on July 25, the Spanish were defeated at Arras. In 1655 more ground was gained, but in 1656 Turenne was defeated at Valenciennes in the same way as he had beaten Condé at Arras. The war was eventually concluded in 1657 by Turenne's victory at the Dunes near Dunkirk, in which a corps of English veterans sent by Cromwell played a notable part (June 3–14); a victory which, followed by another successful campaign in 1658, led to the peace of the Pyrenees in 1659.

On the death of Cardinal Mazarin in 1661 Louis XIV. took the reins of government into his own hands and one of his first acts was to appoint Turenne "marshal-general of the camps and armies of the king." He had offered to revive the office of constable of France (suppressed in 1627) in Turenne's favour if the marshal would become a Roman Catholic. Turenne declined Born of Calvinist parents and educated a Protestant, he had refused to marry one of Richelieu's nieces in 1639 and subsequently rejected a similar proposal of Mazarin. He had later married a daughter of the Protestant Marshal de la Force, to whom he was deeply attached But he sincerely deplored the division of the Christian church into two hostile camps How closely both he and his wife studied such evidence as was available is shown by their correspondence, and, in the end, two years after her death, he was prevailed upon by the eloquence of Bossuet and the persuasions of his nephew, the abbé de Bouillon, to give in his adhesion to the Orthodox faith (Oct. 1668). In 1667 he had returned to the more congenial air of the "Camps and Armies of the King," directing, nominally under Louis XIV, the famous "Promenade militaire" in which the French overran the Spanish Netherlands. Soon afterwards Condé, now reconciled with the king, rivalled Turenne's success by the rapid conquest of Franche Comté, which brought to an end the War of Devolution in February 1668

In Louis XIV's Dutch War of 1672 (*see* DUTCH WARS) Turenne was with the army commanded by the king which overran Holland up to the gates of Amsterdam. The dikes were opened and the country round Amsterdam flooded. This heroic measure completely checked Turenne, whom the king had left in command. Turenne now fought a successful war of manoeuvre on the middle Rhine while Condé covered Alsace. In January 1673 Turenne assumed the offensive, penetrated far into Germany, and forced the Great Elector of Brandenburg to make peace; later in the year, however, he was completely outmanoeuvred by the famous imperial general Montecucculi, who evaded his opponent, joined the Dutch and took the important place of Bonn In June 1674, however, Turenne won the battle of Sinzheim, which made him master of the Palatinate. Under orders from Paris the French wasted the country far and wide. In the autumn the allies again advanced, and though Turenne was again outmanoeuvred, his failure on this occasion was due to the action of the neutral city of Strasbourg in permitting the enemy to cross the Rhine by the bridge at that place. The battle of Enzheim followed, this was a tactical victory, but hardly affected the situation, and, at the beginning of December, the allies were still in Alsace The old marshal now made the most daring campaign of his career A swift and secret march in mid-winter from one end of the Vosges to the other took the allies by surprise Sharply following up his first successes, Turenne drove the enemy to Turkheim, and there inflicted upon them a heavy defeat (Jan. 5, 1675). In a few weeks he had completely recovered Alsace. In the summer campaign he was once more opposed to Montecucculi, and after the highest display of "strategic chess-moves" by both commanders, Turenne finally compelled his opponent to offer battle at a disadvantage at Sassbach. Here, on July 27, 1675, he was killed by almost the first shot fired. The news of his death was received with universal sorrow. Turenne's most eloquent countrymen wrote his *éloges*, and Montecucculi himself exclaimed: "Il est mort aujourd'hui un homme qui faisait honneur à l'homme." His body was taken to St. Denis and buried with the kings of France. Even the extreme revolutionists of 1793 respected it, and, when the bones of the sovereigns were thrown to the winds, the remains of Turenne were preserved at the Jardin des Plantes until Sept 22, 1800, when they were removed by order of Napoleon to the church of the Invalides at Paris, where they still rest.

Turenne was one of the great captains whose campaigns Napoleon recommended all soldiers to "read and re-read." His fame as a general was the highest in Europe at a period when war was studied more critically than ever before, for his military character epitomized the art of war of his time (Prince de Ligne) Strategic caution and logistic accuracy, combined with brilliant dash in small combats and constancy under all circumstances of success or failure may perhaps be considered the salient points of Turenne's genius for war Great battles he avoided "Few sieges and many combats" was his own maxim. And, unlike his great rival Conde, who was as brilliant in his first battle as in his last, Turenne improved day by day. Napoleon said of him that his genius grew bolder as it grew older, and a modern author, the duc d'Aumâle (*Histoire des princes de la maison de Condé*), takes the same view when he says: "Pour le connaître il faut le suivre jusqua'à Sulzbach Chez lui chaque jour marque un progrès" In his personal character Turenne was little more than a simple and honourable soldier, endowed with much tact, but in the world of politics and intellect almost helpless in the hands of a skilful intriguer or casuist His morals, if not beyond reproach, were at least more austere than those prevalent in the age in which he lived. He was essentially a commander of regular armies His life was spent with the troops; he knew how to win their affection; he tempered a severe discipline with rare generosity, and his men loved him as a comrade, no less than they admired him as a commander. Thus, though Condé's genius was far more versatile, it is Turenne whose career best represents the art of war in the 17th century For the small, costly, and highly trained regular armies, and the dynastic warfare of the age of Louis XIV., Turenne was the ideal army leader.

The most notable of the numerous portraits of Turenne are those of P de Champagne at Versailles, and of Senin (dated 1670) in the Jones collection at South Kensington, London Of the older memoirs of Turenne the most important are those of "Du Buisson," *La Vie du vicomte de Turenne*—the author is apparently Gatien de Sandraz de Courtilz (Paris, the Hague, and Cologne, 1688–95); Abbé Raguenet, *Histoire du vicomte de Turenne* (Paris 1741) and especially Ramsay, *Histoire d'Henri de la Tour d'Auvergne, vicomte de Turenne* (Paris 1735), the second volume of which contains the marshal's memoirs of 1643–58. These memoirs, of which the Prince de Ligne wrote that "ce ne sont pas de conseils, ce sont des ordres . . . 'faites' . . . 'allez,' etc."—were written in 1665, but were first published (*Mémoires sur la guerre, tirés des originaux*, etc) in 1738, reprinted in Michaud, *Mémoires sur l'histoire de France*, 3rd series, vol iii, and Liskenne and Sauvan's *Bibliothèque historique et militaire*, vol iv (Paris 1846) A manuscript *Maximes de M de Turenne* (1644) exists in the Staff Archives at Vienna, and of other documentary collections may be mentioned Grimoard, *Collections de lettres et mémoires trouvés dans le portefeuille de M de Turenne* (Paris, 1782), *Recueil de lettres écrites au vicomte de Turenne par Louis XIV et ses ministres*, etc. (Paris 1779), *Correspondance inédite de Turenne avec Le Tellier et Louvois*, ed. Barthelemy (Paris 1874) *See* also the *Observations on the Wars of Marshal Turenne*, dictated by Napoleon at St Helena (1823); Puységur, *La Guerre par principes et règles* (Paris 1748); Précis in *Bibliothèque internationale d'hist milit.* (Brussels 1883); Duruy, *Histoire de Turenne* (Paris 1880); Rov, *Turenne, sa vie et les institutions militaires de son temps* (Paris 1884); Hardy de Périni, *Turenne et Condé* (Paris 1907), Neuber, *Turenne als Kriegstheoretiker und Feldherr* (Vienna 1869); Sir E. Cust, *Lives of the Warriors of the 17th Century* (London 1867); T O Cockayne, *Life of M. de Turenne* (founded on Ramsay's work; London 1853); G. B. Malleson, *Turenne Marshal Turenne*, by "the author of the Life of Sir Kenelm Digby" (London 1907), is a valuable work by a civilian, and is based in the main on Ramsay's work, the memoirs of Cardinal de Retz, James, duke of York, etc, and on Napoleon's commentaries. A remarkable parallel between Turenne and Condé, in Saint-Evremont's *éloge* of the latter, will be found in Carrion-Nisas, *Essai sur l'histoire général de l'art militaire*, ii 83 (Paris 1824), C G Picavet, *Les dernières années de Turenne 1660–1675* (1919), p 513, General Weygand, *Turenne* (1929). (C F A)

TURFAN, the name of a remarkable depression in the Tarim region south of the Tienshan, here over 10,000 ft in height. This is said to be 426 ft. below sea-level at the lowest point. The town of Turfan, just 30 m to the north, stands some 250 ft. above sea-level, and the general level around the depression rapidly reaches over 2,500 feet. The depression is loess covered and would be fertile if it could be irrigated The town of Turfan is a double

settlement, part Chinese and part Turki, with a population of 15–20 thousand In the depression, the temperature varies from 90° for July, calculated at Lukchun, to 13° in January and the daily fluctuations are very great

TURGAI, a former province of Russian central Asia, now included in the Kazakstan A S S R (*q.v*), *see* also Aktubinsk.

The Turgai strait, a narrow passage over the watershed separating the Tobol and the Irgiz, between the east of the southern Urals and the west of the plateau region of the Kirghiz steppe, is of great structural importance Through it came the marine transgressions of previous geological epochs; the upper Cretaceous advanced into the south-west only, but those of the upper Eocene and Oligocene extended along the east of the Urals and the Lower Oligocene sea of Germany reached the Arctic Ocean During the age of the amber forests the Strait of Turgai was closed and no sea again entered Siberia by that route The course of the Tobol river marks the direction of the ancient marine connection. At a recent epoch the present Turgai river, which enters Lake Chalkarteniz and which receives the Irgiz as a tributary, flowed into the Sea of Aral, its volume being then much increased by tributaries which now lose themselves in the sand before reaching it

See Suess *The Face of the Earth,* Vol. III. (1908).

TURGENEV, IVAN SERGEYEVICH (tōōr-gān'yĕv) (1818–1883), Russian novelist, was born at Orel, of a family of provincial gentry His father had married for money a woman older than himself, who made up for her thwarted affections by making herself a domestic tyrant to her children, as well as to her serfs Turgenev was educated at home at the Universities of Moscow and St. Petersburg, and finally (1839–40) at Berlin, where, in contact with young Russian intellectuals, he became a Westernizer In 1843 he published *Parasha*, a tale in verse, which was favourably reviewed by Belinsky Turgenev deserted the civil service for letters and was infatuated with the famous singer, Pauline Garcia (Mme. Viardot); this caused a breach with his mother, who cut off his allowance. He lived as a Bohemian until her death (1850) made him a rich man His lifelong affection for Mme Viardot, who merely tolerated his presence, met with no response, but left a deep impress on his work Turgenev abandoned poetry for the drama (which he also abandoned after 1852) and for prose fiction. His first great success was *A Sportsman's Sketches* (started 1847, in book form 1852), in which the peasants appeared more attractive than their masters. It was received as a protest against serfdom In 1852 Turgenev was exiled to his estate for a while because of his laudatory obituary on Gogol.

His masterpieces included short stories like *The Backwater, Asya, First Love,* and the more ambitious novels *Rudin* (1856), *A Nest of Gentlefolk* (1858), *On the Eve* (1860) and *Fathers and Sons* (1862), in which the love plot was interwoven with current social issues All were commented on at great length by the leading critics. His attempt, however, to draw a strong man in the person of the agnostic and materialist—"nihilist"—Bazarov was resented by the Radical press as a caricature. Turgenev, being sensitive to criticism, was embittered against his countrymen and settled abroad, and his later works are mainly retrospective The two novels in which he tried to deal with actuality, *Smoke* (1867) and *Virgin Soil* (1877), only show the depth of his bitterness and his complete loss of touch with contemporary Russia. However, his last visit to Russia (1880) was a triumphant progress. He died in 1883, at Bougival, near Paris

Turgenev was the first Russian author to be read and admired by Europe During his last years he lived in close touch with the French literary world, contracted intimate friendships (especially with Flaubert) and was regarded as a master by younger men like Maupassant. He was very popular in this French circle, but much less so among his Russian compeers: Tolstoy, Dostoyevsky and Nekrasov all sooner or later came to detest him.

Turgenev is the most poetical (in the 19th century acceptance of the word) of the Russian realists. He had undergone the profound influence of Pushkin (as well as of Lermontov and George Sand). His novels are largely variations on the theme of *Eugene Onegin*. His character drawing does not depend on analysis and psychology, but on a subtly-woven poetic atmosphere that accompanies the characters like an aura. This applies mainly to his women; they are invariably stronger and more attractive than his men, who (with the single exception of Bazarov) are neurasthenic weaklings His style is marked by a careful simplicity and elaborate naturalness that answered to the highest ideals of 19th century taste. Delicately-drawn landscape passages are among its most outstanding features

Bibliography.—*The Novels of Ivan Turgenev,* trans. by Constance Garnett (17 vols., 1919–23); *Novels and Stories,* trans. by Isabel F. Hapgood, with an introduction by Henry James (13 vols, 1903); *The Plays of Ivan Turgenev,* trans by M S. Mandell, etc (1924); *Tourguéneff and his French Circle* (letters, etc) ed. by E. Halperine-Kaminsky (1898) *See* also Henry James in *French Poets and Novelists* (1878) and *Partial Portraits* (1888); E. Garnett, *Turgenev, a Study* (1917); A. Yarmolinsky, *Turgenev* (1926). (D. S M)

TURGOT, ANNE ROBERT JACQUES, Baron de Laune (1727–1781), French statesman and economist, was born in Paris on May 10, 1727, the youngest son of Michel Étienne Turgot "provost of the merchants" of Paris He was educated for the Church, and at the Sorbonne, to which he was admitted in 1749 (being then styled abbé de Brucourt), he delivered two remarkable Latin dissertations, *On the Benefits which the Christian Religion has conferred on Mankind,* and *On the Historical Progress of the Human Mind* In 1750 he decided not to take holy orders, giving as his reason, according to Dupont de Nemours, "that he could not bear to wear a mask all his life." In 1752 he became *substitut,* and later *conseiller* in the parlement of Paris, and in 1753 *maître des requêtes* In 1754 he was a member of the *chambre royale* which sat during an exile of the parlement; in 1755 and 1756 he accompanied Gournay, then intendant of commerce, in his tours of inspection in the provinces, and in 1760, while traveling in the east of France and Switzerland, visited Voltaire, who became one of his chief supporters

In August 1761 Turgot was appointed intendant of the *généralité* of Limoges, which included some of the poorest and most over-taxed parts of France; here he remained for 13 years He was already deeply imbued with the theories of Quesnay and Gournay (*see* Physiocratic School), and set to work to apply them as far as possible in his province He continued the work on the *cadastre*, or new official survey, begun by his predecessor Tourny, in order to arrive at a juster assessment of the *taille;* he also obtained a large reduction in the contribution of the province. He published his *Avis sur l'assiette et la répartition de la taille* (1762–1770), and as president of the *Société d'agriculture de Limoges* offered prizes for essays on the principles of taxation Quesnay and Mirabeau had advocated a proportional tax (*impôt de quotité*), but Turgot a distributive tax (*impôt de répartition*). Another reform was the substitution for the *corvée* of a tax in money levied on the whole province, the construction of roads being handed over to contractors In 1769 he wrote his *Mémoire sur les prêts à intérêt,* in which the question of lending money at interest was for the first time treated from a scientific, not from a moral standpoint Among other works written during Turgot's intendancy were the *Mémoire sur les mines et carrières,* and the *Mémoire sur la marque des fers,* in which he protested against state interference and advocated free competition.

During the famine of 1770–1771 he enforced on landowners "the obligation of relieving the poor" and especially the *métayers* dependent upon them, and organized in every province *ateliers* and *bureaux de charité* for providing work for the able-bodied and relief for the infirm. Turgot made the *curés* the agents of his charities and reforms when possible In 1770 he wrote his famous *Lettres sur la liberté du commerce des grains,* addressed to the comptroller-general, the abbé Terray. Three of these letters have disappeared, having been sent to Louis XVI. by Turgot at a later date and never recovered

Turgot's best known work, *Réflexions sur la formation et la distribution des richesses,* written in 1766 for the benefit of two young Chinese students, appeared in 1769–1770 in Dupont's journal, the *Ephémérides du citoyen,* and was published separately in 1776. After tracing the origin of commerce, Turgot develops Quesnay's theory that the land is the only source of wealth, and divides society into three classes, the productive or agricultural,

the salaried (*stipendiée*) or artisan class, and the land-owning class (*classe disponible*). He advocates the *impôt unique, i.e.,* that only the *produit net* of the land should be taxed, and the complete freedom of commerce and industry

On July 20, 1774 Turgot was appointed minister of marine through the influence of Maurepas, and on Aug. 24 he became comptroller-general. His first act was to submit to Louis XVI. his guiding principles. "No bankruptcy, no increase of taxation, no borrowing." Turgot's policy, in face of the desperate financial position, was one of rigid economy in all departments. He contemplated a thorough-going reform of the *ferme générale,* and, meanwhile, imposed certain conditions on the leases as they were renewed—such as a more efficient personnel, and the abolition for the future of the abuse of the *croupes* (the name given to a class of pensions), and annulling certain leases, such as those of the manufacture of gunpowder and the administration of the *messageries,* the former of which was handed over to a company with Lavoisier as one of its advisers, and the latter superseded by a better service of diligences which were nicknamed "turgotines." He also prepared a regular budget. Turgot's measures reduced the deficit, and raised the national credit to such an extent that in 1776, just before his fall, he was able to negotiate a loan with some Dutch bankers at 4%; but the deficit was still so large as to prevent him from attempting to realize his scheme of substituting for indirect taxation a single tax on land. He suppressed, however, a number of *octrois* and minor duties

Turgot's edict for free trade in corn signed on Sept 13, 1774, was strongly opposed in the *conseil du roi.* Turgot was hated by many in high places who had been interested in the speculations in corn, and was opposed by Linguet and by Necker, who in 1775 published his treatise *Sur la législation et le commerce des grains* But Turgot's worst enemy was the poor harvest of 1774, which led to a slight rise in the price of bread in the winter and early spring of 1774–1775 and to those extraordinary bread-riots known as the "guerre des farines." Turgot showed great firmness and decision in repressing the riots, and was loyally supported by the king throughout

Turgot's famous "Six Edicts," were finally presented to the *conseil du roi* (Jan. 1776). The two which met with violent opposition were, firstly, the edict suppressing the *corvées,* and secondly, that suppressing the *jurandes* and *maîtrises,* the privileged trade corporations Turgot announced in the preambles to these his intention to subject the noblesse to taxation and to establish as a principle the right of every man to work without restriction He obtained the registration of the edicts by the *lit de justice* of March 12, but by that time he had won the hatred of the nobles and the parlements, the court, the "financiers," the clergy, the rich bourgeoisie of Paris and others The queen disliked him for opposing the grant of favours to her protégés, and he had offended Mme. de Polignac in a similar manner. Malesherbes and Maurepas ceased to support him, and Maurepas became reconciled with the queen and her party His large reforms amounted to a complete revolution and Louis XVI. recoiled at the prospect. On May 12, 1776, Turgot was asked to resign. He retired to la Roche-Guyon, château of the duchesse d'Enville, returning shortly to Paris, where he spent the rest of his life in scientific and literary studies, being made vice-president of the Académie des Inscriptions et Belles Lettres in 1777. He died on March 18, 1781.

In character Turgot was simple, honourable and upright, with a passion for justice and truth. He was an idealist, his enemies would say a doctrinaire, and certainly the terms "natural rights," "natural law," etc., frequently occur in his writings. His friends speak of his charm and gaiety in intimate intercourse, but among strangers he was silent and awkward, and produced the impression of being reserved and harsh. Many of the reforms and ideas of the Revolution were due to him; the ideas did not as a rule originate with him, but it was he who first gave them prominence. Oncken looks upon him as a bad physiocrat and a confused thinker, while Léon Say considers that "though he failed in the 18th century he triumphed in the 19th."

BIBLIOGRAPHY.—G Schelle, *Turgot* (Paris, 1909); and Marquis de Ségur, *Au Couchant de la monarchie* (Paris, 1910), contain much that is based on recent research. The principal older biographies are those of Dupont de Nemours (1782, enlarged in his edition of Turgot's *Works,* 1807–1811), and Condorcet (1786), the best modern ones are those of A. Neymarck (Paris, 1885), Léon Say (Paris, 1887); and W. W Stephens (London, 1895). See generally, Oncken, *Geschichte der Nationalokonomie,* vol ii ch i; Schelle, *Dupont de Nemours et l'école physiocratique* (1888); Henry Higgs, *The Physiocrats* (1897); R P. Shepherd, *Turgot and the Six Edicts* (1903), in Columbia Univ. Studies, vol xviii No 2; *Oeuvres de Turgot et documents le concernant, avec biographie et notes par G. Schelle* (5 vols, 1913–23)

TURI, a Shī'a Mohammedan tribe which holds the Kurram Valley in the North-West Frontier province, India, and enjoys increasing prosperity. Divided into five clans, all apparently of Hindki (*q v*) origin, the Turis wrested the valley from the Bangash Pathāns after 1700, distributing its lands as conquered so that every original settler's family now holds fields all over it A sturdy race, whose "fathom" is reputed to be 6½ft, they are distraught by faction, but hospitable, and a Turi escort (*badragga*) is famed for its fidelity They threw in their lot with the Sunnite Pathāns (1851–56), but in the second Afghan War furnished Roberts with supplies, and in 1892 accepted British protection.

TURIN, a city of Piedmont, Italy, capital of the province of Turin, formerly of the kingdom of Sardinia (until 1860), and of Italy till the removal of the seat of government to Florence in 1865 Pop (1921) 493,289 (town), 502,274 (commune), thus showing rapid growth at the expense of the Alpine valleys (*see* ITALY) with a garrison of 8,500 The area of the city is 4,155 acres, and its octroi circle measures nearly 9 m Built upon alluvial soil 784 ft. above sea-level, it stands upon the river Po The streets and avenues, almost all of which are straight, intersect at right angles. In general it has a modern aspect, but its regularity of form is in reality derived from the ancient Roman town of Augusta Taurinorum, which formed its nucleus. The mean temperature at Turin (1871–1900) is 53° F (winter 35°, summer 71°), with an average maximum of 90°, and an average minimum of 17° Snow falls on an average only on seven days per annum The rainfall averages 34 in

The cathedral of St John the Baptist (the see has been archiepiscopal since 1515) is a cruciform Renaissance building dating from 1492–1498, by the Florentine architect Baccio Pontelli, Meo del Caprina being the contractor Behind the high altar of the cathedral is the chapel of the Sudario or Sindone, built (1657–1694) by Guarini as a royal burial-place The "sudario" from which it takes its name is asserted to be the shroud in which Joseph of Arimathea wrapped the body of Jesus La Beata Vergine della Consolata, another of Guarini's works, has a tower which belonged to the church of St Andrew, founded by the monk Bruning in 1014 Other churches of note are San Filippo (1672–1772), the largest in Turin, the dome of which fell in just as it was approaching completion under the hands of Guarini and was restored by Juvara, and La Gran Madre de Dio, erected to commemorate the return of the court in 1814. The Palazzo Madama was erected by William VII of Montferrat at the close of the 13th century on the Roman east gate of the town, remains of the towers of which were incorporated in it It owes its name to the widow of Charles Emmanuel II, who added the west façade and the handsome double flight of steps from Juvara's design (1718). The extensive royal palace was begun in 1646 Many of the baroque palaces have fine pillared courtyards, some of them are the work of Guarini. The tower of the citadel (1565) contains the artillery museum The Castello del Valentino is partly in the French style of the 16th century. It contains the polytechnic school, and geological, mineralogical and industrial museums, and the university botanical garden. The university, founded about 1400 by Lodovico di Acaja, had 2,049 students in 1925–26. The engineering school had 1,243 students and the institute of commerce and economics 554. The old university buildings erected in 1713 by the Genoese architect Ricca contain the library, some treasures of which were lost by fire in 1906

The academy of sciences, founded in 1757, is in a building erected in 1678 by Guarini and contains the local antiquities of Piedmont and Egyptian treasures partly collected by Drovetti, partly excavated in the present century at Thebes, Assiout, etc

The pictures are by Van Dyck and by north Italian masters. There is a museum of zoology and mineralogy in Palazzo Carignano (another of Guarini's buildings), and the royal palace contains the royal armoury (a fine collection begun by Charles Albert in 1833) and the royal library with its rich manuscript collection and its 20,000 drawings.

There are many modern public monuments including those to Emmanuel Philibert (1838), Charles Albert (1861), Victor Emmanuel II. (1899), the Duke of Aosta (1902), Mazzini (1915). The Mole Antonelliana, built by Alessandro Antonelli, is used for the Risorgimento Museum. It is the highest brick edifice in Europe, its summit being 510 ft above ground, the dome being raised upon a hall with three galleries, one above the other. The newer parts of the city, extending towards the south beyond the stadium (1911) are finely laid out.

Among the hospitals is that called by the name of its founder, Cottolengo, a vast institution providing for more than 7,000 persons.

The industries comprise metallurgy, machine-making, chemicals, silk and cotton weaving, tanning and leather-working, artificial silk and fibres, matches, candles, soap, furniture, perfumes, glass, damasks, velvets, woollens, ready made clothing, etc. The manufacture of motor-cars has become of great importance. Turin is the chief seat of the industry in Italy. Aeroplanes are also manufactured. and chocolate, liqueurs and vermouth are made. The application of electricity is widely developed on account of the proximity of the Alpine valleys, and the hydro-electric plants of the Mont Cenis, the Val d' Aosta, and the Toce valley all concentrate on Turin.

Milan, owing to its nearness both to the St. Gotthard and to the Simplon, is the most important railway centre of Italy. Turin is however nearest to the Mont Cenis, while the completion of the line through Cuneo over the Col di Tenda now affords direct communication with the French Riviera.

On the Hill of Superga (2,300 ft. above the sea) Victor Amadeus II erected a basilica in memory of the liberation of Turin from the French in 1706. King Charles Albert and other Savoy princes are buried in the crypt. Not far from Turin are also the royal castles of Moncalieri, Stupinigi, Rivoli, Racconigi, Agliè, Venaria Reale.

Turin was made the chief town of Piedmont by Amadeus, first duke of Savoy. (*See* SAVOY, HOUSE OF) Between 1536 and 1562 Turin was occupied by the French, and in 1630 it lost 8,000 of its citizens by the plague. The French were masters once more from 1640 to 1706, and again from 1798 till 1814, when Piedmont was restored to the house of Savoy.

The ancient *Augusta Taurinorum* was a city of Gallia Cisalpina, the chief town of the Taurini. The natural advantages of its site and its position with relation to the pass over the Alpis Cottia (Mont Genèvre: *see* COTTII REGNUM) made it important, though Hannibal, after crossing the Alps in 218 B.C., was able to take it after a three days' siege. It was partly burned down in A.D. 69, but continued to be prosperous. The Roman town formed a rectangle 2,526 ft. by 2,330 (770 × 710 metres). This measurement is questioned by F. Haverfield, *Ancient Town-Planning* (Oxford, 1913) 87, but is confirmed by an article by U. Savoia in *Town-Planning Review* xii. (1927). The walls, which were 21 ft. high, 7 ft. thick at ground level and 3 ft. at the top, were standing till about 1600; and the north gate, the Porta Palatina, exists. The interior of the town was divided by seven streets from east to west and eight from north to south into 72 blocks (*insulae*), and the ancient pavement and the drains below it are frequently found under the streets of the central portion of the modern town, indicating that they follow the ancient lines Remains of a theatre have been discovered in the palace garden.

See C. Promis, *Storia dell' antica Torino* (Turin, 1869); A. d'Andrade, *Relazione dell' ufficio regionale per la conservazione dei monumenti del Piemonte e della Liguria*, 7 *seq.* (Turin, 1899).

(T. A.)

Battle of 1706.—Turin was besieged in 1706 by the French under La Feuillade (*see* SPANISH SUCCESSION, WAR OF THE) who was covered by another army under the duc d'Orleans. Eugene of Savoy (*q.v.*) marching to the relief of Turin with 30,000 Austrians and Germans, eluded Orleans and in mid-August appeared before the French siege lines. The united armies of Feuillade and Orleans numbered over 70,000 men, but on Sept. 7 Eugene boldly attacked them in their entrenchments between the rivers Doria and Stura. After the usual artillery duel, Eugene gave the order to advance. The Brandenburgers on the left quickly got to within a few paces of the entrenchments, but were driven back by the French fire. Eugene then led the Germans on his left in a brilliant attack which stormed the entrenchments. Seeing this, Eugene's cousin, the duke of Savoy, attacked the French centre and, after three repulses, stormed it, Orleans being wounded, and his lieutenant, Marshal Marsin, killed. The French tried to rally, but the garrison of Turin took part in the discomfiture of the fugitives. Feuillade raised the siege and joined Orleans in a disorderly retreat. Each side had about 3,000 killed and wounded, but 6,000 prisoners fell into Eugene's hands and French prestige in Northern Italy was destroyed.

TURINA, JOAQUIN (1882–), Spanish composer, was born at Seville on Dec. 9, 1882. He studied under D'Indy, in Paris, from 1905–14. On his return to Spain he brought out an encyclopaedia (*Enciclopedia abreviada de la música*, Madrid, 1917). His principal works are: *Procesión del Rocio* for orchestra; music for the morality play, *La adúltera penitente;* a dramatic work, *Jardín de oriente* (1923); a pianoforte quintet, a string quartet, *Escena Andaluze*, for viola, pianoforte and string quartet; *Poema de una Sanluquena*, and songs.

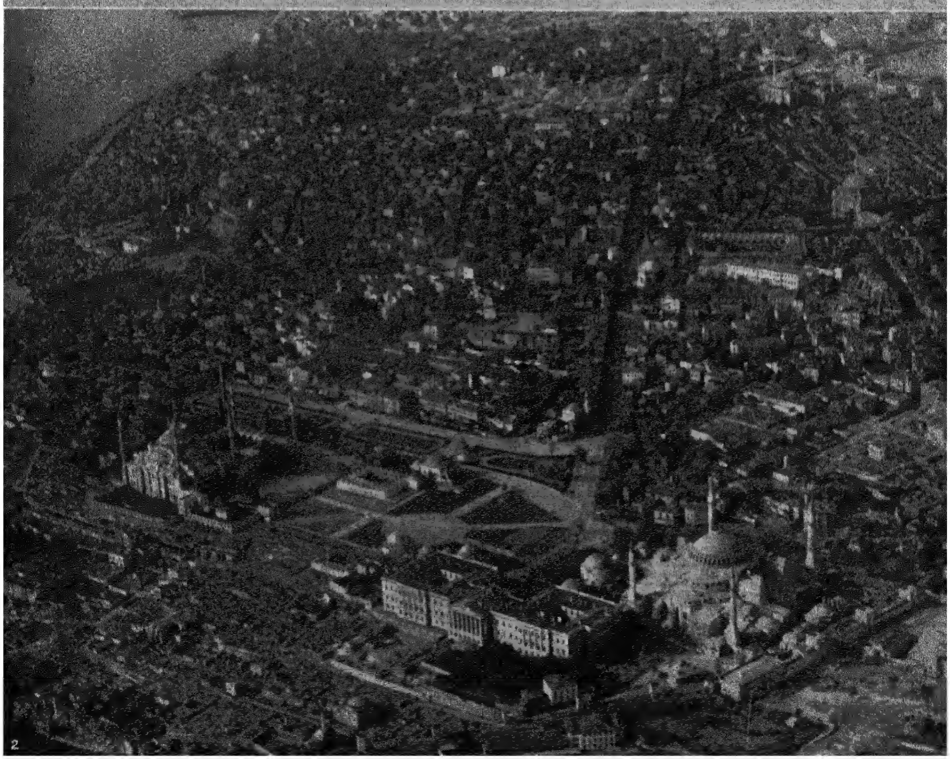
TURKESTAN: *see* TURKISTAN.

TURKESTAN (Haziet, Yasi), a town in the Kazakstan A.S.S.R., in 43° 8′ N., 68° 18′ E., on the Orenburg-Tashkent railway 20 m. E. of the Syr-Daria river, alt. 833 feet. Pop (1926) 21,786. Its main industry is cotton, and it acts as a depôt for the collection of hides and wool It is an ancient town and in 1397 a Persian architect was commissioned by Timur (Tamerlane) to build a mosque in honour of the Kirghiz patron Hazret Yasavi.

TURKEY. The present area of Turkey-in-Europe and Turkey-in-Asia combined, as contained within the frontiers fixed by the Treaty of Lausanne, is 1,013,000 sq kilometres. The population of this republic as estimated by the census of 1927 was over 13,600,000 but a careful estimate made by European authorities in 1926 put it at 13,200,000.

The present frontier of Turkey in Europe runs from Aghios Stephanos on the Black Sea (near Cape Iniada) along the line of the small river Resvayiap due west to Kizil-Kilisse and the river Tundza. Hence it proceeds south-westwards to the river Maritsa which it crosses between Mustafa Pasha and Kedikeui. From here it turns sharply south and then south-eastwards and reaches the left bank of the Maritsa which it follows to the Aegean sea to the mouth of that river at Enos. This frontier was substituted at the Treaty of Lausanne for that fixed by the Treaty of Trianon which ran from Ormanli, just south of Midia, to Kallicrateia opposite Büyük Chesme on the Sea of Marmora. The whole of eastern Thrace was thus given back to Turkey and a substantial Turkey-in-Europe recreated. The frontier above described is against Bulgaria from Aghios Stephanos to a point south of the Maritsa at Hortakeui. From here to the Aegean it is against Greece. The main railway-line from Europe via Sofia to Constantinople enters Turkey near Mustafa Pasha but passes over the Turkish border again just south of Adrianople into Greek territory which it traverses for some ten miles along the west bank of the Maritsa.

The chief land-frontier of Turkey however is in the east. From a point about 20 miles south-west of Batum it extends south east keeping Artvin in Turkish territory and leaving Akhaltsikh to Russia. It then passes in front of the Russo-Armenian towns of Alexandropol and Erivan, and turns due south at Mt. Ararat. From here it passes the town of Bayezid leaving Urmia and Lake Urmia to Persia and running along a mountain ridge. Near the town of Amadia it turns due west along the Iraq frontier to Jezireh where the Arabian and Syrian frontiers begin. From Jezireh it goes north of Urfa and Marash to the Sea just east of Adana.



PHOTOGRAPHS, (1) MERL LAVOY, (2) ORIENT AND OCCIDENT

VIEWS OF CONSTANTINOPLE

1. Inside the outer bridge of the Golden Horn, where native craft dock and the water guilds that handle the business of the harbour are stationed. On the left (background) is the Mosque of Suleiman the Magnificent, built by Sinan

2. Aerial view of Stamboul, the oldest section of Constantinople. In the foreground is the site of the ancient Hippodrome (about A.D. 196), faced (right) by the church of Saint Sophia and (left) by the Mosque of Ahmed

Geology and Structure: *see* Asia Minor.

Geography.—There is a geographical unity in Asia Minor and Turkey in Europe which largely explains the cultural unity which prevailed in the same region in the earliest times. Asia Minor is, in the main, a high plateau or rolling downland sinking on all sides except the east to a region of wooded foothills from which valleys lead directly or indirectly to the sea on north, west and south and to flat alluvial plains on the south-east. Eastwards the plateau tends rather to rise in height and to change into abruptly broken and mountainous country. Thrace, or Turkey-in-Europe, is a continuation of the foothills to the north-west, with the Bosporus depression intervening to let pass the accumulated waters of the Black Sea. Marmora is a hollow which has been filled up by these intervening waters and the Dardanelles a secondary trough through which they have slowly pushed their way.

On the west the foothills of the plateau are penetrated by two main river valleys the Gediz Chai (the ancient Hermus) and the Menderes (the Maeander) which each give a penetrative route eastwards for some hundred and fifty miles. The Sakaria, which runs roughly south from the Ismid region and the Kizil Irmak (the Halys) which runs south-westwards and then nearly completes a circle, are barriers to lateral traffic rather than passages for intrusion. In Thrace there is only one river of importance—the Ergene—which is a tributary of the Maritsa

The surface character of the country corresponds closely with the climatic conditions. The whole of the coast for a depth of about 75 miles on an average (except on the south where it is slightly narrower) is forest or bush-land. Above the 2,500 foot level this vegetation ceases and the core of the plateau emerges The forest region is densest on the north coast where the climate is essentially Pontic and the wooded strip is continued across the Bosporus into eastern Thrace along the Black Sea up to the Balkan Ridge From a point near Mudania on the south coast of the Sea of Marmora to Batum on the Russo-Turkish border the country is homogeneous, being wild, thickly wooded and brought into cultivation only in narrow strips along the coast and, from Ismid to the Kastamuni district, in valleys parallel to the coast. Westwards the coast is cultivated extensively as far as the Troad, although a patch of wilder country intervenes between the Troad and Smyrna. But from Smyrna inland as far as the Sakaria and right down to the south coastline opposite Rhodes the bulk of the land is highly cultivated; it is here that the bulk both of the economic wealth and the population are derived From Adalia to Mersina, however, and further east still, the enormous ridge of Akseki Dagh and Bulgar Dagh repeats, but with more emphasis and with greater elevation, the forest and mountain features of the Pontic shore. East of Adana the same mountain ridge continues in a double massif towards Armenia and the uplands of Diarbekir The plateau is thus rimmed round except on the west with a mountain and forest edge, in which the mountains often achieve a very much higher elevation than the central plateau.

The landscape of Anatolia varies little. Mountains, valleys and plateaux form its main constituents Marsh and lake are rare. Only in the central waste land near Konia is there anything of the kind and a small group of lakes in the Isbarta region.

Climate.—The climate of Asia Minor is threefold. From the Troad to Batum along the wooded coastal strip it is what can be called Pontic—that is to say it shares the rigours of winter and the warm summer moisture of the Black Sea regions. The hills are under snow in the spring and winter months and the icy winds of Russia blow across unimpeded. Constantinople itself has a climate which in no respect resembles that of the Mediterranean, either in summer or winter. The mean temperature in that city (Fahr.) in January and February is 41° and in August is 74·5°, with a daily maximum of only 82°. Eastern Thrace shares the same Pontic climate as Constantinople and receives the same continuous breezes in summer and blizzards in winter that come from South Russia.

From the Troad along the Ionian coast to Aidin and round to the south coast as far as Adana the coastline and the foothills of the plateau enjoy a climate that is essentially Mediterranean.

The remainder of Asia Minor up to the present frontier on the east has frequent light snowfalls in winter and a dry hot summer, averaging some 90°. The chief rainfall comes in early summer in the very centre of the plateau and there is the smallest in all Turkey, being under 10 inches per annum. This area is that between Kutahia and Kaisarieh and includes the central desert. Outside this zone and up to the wooded coastal belt the rainfall increases and is between 10 and 20 inches. The belt itself has the heavier fall of between 20 and 30 while most of eastern Thrace and Gallipoli has the maximum of 30–40 inches.

Flora and Fauna: *see* Asia Minor.

Archaeology.—Turkey-in-Europe and Turkey-in-Asia form a unit of ancient culture which is almost complete. The present boundaries correspond strangely with the most ancient that can be established for a unity of Anatolian prehistoric civilisation

North-westwards the unity is not so marked and there are as yet no known sites in Eastern Thrace and the Dobrudja which can extend the area

It is impossible for us to establish either the earliest date for human habitation in Asia Minor, or the affinities of the most primitive objects hitherto found Our knowledge begins really with the intrusive peoples of the early Bronze Age or of the Chalkolithic Age and our only fully excavated site for this period lies on the periphery rather than in the centre of the region—namely Troy (Hissarlik) and even so it was excavated some fifty years ago when the science of stratigraphical excavation was hardly developed.

Geographically the river Halys has always formed a boundary in Asia Minor. Within its wide sweep there developed towards the end of the third millennium B C a civilisation which can be regarded as wholly Anatolian—the Hittite (*q v*) The origin of this vigorous and virile culture is at present unknown But in all probability it was composed of a blend of indigenous Cappadocian culture with instrusive elements from west and north-east. It was probably the most characteristically Anatolian culture that has ever grown up in the plateau of Asia Minor. In comparison the culture of Troy, which lived as its neighbour, must be considered as European.

In the middle of the third millennium, and even earlier, the highlands of Cappadocia were being actively exploited for their precious metals and their copper by colonies of Semitic speaking peoples whose transactions have been found recorded on tablets at Kul-Tepe, a village not far from Boghaz Keui (the site which later became the great capital of the Hittite empire). While these Semites were exploiting the region the Hittite empire had not even begun to germinate By 1750 the Hittites are heard of in Babylonian records They are then powerful, organised and militant Boghaz and Boz Eyuk in the Yozgad region are the greatest and the earliest Hittite sites thus far explored The great library of archives in the shape of tablets inscribed in cuneiform at the former site constitute our greatest body of first hand evidence for Hittite culture

By 1400 the Hittite Empire was at the height of its power and had become an international state of great importance in the Near East. Gradually the Hittite extended southwards towards Syria, and Carchemish on the upper Euphrates became an outpost city of great importance and wealth, while the whole of the modern province of Aintab bears witness to Hittite settlement. But in 1288 at the battle of Kadesh, Hittite power received a check. Soon after, about 1200, a disaster seems to have overtaken both the Hittite Empire and the more European power in north-west Asia Minor. Troy and Boghaz Keui seem to have been wiped out more or less at the same time.

Of the Phrygians we know all too little, but we can be certain that after 1200 they form the predominant element in Northern Anatolia, that they are racially akin to the Achaeans of Greece, that they are Aryans by race and speech, and that their language is closely allied to Latin on the one hand and to Thracian on the other. But again our archaeological evidence is wanting. We have no archaeological context for them Gordion, an admittedly Phrygian site, is late and tells us nothing of the Phrygians of a time before 1000 Whoever they were—and perhaps they can be identified with the people known as the Muski or Moschoi—they

succeed the Hittites as masters of Anatolia. They are also virile enough to have lasted as a separate people into the third century of our era, using their own language down to Christian times

As the Hittite Empire fell so the southern colonial settlements like Carchemish became isolated city states more or less dependent upon the rising Assyrian power. Hittite cities are few; besides the three already mentioned there is one more, recently identified (in 1927), at Kungin Kaleh on the Halys near the point where the new Angora-Kaisarieh railway crosses it. It is of great area and evidently a site of considerable importance. Its walls can still be traced But signs of Hittite domination are found widespread in Asia Minor in the shape of rock-sculptures and fortresses.

From the time of the fall of the Hittite Empire about 1200 B C the history of Asia Minor becomes obscure and archaeology has little to give us By the end of the seventh century the Lydian empire had established itself on the ruins of the western part of the Hittite regions The Ionian coast, always a self-contained region whose inhabitants lived a life apart from that of the rest of the Asia Minor, contained a heterogeneous body of settlers who had never fallen directly under the Hittite yoke and who were never united into one power until the Persians welded their empire to reach to the Aegean Lydians, Lycians, Carians and many other semi-barbaric peoples had retained a semblance of independence throughout the Hittite domination largely because of contact with the Achaeans and seafaring peoples of the west.

Lycians and Carians, however remain without archaeological content except for the sixth century tombs of Lycia, based wholly on the Greek styles of architecture and sculpture.

The fall of Troy and of the Hittite empire alike laid the Anatolian coast open to western enterprise and by 700 Greeks were pouring over from the islands and the mainland and founding colonies and settlements along the whole coastline. Ephesus, Priene, Magnesia on the Maeander, Miletus and Sardis have been thoroughly excavated and throw a flood of light upon the Greek period from 650 down to the Hellenistic times Pergamon has produced the finest discoveries of the Hellenistic period in the shape of the mighty sculptures of the altar of Zeus, now to be seen in Berlin Tralles has added to our knowledge of Hellenistic art Sardis illuminates us but little for the earlier Lydian period but fully for the Hellenic Clazomenae and Cnidus have given us of the treasures of early Greek art.

The Roman period is as fully represented and at Angora survives one of the most important Roman documents extant in the shape of the *Monumentum Ancyranum*, the will of Augustus, inscribed on the walls of a small temple. Roman roads as well as roads built by the Persians, Roman aqueducts and the elements of a prosperous Roman province survive throughout Anatolia.

Byzantine power is represented by many great cities of which Nicaea (Isnik) was the most important, as being the centre of Greek reaction and reorganisation after the Latin conquest of Constantinople in 1204 Unfortunately nothing of Nicaea now remains except the walls, and all the churches, in which were some of the finest mosaics extant, were destroyed during the Turco-Greek war of 1921 Aphrodisias, a Byzantine town of the interior along the Maeander valley inland from Aidin, has produced an astonishing wealth of exceptionally interesting works of early Byzantine art

Turkey-in-Europe has, for political reasons remained inaccessible to the archaeologist There is no excavated site there or in the Gallipoli peninsula Yet the plains of eastern Thrace are studded with the tumuli and settlements of many races and the importance of excavation in those parts is manifest. Ainos (the modern Enos) at the mouth of the Maritsa river is an old Greek colony and there are many others along the shores of Marmora. Cyzicus near Panderma is the largest site in the Marmora region but it has never been excavated Gallipoli was in antiquity fairly well populated in the Hellenic period, mainly by Athenian colonies.

Population.—All statistics for population in Turkey are suspect No reliable and absolutely trustworthy census has yet been taken. Even that taken on October 28, 1927 is not to be relied on since the method of counting was not adequately controlled. The total given by that census was 13,647,810.

Constantinople is said to have a total of 1,011,265 inhabitants, though in the recent census the total was given as some 850,000. The larger number, however, may be taken as including all the suburbs along the Bosporus and the Golden Horn, while the smaller number represents only the strictly urban population. Of the total of 1,011,265 a majority is Turkish—682,801 in all. There are 181,188 Greeks, 81,357 Armenians, 3,782 Bulgarians, 387 Greek Catholics and 61,750 Jews and other nationalities.

A TURK PASSING A LEISURELY HOUR SMOKING THE LONG "HOOKAH"

In Anatolia and Eastern Thrace, on the other hand, the distribution of populations has changed completely since 1922. The Greek population of these two provinces was some three million. During the period of the Greco-Turkish war of 1921–1922 half of this total emigrated into Greece and have under the auspices of the League of Nations been permanently placed in the new provinces of Greece, Thrace, Macedonia, and also to a large extent in Attica and Thessaly The remaining one and a half million have vanished Their disappearance can be attributed to starvation, massacre (of which that of Smyrna in 1922 was the most serious) and gradual extermination.

To counterbalance this serious loss of an industrious population Turkey can show only some 500,000 Turkish subjects who were exchanged for equal numbers of the Greek emigrants. The setback to Turkish prosperity by this expulsion and extermination was serious, but there are signs that the country is now beginning to recover. The most populous vilayet is that of Smyrna which totals 532,009. Konia comes next with 502,228 while that of Angora has 404,725 and that of Brusa 399,545 Eastern Thrace is still fairly populous despite the loss of the Greeks who formed a high proportion of its inhabitants The vilayet of Adrianople has no less than 150,889 inhabitants while that of Rodosto on the Sea of Marmora (originally a Greek town) has 132,120. The total population shows an excess of some 500,000 women over men, a condition largely caused by the war

The capital is now Angora which has a population of some 75,000 and is a growing city, but since 1928 the Government has shown a tendency to use Constantinople as the capital during the summer months.

Statistics are not available to show the total numbers of Kurds, Circassians, Armenians, Arabs and other nationalities in the various vilayets.

On the whole Turkey has abandoned the old Ottoman idea of Imperial sway over many races and in its place has adopted an uncompromising nationalism which seeks to assimilate all subject races to the Turkihs This has naturally provoked certain opposition, particularly on the part of the Kurds, who have a very highly developed sense of nationalism But with most of the other races it is certainly succeeding and Turkey to-day presents a much more homogeneous appearance that she did before the war Constantinople has the greatest racial mixture.

The total number of Jews in Turkey is about 150,000. The bulk of these are the Spanish Jews of the same type as those found at Salonika, of the Sephardim group. The rest are Polish Jews of the Ashkenazim group or Denumehs (Jewish converts to Islam).

Treaties and Constitution.—The present boundaries, treaty arrangements and constitution of the country result in the main from the Treaty of Lausanne which was signed on July 24, 1923, between Turkey on the one hand and Greece, Great Britain, France and Italy on the other. A subsequent treaty was signed between Turkey on the one hand and the governments of Iraq and Great Britain on the other on June 5th, 1926, by which boundaries between Iraq and Turkey and other matters were arranged. A treaty was signed at Kars (Oct. 13, 1921) between Turkey and the Caucasian republics of Armenia, Azerbaijan and Georgia,

confirming Turkish possession of the three Sanjaks of Kars, Ardahan and Batum (excluding the town of Batum).

For the signing of the National Pact and the establishment of the Turkish Republic *see* the section HISTORY. The existing Grand National Assembly has now been put on an electoral basis and there have been two general elections in Turkey since 1922. Deputies are elected by selected voters There are what are called First Class Electors and Second Class Electors. The former class consist of those citizens who are not foreigners or undischarged bankrupts and who have not, by reason of service with foreign embassies or consulates acquired special privileges or rights. These electors elect voters of the second class who proceed to the election of the deputies. There are some 400 deputies in all and they are paid LT 3600 per annum.

The sequel to the abolition of the Caliphate came on April 10th 1928 when the Grand National Assembly in session at Angora unanimously approved of the proposal put forward by General Ismet Pasha, the Prime Minister, that certain articles of the Constitution should be amended in order to separate religion from the State. In detail his proposal was that a new law should be substituted for Articles II, XVI, XXVI and XXXVIII of the Constitution. These articles dealt with the form of oath taken by Deputies and the President The new law makes the oath secular and so dissociates religion from State proceedings.

Local Government in Turkey is highly organised and of ancient standing The country is divided into vilayets or provinces, kazas or counties, nohiyes or districts which contain smaller units of government in the Kassabas (towns) and villages A vali is the chief administrative officer of a vilayet being appointed by the Minister of the Interior and representing directly the Grand National Assembly The head of a kaza is a kaimakam, who is also appointed by the Minister of the Interior The head of a nahiye, however, is a mudir and is appointed by the District Assembly The vali has an administrative council to assist him

There are both Provincial Assemblies of the vilayets and District Assemblies of the nahiyes The Provincial Assembly meets once a year for a minimum of 15 days and a maximum of 40. with the vali as its president Delegates to this assembly are elected by kazas in the proportion of one delegate to 18,750 male or two for 31,250 Above the latter figure delegates are elected one for each 12,500 males.

After the reorganisation made in 1923 there were 62 vilayets in Turkey-in-Europe and Turkey-in-Asia. Of these 62 vilayets 8 only were in Europe The ancient system gave only 12 vilayets altogether for the whole of the Ottoman Empire The reorganisation has therefore further decentralized the government even more than before

One result of the Treaty of Lausanne was to establish from an international point of view the régime of the Dardanelles and the Bosporus Article 23 of the Treaty of Lausanne lays down the "principle of freedom of transit and navigation (by sea and by air) in time of peace as well as in time of war" The fullest facilities are to be given to the shipping and the aeroplanes of all nations in time of peace. In time of war, if Turkey is a neutral, the rights of international shipping are still considerable and if Turkey is a belligerent the Straits shall still be free for all neutral shipping, although the right of search shall be kept by Turkey. No fortifications other than those requisite for local protection of shipping shall be allowed and all the forts of the Bosporus and the Dardanelles are dismantled. A permanent Allied Commission of the Straits sits at Constantinople.

Education.—The bulk of the population of Turkey is still illiterate. Recent estimates give only 15% as educated and able to write. The problems that face the present government are therefore pressing. The law of 1929 which introduced Latin characters as compulsory in the place of the old Arabic is not so gigantic an educational problem as it would appear in larger and more educated countries. Angora is to control the whole educational system and its finance.

Under Article 87 of the new constitution primary education is now obligatory on all who are Turkish by birth. Government schools correspond exactly to British elementary schools. In March 1924 a total of 490 medressehs (Church schools) were closed and the primary schools were opened. 19 secondary schools have also been established with 7,400 pupils and co-education is encouraged in both types of school. The number of primary schools is said to be 6,000, with 430,000 pupils. There are also 23 training schools for teachers for commerce and agriculture, with 5,200 students.

Higher education is provided at technical schools, at the Law School of Angora and at the Stamboul University, which now occupies the offices originally built for the Ministry of War—the Seraiskerat. There are technical schools at Stamboul the École des Arts et Métiers for mechanical training and instruction in carpentry; at San Stefano (for Agriculture); for Forestry at Buyukdere and for Viticulture at Erenkeui At Haidar Pasha there is an excellent Veterinary School The University of Stamboul has five Faculties—Law, Letters, Science, Medicine and Theology, and a reasonably high standard There is also an École Normale

The most important foreign institution is Robert College where pupils are taken irrespective of race or religion The teaching staff consists of 64 instructors of whom 31 are American. The students number about 500 The College for girls has a teaching staff of 50 with some 350 pupils These and other foreign schools were, at the Treaty of Lausanne, put upon the same basis as Turkish schools

The terms of the Treaty of Lausanne allowed for the establishment of schools for Greek and Armenian minorities. But the extermination of these races outside Constantinople has made the clauses applicable only to that city There are 62 Greek schools with over 14,000 pupils, 53 Orthodox Armenian under the charge of the Armenian Patriarch, and 14 Armenian Catholic.

Justice and Law.—The old system which obtained before the National Assembly revised the constitution was based on the Sunni Moslem law which was religious in origin and sanction and based upon the teaching embodied in the Koran That it worked well is undisputed and a very high standard of justice was reached even so early as the sixteenth century, when the Sultan Suliman the Magnificent raised the level of administration to a higher level than was then current in western Europe. The tradition of sound popular justice survived and the courts of the Ottoman Empire, despite the capitulations, and despite their notorious slowness were. before the time of Abdul Hamid, mediums of justice not inferior to those of Christendom In 1869 the religious law was codified into a Civil Code known as the Mejelle and combined with the statute law constructed by successive Sultans. As from May 1. 1924, however, the whole of the old code was abolished and the religious sanctions removed A new judicial system was organised on a secular basis and in 1926 a Civil Code was established based and modelled upon the present Swiss code. The courts are now classified into (1) Police or local justice courts administered by Justices of the Peace, (2) District Courts under a President and two Judges with civil and criminal powers that concern marriage and divorce, probate and civil rights, (3) Assize Courts under a President and four Judges for serious criminal cases and finally (4) the Court of Cassation which is the only court of appeal. This latter is situated at Eskishehir in Asia Minor and is independent of Angora and Constantinople.

Ministers and high state officials are tried by a High Court composed of eleven members of the Court of Cassation and ten members of the Council of State.

There are in all some 600 police courts of which 160 are in villages. Independent of all these courts are the two Tribunals of Independence which are arbitrary judicial bodies in perpetual session but without any fixed place of session. They are like travelling assizes but their purpose is mainly political and they are the consequence of the dictatorship by which the country is really governed. Each consists of a board of three judges and they are similar to courts martial since their origin and methods are mainly military. In essence they override the law of the land as otherwise administered. Trials, however, by these courts are in public and penalties inflicted are according to the existing laws

as far as possible. They are under the control of the National Assembly in theory but in fact more the instruments of the President of the Republic. They exist primarily to combat political and military conspiracies, mutiny, treason and desertion. In 1926 some 17 well known persons were condemned to death and hanged by the decisions of these tribunals as being concerned in a plot against the republic. These tribunals were, however, suspended in March 1927, though they can be reconstituted.

The change in the civil code has been followed by the abolition of polygamy and by the grant to women of equal rights in divorce and marriage, though their political status is still unchanged. In divorce in particular there have been established enactments of considerable wisdom and breadth of mind

Foreigners are guaranteed equal rights with Turkish citizens in the law but they have neither superior status nor privileges except in certain matters of personal rights and status

In detail the dress regulations which have the sanction of law are as follows All officials except those to whom special uniforms are assigned must wear western costume. In the National Assembly frock coats are obligatory and the President must wear dress clothes and a top-hat The fez and turban are abolished Women are not so strictly disciplined. The veil is still seen frequently in Constantinople and also in the provinces although the general custom, however, is to wear a headdress of a type based upon the modern Russian

Tenure of Property.—Real property is held in one of four various ways: either *mulk*, *emiriyē*, *vakuf* or *khaliyē* (1) *Mulk* is the absolute property of its owner, and can be disposed of by him as he wills without restrictions, save those enumerated lower down (*General Dispositions*) as general for all the four classes (2) *Emiriyē* is practically "public domains" The state may grant land of this category to private persons on payment by the latter of the value of the proprietary right—the tithes, ground-rent (should there be private buildings upon it), and the land-tax. *Emiriyē* cannot be mortgaged, but can be given as security for debt on condition that it be restored when the debt has been repaid; no forced sale may take place after the decease of the debtor. *Emiriyē* is not transmissible by will, but may be transferred by donation, which returns to the donor should he outlive the beneficiary. Should a proprietor of *emiriyē* plant trees or vines, or erect buildings upon it, with the consent of the state, they are considered as *mulk* The *emiriyē* then becomes *mulk*, with certain restrictions as to transfer dues A transfer duty of 5% on the estimated value of *emiriyē* is paid on transmission by sale, inheritance or donation, of 2½% on the amount of the debt in case of mortgage or release from mortgage, and of 10% on expenses of registration A different scale is established for *emiriyē* with *moukataa* (rent paid for *emiriyē* with *mulk* property established upon it) (3) *Vakuf* is "all property dedicated to God, of which the revenue is consecrated to His Poor"; or "property of which the usufruct, such as tithe, taxes and rents, is attributed to a work of charity and of public interest" When once a property has been registered as *vakuf* it can never be withdrawn. There are two classes of *vakuf:* (*a*) Land so declared either directly by the sovereign or in virtue of imperial authority under past régimes; (*b*) lands transformed by their properties from *mulk* into *vakut.* The laws and regulations concerning *vakuf* are too intricate to be described; generally it may be said that they form a great obstruction to dealing with a large proportion of the most valuable property in Turkey, and therefore to the prosperity of the country The *vakufs* are administered by a special ministerial department (*evkaf nazareti*), whose property on behalf of the state, they theoretically are. (4) *Khaliyē.* This property is also styled *mevad.* It consists of uncultivated or rough lands, such as mountains, stony ground, etc., which are useless without clearance, to which no possession is claimed, and which are at such a distance from the nearest dwelling that the human voice cannot be made to reach them from that dwelling Any one can obtain a gratuitous permit to clear and cultivate such lands; the laws governing ordinary agricultural lands then apply to them. The permit is withdrawn if the clearance is not effected within three years. If the clearance is effected without the necessary permit, the land is nevertheless granted on application, and on the payment of the *tapu* or sum paid by the proprietor to the state for the value of the land.

Agriculture.—In all only about 20% of the total area of Turkey is under cultivation. But since 1925 zones of development with Directors of Agriculture have been formed for the further development of the country. Further the Agricultural bank has been established upon a state-controlled footing, in order to facilitate loans to local groups and individuals. Agricultural schools have also been established where free instruction is given In all some three hundred thousand refugees from the old provinces of Turkey in Europe have been settled and all tithe payments have been abolished The latter reform was effected in February 1925 and in its place a system of land-taxation fixed which is based rather upon the productive than upon the area of the soil At the same time a modified form of land-tax survives in the shape of a 6% per thousand tax on land values based upon the registered value of lands as established in the year 1915.

BY COURTESY OF GERLINGS
A PORTER CARRYING A LOAD ACROSS THE GOLDEN HORN PONTOON BRIDGE

The most important agricultural product of Turkey is tobacco The value of the crop exported in 1922–24 exceeded by 20% all other exports. But in 1926 the quantity exported was below expectation Tobacco is grown throughout Turkey and varies greatly in quality The best comes from the Pontic coast near Samsoun and also from Bafra, Sinope and Trebizond Samsoun tobacco fetches the highest price at 200–250 piastres the kilogramme; that from the marmora region the lowest at 70–95 piastres. Smyrna tobacco is largely bought by Germany. In 1925 the Government transformed the "Régie des tabacs" into a State Monopoly, and at the same time made a monopoly for cigarette paper The United States of America are the largest purchasers of Turkish tobacco grown in Turkey The consumption within Turkey itself is about 10 million kilogrammes.

Cereals are not a very large crop and suffice only to provide three-quarters of the needs of the population. Angora, Sivas, Kastamuni and Konia are the chief corn-producing areas.

Cotton is largely grown in the south of Asia Minor, near Adana, where some million and a quarter acres are under cultivation Near Smyrna also there is a growing cotton industry, and in 1925 some 40,000 bales were produced, which amount is almost the same as the pre-war output

Figs as an article of commerce in Turkey come exclusively from the Smyrna region The average annual output is about 25,000 tons. Nuts are extensively grown in the Pontic districts in the wooded belt. The Trebizond crop in 1925 was some 25,000 tons valued at nearly a million pounds sterling America is the principal customer and they are bought mainly by chocolate manufacturers Filberts, walnuts, chestnuts and almonds are the chief nuts exported.

With Italy, Spain and Greece, Turkey is one of the chief exporters of olive oil The Brusa region and the Ionian coast are the principal areas of cultivation Some 40,000 tons of oil were prepared in 1925, but the methods of extraction are still primitive and the war damage in the olive-growing regions was extensive.

Opium poppies are grown in the Smyrna, Malatia and Tokat regions and the average yield is some 3,000 to 5,000 cases, a large decrease on pre-war years. The opium so produced is almost wholly exported for medicinal uses, principally to Holland

Sugar beet is a wholly new crop for Turkey. A company has been founded with a capital of LT 300,000 and there are factories, constructed during the last three years at Alpulu in eastern Thrace and at Ushak The former can deal with 150 and the latter with 500 tons of beet a day. The factories and the company involved has special government protection and exemption from taxation. Considerable quantities of sugar are now being refined

for local consumption.

The silk industry, being one of those which relied upon the skilled work of Greeks and Armenians, is virtually dying. There are now only 42 factories as compared with the 160 of 1914.

In livestock the country is rich and the pastures are good. In 1926 nearly 13,000,000 sheep, 5,000,000 cattle and 500,000 buffaloes were recorded The Angora goat which still thrives on the uplands of the plateau is one of the most profitable of all livestock in Turkey 2,760,502 were recorded in 1926 whereas there were only a million and a half in 1924 The export of mohair derived from their skins is almost exclusively to Great Britain

Forests.—Nearly 9% of the total area of Turkey-in-Asia is forest land, covering an area of some 25,419 square miles A large proportion of Eastern Thrace is under forest and uninhabited, amounting in all to 1,648 square miles Pines are 37% of the total and oaks 14%. Cedars and beech are common. The Pontic coast and Cilicia are the most deeply wooded areas. Afforestation is unknown and any scientific knowledge of forestry is as yet in its infancy. But the concentration of population in the towns and coastal areas and the paucity of inhabitants has prevented the extreme deforestation that one finds in Greek lands. There is in fact a body of 2,500 officials primarily concerned with forestry and an actual school of forestry in Constantinople. The chief forests are in the Pontic region near Sinope and near Amasia Here they are continuous and dense. In the Taurus they are considerable but not so dense

Mineral Wealth.—In coal Turkey, compared with other Balkan lands is relatively rich The coal-fields of the Eregli region, on the Pontic coast some 150 miles from Constantinople, are largely worked and have been productive for over 80 years. In all there are some 80 concessions at work and as much as a million tons has been produced annually The workings are mainly open and on the sides of cliffs There is another group of mines in the bay of Kozlu some 18 miles to the east Further along still is Zunguldak, served by a modernised port The mines here are some 5 miles inland Other coal-bearing regions exist still further to the east An annual average for the mines of all these districts together, omitting Eregli, has been estimated at 900,000 tons The only other coal-fields are in the Erzerum district, but owing to the disturbed state of this region and its proximity to the Russian frontier it is doubtful if they are now worked Eregli coal is the best Lignite is found at many places in Anatolia and also at Keshan on the sea of Marmora Other minerals are gold, found in the Taurus and in the Smyrna and Brusa regions, but not now worked; silver, principally in the Taurus; zinc, tin, sulphur, salt, and mercury The petroleum deposits in Erzerum are not worked.

In one rare mineral Turkey has what amounts to a world monopoly—meerschaum It is found in the valley of the river Pursak in the Eski Shehir district. The present Government has begun to organise the mining for this mineral on a regular and more scientific basis Five main quarries in an area of 100 sq.km are worked In 1923 33,738 kilogrammes were exported, the estimated worth being LT 51,150. In 1924 the export had increased Italy, Germany and Austria are the chief purchasers.

Copper is the mineral in which Turkey can be said to be richest There is one large field at Arghana, near Diarbekir on the Iraq-Syrian frontier. The total deposit here has been estimated at 1,600,000 tons. The ore is first treated in furnaces at Arghana and later refined at Tokat. It is ultimately exported from Samsun on the Black Sea The mines are Government property and have yet to be fully and scientifically exploited. The average yield of copper in the ore from Arghana is 16%. Other copper deposits are in the Kars, Trebizond, Sinope and Smyrna regions.

Manganese, which is plentiful in the Caucasus, is found in the Marmora region near the Balia Maaden mines It also occurs near Eregli and in the Smyrna region. Fifty-one concessions are in existence but so far little exploitation has taken place.

Emery is found in the Smyrna and Aidin regions, and is worked by British and American Companies.

Fisheries.—These constitute an important contribution to the wealth of the country. The passage through the Bosporus from the Black Sea of very large quantities of fish gives opportunities for fishing in the narrow and controlled Bosporan waters which are of incalculable value if properly exploited. Byzantium and Chalcedon (on the site of Moda) owed their wealth and their foundation to this source Anchovies, mullet, sturgeon and tunny are the principal fish of value which come from the Black Sea to the Bosporus. Sword-fish, a coarser type, is a further addition, its flesh being greatly prized by those who cannot afford meat Oysters, mussels, lobsters and prawns are common along the shores of Marmora and at the Princes' Islands

No very accurate statistics are available since the industry is entirely without organisation, but in 1922–3 the total amount of fish caught was estimated at 22,000 tons The Bosporus fisheries are further said to be worth £250,000 per annum

The destruction or departure of the Greek population has deprived Turkey of the bulk of its expert fishermen, so that it may be assumed that before 1921 the value of the fisheries was considerably greater

Communications.—Turkey-in-Europe is well served with railways The main line which conveys the Orient Express and all other European traffic to Constantinople has branches from Alapie to Kirk Kilisse and from Muradli to Rodosto on the Sea of Marmora From Haidar Pasha station on the Asiatic shore of the Bosporus a main line runs to Ismid, Eski-Shehir and Angora, bearing considerable traffic From Angora eastwards a line has recently been constructed to Kaisariyeh (Caesarea), being some 500 kilometres in length The section Angora-Kaisariyeh was opened to traffic in June 1927 A continuation to Sivas is now under construction by a Franco-Belgian company and a further extension from Sivas to Samsoun on the Black Sea also now under construction, will complete an extensive policy of railway expansion which was begun in 1923 after the establishment of the new Republic

From Eski-Shehir a main line runs southwards past Kutahia to Afium Karahissar, whence a branch runs to Smyrna From this junction it continues to Konia and Adana across the Taurus range Just east of Adana it enters Syria and so continues to Cairo on the one hand and in the direction of Mosul and Baghdad on the other. Through connections can now be made from Paris to Cairo by coaches which are ferried across the Bosporus from Stamboul to Haidar Pasha

From Smyrna a line runs north to Panderma on the Sea of Marmora and south to Odemish, to Sokia, to Aidin and Egirdir

A light line existed before the war from Erzingan to Erzerum, Kars and Alexandropol, but it is not known whether it is still in use

The main policy of the Turkish government at present is to construct lines which will favour the commercial development of Anatolia and the export to ports of its produce Guarantee bonds to a maximus of LT 200,000,000 have been issued to cover this railway, port development and survey scheme

Shipping and Commerce.—By the Lausanne Treaty the right of cabotage (coastwise shipping) is confined to Turkish ships, and as a result of this provision Turkish ships have increased in numbers, but their progress is hindered by the shortage of credit In 1925 the number of Turkish steamships was 170 of 95,286 tons and the number of sailing vessels 3,745 of 115,767 tons. In 1927 the former total had increased to 186,986 tons

The following table sets out the port traffic in 1924 at the principal ports —

Port and dependencies	Turkish ships		Foreign ships	
	No	Tonnage	No	Tonnage
Constantinople	30,146	1,833,971	4,019	5,445,110
Smyrna	8,451	616,355	2,330	1,356,566
Samsoun .	10,940	3,541,060	493	856,041
Mersin .	5,802	257,439	2,112	736,550
	64,348	6,248,825	8,954	8,394,267

The principal exports of Turkey are tobacco, dried fruits, cotton, wool, mohair, opium, hazel nuts, valones and liquorice

root. Corn is not yet produced in sufficient quantities to permit of export and there are no manufactured articles made in Turkey which are required by other countries.

State monopolies are as follows: tobacco, sugar, petroleum and benzine, all forms of alcohol, salt, sporting gun cartridges, industrial explosives and matches The tobacco monopoly is of pre-war date, but that in sugar and petroleum began in 1926. These last do not mean that there is any restriction in import but only that the monopoly tax has to be paid on every import of these articles. On the other hand, the import of salt is prohibited, while that of matches is regulated by a Belgian company to whom the monopoly was ceded The monopoly in alcohol was ceded to a Polish syndicate, but the whole question of this monopoly is now under consideration with a view to revision Cartridges and explosives are in the hands of a Turkish company, through whom all orders are passed.

The following tables show the values of the chief imports and exports and their distribution —

Imports and Exports by Commodities

	1924		1925	
	Imports	Exports	Imports	Exports
Cereals	23,005,732	5,425,467	23,051,092	5,578,458
Tobacco		46,581,432		60,984,421
Fruit, etc.		39,477,850		37,017,682
Cotton goods	63,571,483	11,047,999	74,127,634	15,476,821
Woolen ,,	13,263,837	13,170,269	17,625,521	11,548,110
Metals	16,168,158	4,319,269	21,556,078	3,757,258

Direction of Foreign Trade

	Imports		Exports	
	1924	1925	1924	1925
Italy	40,983,960	42,785,742	34,883,764	46,095,080
England	34,278,190	37,846,817	23,281,808	17,441,277
Germany	19,114,015	27,442,072	20,551,136	27,662,802
France	18,302,473	26,077,966	18,780,421	24,182,022
U.S A.	11,377,884	19,654,074	16,391,604	25,102,934
Syria	7,526,930	9,070,839	9,243,138	11,719,886
Russia	6,369,307	6,101,597	2,005,323	4,901,691

Ports.—The port of Constantinople consists of a war harbour, an inner and an outer port

Posts and Telegraphs.—In 1874 Turkey became a member of the International Postal Convention, but six powers maintained their own post offices until the abolition of the Capitulations The reason for this was the complete unreliability of the postal services After the evacuation of the city of Constantinople by the Allied forces in 1923, the whole of the postal services were taken over by the Turks The results have, however, been far from satisfactory, since the reliability of the system employed and of the postal servants is not great There are in all 714 post offices in Turkey.

The telegraphic service is under the control of the Postal Department, and the Eastern Telegraph Company has again established itself after a prolonged dispute. The cables owned by this company that serve Turkey are (1) that from Syra to Chanak on the Dardanelles and so to Constantinople, (2) the Salonika-Lemnos-Tenedos-Dardanelles route, (3) that from Chesme to Tenedos and Chios and (4) that from Constantinople via the Black Sea to Odessa.

Three wireless stations exist—at the Ok Meidan above the Golden Horn, at Osmanieh some four miles from Constantinople in the open country west of Pera, and at Angora. Private wireless sets are now licensed but transmitting sets forbidden. The annual private license costs some three English pounds.

There is only one commercial aeroplane service, namely that from Rome via Brindisi, Athens and the Dardanelles to Constantinople. It is manned by hydroplanes, which harbour in the Bosporus near Therapia. It is, weather permitting, a daily service. A Turkish aviation league, primarily with military objects, exists for the purpose of stimulating interest in aviation.

The telephone service of Constantinople is controlled by an Anglo-French company under an English director, with a capital of £450,000, of which £250,000 is paid up. The Turkish Government exacts a percentage of 15% on gross revenue. There are some 4,000 subscribers in Constantinople and its suburbs. Angora enjoys an automatic telephone system and the rest of the country is covered by a State system

FINANCE

Maladministration under Abdul Hamid followed by the disasters of the Italian war of 1911 and the Balkan war of 1912 and the Great War from 1914 to 1918, has plunged the finances of Turkey into difficulties such as no other country now faces Nevertheless, the fact that there has been no financial crisis comparable to those in Germany and Austria after the war is remarkable and it is noteworthy that the Turkish Lire that before the war was almost the equivalent of the English pound in value, was in 1919 of an exchange value of about 1·50 LT to the pound sterling, while since then it has sunk slowly to about 9·50, at which figure it now remains The budget presented to the National Assembly in 1925–26 showed a Revenue of LT 145,306,978 and an expenditure of LT 162,228,942, with a consequent deficit of LT 16,981,964. But after the budget had passed the Assembly the expenditure was increased by nearly three million Turkish pounds and the revenue was shown as slightly decreased, with a consequent deficit of LT 30,885,873.

The budget for 1926–27 shows an estimated expenditure of LT 188,141,708, but the revenue is not yet known.

National defence is by far the largest item of expense In 1924–25 it cost LT 26,279,386, in 1925–26 LT 43,058,874 and in 1926–27 LT 57,996,143 This progressive increase follows to some extent the progressive prosperity of the country but the expenditure on armed forces still remains extremely high, being well over twice the expenditure on public works (the next largest item) in the last two years. And while it was about a quarter of the whole expenditure in 1924–25 it is almost a third in 1926–27 Another non-productive expense, which only appears first in 1925–26, is that on military factories, which in that year is some four million Turkish pounds and in the estimates for the next year increased by a million. Gendarmerie also costs an average of ten million Turkish pounds, without much annual variation On the other hand, the expenditure on public works shows a small but steady increase in three years from 17 to 22½ million Turkish pounds Education, however, which in 1924–25 cost LT 6,877,626, has decreased in 1926–27 to LT 6,000,184

The financial situation of Turkey is complicated by her heritage from the past. While paying no reparations for the war of 1914–18 she is still saddled by a very large foreign debt

Foreign Debt.—In 1875 the financial condition of the Turkish Empire had become so serious that payment in full of interest on existing foreign loans was suspended and it was announced that 50% only would be paid, the remainder being issued as certificates known as "Ramazans," being 5% bonds maturing in five years. In 1881 the bondholders began negotiations at Constantinople for the further payment of their claims The "Decree of Muharrem," issued on Dec. 20, 1881, made arrangements for the reduction of the debt from £252,801,805 to £106,437,234. A minimum of 1% was fixed as interest on this sum, to be increased as opportunity offered. But an International body was appointed to supervise the administration of the debt known as the "Council of Administration of the Ottoman Public Debt," and it was composed of one member each from Great Britain, Austria-Hungary, France, Germany, Italy and Turkey and one from the Imperial Ottoman Bank. This council had charge of the duties on spirits, stamps, silk, salt and some other revenues assigned for payment of interest on the debt. In 1914, however, all payments ceased and Turkey entered the war. On the establishment of the National Assembly all these revenues assigned to the debt were taken over for purposes of revenue to the Turkish budget, so that between 1914 and 1924 virtually no payments of interest to bondholders were made by the Turkish authorities. But in 1920 the Debt Council, from accumulated funds, were able

to make some small payments on coupons that had matured between 1915 and 1920 and further payments have been made on coupons up to 1922

By the Treaty of Lausanne, which came into force in 1924, the territories detached from Turkey as a result of the War were called upon to contribute to the Ottoman debt, which at that time was estimated at LT 141,666,299 Of this sum the New Turkey was responsible for LT 84,597,495. Albania, the Hejaz, Iraq, Nejd, Maan, Palestine, Trans-Jordan and parts of Asiatic Turkey now incorporated in Greece, Bulgaria and Yugoslavia are responsible for the substantial contributions But so far the only provinces to whom payments were so assigned which have either made arrangements to pay, or paid, are Palestine (whose payment was partial only), Syria, Lebanon and Greece

Taxation.—The present Government is deriving most of its revenue from direct taxation, which, on the whole shows a tendency to increase Customs tariffs are not high and the bulk of the taxation is internal Indirect taxes are also very heavy and the prosperity of the country is suffering from the inability of new enterprises to survive the rigours of taxation in their early stages Bankruptcies have been more frequent in 1928 than in 1927 and there is not so marked a growth of prosperity as was evident between 1922 and 1926

Taxation per head of the population is some LT 20 (about £2 5 0), which is relatively low compared with that of Great Britain (£15 14 0 per head) France (£5 10 0), Germany (£5 0 0), Greece (£4 0 0) or Bulgaria (£2 0 0), but it is high for a country so little organized as Turkey The direct taxes are income tax, land tax and road tax The agricultural tithe of 12½% was abolished in 1925 In 1927 an aviation tax for the provision of funds for the formation of an air force was levied at the rate of 10% added to all tax payments Income tax is levied at the rate of 6% on all incomes up to LT 3,000, rising by a sliding scale to 14% on incomes above LT 50,000 Certain exemptions are granted to farmers, writers, teachers and other professional classes

In 1926 a consumption tax at 2½% was levied on all purchases in shops, restaurants and hotels, and it is still in force It was payable by stamps affixed to all receipts for purchases

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DEFENCE

The writers who have left the most complete and trustworthy contemporary accounts of the Turkish army in the 14th and 15th centuries, when it reached the height of its most characteristic development, are Bertrandon de la Brocquière, equerry to Philip the Good, duke of Burgundy, and Francesco Filelfo (*q v*) of Tolentino Both ascribe the military superiority of the Turks over the nations of western Europe to two facts—firstly to their possession of a well-organized standing army, an institution unknown elsewhere, and secondly to their far stricter discipline

The regular troops comprised the Janissaries (*q v*), a corps of infantry recruited from captured sons of Christians, and trained to form a privileged caste of scientific soldiers and religious fanatics; and the Spahis, a body of cavalry similarly recruited, and armed with scimitar, mace and bow Celibacy was one of the rules of this standing army, which, in its semi-monastic ideals and constitution, resembled the knightly orders of the West in their prime. The Janissaries numbered about 12,000, the Spahis about 8,000 A second army of some 40,000 men, mostly mounted and armed like the Spahis, was feudal in character, and consisted chiefly of the personal followers of the Moslem nobility; more than half its numbers were recruited in Europe This force of 60,000 trained soldiers was accompanied by a horde of irregulars, levied chiefly among the barbarous mountaineers of the Balkans and Asia Minor Many Christian soldiers of fortune enlisted with the Turks as artillerists or engineers, and supplied them at Constantinople with the most powerful cannon of the age Other Christians were compelled to serve as engineers or in the ranks As late as 1683 a corps of Wallachians was forced to join the Turkish army before Vienna, and entrusted with the task of bridging the Danube But in the 18th and early 19th centuries the introduction of Christians tended to weaken the *moral* of the army already sapped by defeat, it was found impossible to maintain the discipline of the Janissaries, whose privileges had become a source of danger; and the feudal nobility became more and more independent of the sultan's authority These three causes contributed to make reorganization inevitable

The destruction of the janissaries in 1826 marked the close of the history of the old Turkish army, already the re-creation of the service on the accepted models of western Europe had been commenced This was still incomplete when the new force was called upon to meet the Russians in 1828, and though the army displayed its accustomed bravery, its defective organization and other causes led to its defeat Since then the army has been almost as constantly on active service as the British; the Crimean War, the Russo-Turkish War of 1877, the Greco-Turkish War of 1897 and the Italo-Turkish War of 1911 witnessed the employment of a large proportion of the sultan's available forces, while innumerable local revolts in different parts of the empire called for great exertions, and often for fierce fighting on the part of the troops locally in garrison and those sent up from the nearest provinces Finally, the Turkish army made its greatest effort in the World War (*q.v.*), where, despite administrative inefficiency and corruption on the one hand, and the defective equipment and handling of the fighting troops on the other, it earned the admiration of its

opponents by its stubborn endurance and resistance. German leadership played a considerable part in its early success at the Dardanelles (*q.v.*), and to a less degree in other theatres, but friction between the German and Turkish officers became an increasing handicap. The results were aggravated because the Turkish army threw up only a few leaders, of whom Mustafa Kemal (*q v*) was the most notable But round him gathered a nucleus of better trained younger officers, and after the disasters which marked for Turkey the close of the World War, it was the influence of this new school which brought about the rapid recovery of the Turkish army, shown in the expulsion of the Greek forces from Asia Minor

MODERN ARMY

Art. 40 of the constitution of Turkey states that, "The supreme command of the army is vested in the moral personality of the Great National Assembly and is exercised by the President of the Republic. In time of peace the command of the military forces is entrusted to the chief of the general staff within the limits of the corresponding laws. In time of mobilization the command of the armed forces is entrusted to a person nominated by the President at the proposition of the Council of Commissars."

The land forces of the Turkish Republic in time of peace amount to: 163 infantry battalions, 42 field, 44 mountain, 5 howitzer and 27 heavy artillery batteries; 48 cavalry squadrons, 13 machine-gun mounted companies; 29 pioneer companies, 8 transport companies, 3 radiotelegraphic companies, 1 light-projector company and 8 field hospitals. These forces are formed in 18 infantry and 5 cavalry divisions composing the IX Army Corps, distributed over 3 military inspection regions. Each of these comprises 2 to 4 army corps, and is under a chief who is the designated commander of the corresponding army on mobilization An army corps is normally composed of 2 infantry divisions, 1 heavy artillery regiment of 2 to 4 batteries, 1 squadron of corps cavalry, 1 technical company, 1 transport company, 1 automobile company and 1 company for communications and liaison. The VIII. Army Corps has no heavy artillery An infantry division has 3 infantry regiments of 3 battalions and 3 machine-gun companies each, 1 artillery regiment of 2 field and 2 mountain batteries, 1 pioneer company and 1 company for communications and liaison. The first 9 divisions are numbered from 1 to 9, while the remaining 9 divisions bear different numbers, inherited from the old organization. A cavalry division is composed of 3 cavalry regiments of 3 squadrons, 1 machine-gun mounted company and 1 to 2 mountain batteries each. The numeration of the cavalry divisions is also inherited from the old organization.

The distribution of these forces is as follows:—

Military Inspection Region	*Army Corps and Headquarters*
1st Angora	II. Balikesir
	III. Constantinople
	IV. Eskishehr
2nd Konia	I. Afiun Qarahisar
	V. Konia
3rd Diarbekr	VI. Toqat
	VII. Diarbekr
	VIII. Erzinjan
	IX. Sariqamish
1st Cavalry Division	Jeziret Ibn 'Omar (North of Mosul)
2nd Cavalry Division	Kirk-Kilisse (Thrace)
7th Cavalry Division	Qara Kilissa (Anatolia)
8th Cavalry Division	Van
14th Cavalry Division	Urfa (Turkish Mesopotamia)

In addition, the following other forces exist within the framework of the army corps —

1. The National Guard of the Great National Assembly, consisting of 1 infantry battalion, 1 machine-gun company and 1 cavalry squadron.
2. 4 frontier commissariats of 4 battalions and 4 machine-gun companies each, in Artvin, Diarbekr, Adana and Adrianople.
3. 40 heavy batteries and technical units for the fortified places, namely; Smyrna, 8 batteries, 1 projector company and 1 pioneer company; Kars, 12 batteries, 1 pioneer company and 1 liaison company; Erzerum, 20 batteries and 1 liaison company; Chatalja, 8 batteries.
4. 16 batteries of coast artillery, at Samsun and other points.
5. 1 railway battalion, 1 pioneer and 1 liaison company.

Service in the army is obligatory. Its duration is 1½ years in the infantry and transport, 4 years for the navy and 2 years for all other arms.

The Gendarmerie represents a force of about 25–30,000 men, organized in 9 flying gendarmerie battalions and numerous companies, platoons and posts. There are also 5 mounted gendarmerie regiments, one each at Angora, Chorum, Yozghad, El 'Aziz and Erzinjan respectively. The recruiting is on a voluntary basis.

The equipment of the army is satisfactory, but it is not uniform. The rifles are of diverse types The number of automatic rifles is only 1,200 to 1,300. The machine-guns are altogether about 800, *i e.*, 40 for each division. The field guns are estimated to be about 600 to 650, but the reserve of shells is low. The cartridge factory in Angora is being steadily developed, but the production is insufficient.

Air Service.—The air service numbers 13 incomplete squadrons of 8 aeroplanes each, 2 schools for aviation (land and naval) in Smyrna. The instructors are French officers The air units are concentrated in Smyrna, where there are 7 hangars for aeroplanes, others are being planned for construction at Afiun Qarahisar, Mersina, Constantinople and Erzerum A workshop for repairs exists also in Smyrna. The organization of the meteorological service is not completed as yet and is to include 24 meteorological stations. The service will have the assistance of the existing radiotelegraphic stations and those under construction in Constantinople, Smyrna, Qastamuni, Gallipoli, Sivas, Angora, Eskishehr and Konia. Much attention is being given to the development of the air forces by the authorities and the public alike, who are raising donations and subscriptions for this end. The air services for postal and passenger service are only in embryo

Navy.—The naval forces are in an unsatisfactory condition By the end of the World War the fleet numbered about 20 units, thanks to the German battle cruiser "Goeben" (which passed to Turkey in 1914) and some torpedo boats By the Sèvres Treaty, only about 10 unimportant units were left to Turkey. By the Lausanne Treaty, however, Turkey got back the remnants of her fleet and moreover the liberty for further armaments Turkey intends to entrust to a Japanese mission the development of her fleet, within the limits and necessities of a mobile defence to supplement the coast defence. To this end it is intended to repair and arm anew the cruisers "Goeben," "Hamidiye," seven gun-boats, two submarines and three torpedo boats. Further, within a period of 8 years, the construction is intended of 2 battleships, 2 cruisers of 10,000 tons each, 2 cruisers of 7,500 tons each, 4 destroyers, 12 torpedo boats (of 800 to 1,000 tons each), 4 submarines up to 1,200 tons each and 6 mine-layers A sea dock is planned for construction at Izmid, where an inlet of the Sea of Marmora has the shape of an easily defensible fjord. Two more naval aviation schools are planned (besides that in Smyrna); one in Constantinople and another in Trebizond, and 4 hydroplane stations. In the present situation the fleet can be used only for a defensive purpose, owing to its numerical and technical weakness and to the coastline of nearly 4,000 kilometres that has to be defended, especially the Aegean coast line where the opposite islands are in the hands of foreign states; but in the Black Sea it might to some extent take the offensive.

The mercantile fleet is developing rapidly in consequence of the provision in the Lausanne Treaty that the coastal and port services, as well as the fishing, are an exclusive privilege to the Turkish national flag, though exceptions have been made in the case of certain well-known lines. The steamship company "Seiri-Sefain" alone possesses a fleet of 60 units.

The New Turkey.—Sport and scout organizations are much in favour now all over Turkey, and are helped by the authorities. Other facts of a general character that are important from a military point of view are the reforms of Mustafa Kemal, which aim at the rousing of national pride and feeling by abolishing obsolete religious and political prejudices and introducing up-to-date

methods Moreover, the emigration and expulsion of the ethnical minorities have given a homogeneous basis to the State, and in this respect only the Kurds in the regions of the Mosul frontier remain as a source of disquiet for the Turks.

Topography.—From a topographical point of view, the salient feature of Asiatic Turkey is that it is a plateau, surrounded on three sides by the sea and by high ranges of mountains. This creates a double line of defence, one on the sea coast and another on the mountain ranges, especially on the northern and southern coasts. The western coast, with its parallel valleys between the sea and the range of the inland plateau, is the more accessible one. On the east the plateau is guarded by the high Armenian mountains, extending far towards Persia and the Caucasus.

North-eastern Theatre.—Against an enemy coming from the Caucasus and the Black Sea, the defence of Turkey is highly favoured by the mountainous character of the territory. There are four roads from Russia to Turkey The first is along the coast, from Batum (terminus of the railway from Tiflis) to Trebizond It passes between the coast and the mountain range of Lazistan and is not easy for movements The second is from Batum and Olti along the valley of the river Chorokh in the direction of Baiburt. The third route is the classical road from Alexandretta on the Mediterranean to Tiflis and the basin of the Caspian Sea. At Erzerum it is crossed by the other classical road from Tehran to Trebizond. The railways Tiflis-Alexandropol-Kars-Erzerum, Tabriz-Nakhichevan-Alexandropol and the branch line Nakhichevan-Bayazid-Alashkerd are highly important in this respect and make possible military action on an extensive scale

The defence is favoured further by the fact that both Kars and Erzerum are successive fortresses The railway, Angora-Qaisari-Sivas-Erzinjan-Erzerum, will assist the defence if constructed The fourth route, giving access to Armenia and Kurdistan, runs from Erivan through Bayazid, and through the valley of the Murad-Tchai (upper course of the Euphrates) arrives at Melazkerd, from where there are roads from Erzerum, Bitlis, Diarbekr and Kharput.

Thracian Theatre.—Owing to the demilitarized zones along the frontiers with Greece and Bulgaria and on the Straits (Bosporus and Dardanelles), the defence of Thrace is important in the sense of a tête-de-pont, serving for the defence of Asia Minor itself, along the important water line Bosporus-Marmora Sea-Dardanelles, on its European side A defence far in the interior from the coast of the Sea of Marmora, *i e*, at Adrianople and Chorli, in some respects might be useful for Turkey, but the Straits remaining unfortified, the flanks would be highly endangered The real line of defence remains the line of the Bosporus and Dardanelles In this respect the Asiatic coast of the Sea of Marmora has a very important bearing, especially with its numerous fjord-like bays

Aegean Theatre.—This coast is more easily accessible for an enemy than the Black Sea or Mediterranean coast, owing to the fine harbours and numerous parallel roads to the interior far up the plateau The country, moreover, is the richest of all Asia Minor, it being the cradle of ancient civilizations. But, although the islands off the coast, the Dodecanese, are not in the hands of the Turks, with good manoeuvring they might make difficult any landing operation, since good roads and railways are available in these regions.

Mediterranean Front.—This coast, from Maqri to Alexandretta, has the same features in general as the Black Sea coast, presenting a double defence line In addition, the range of the plateau, *i e.*, the Lycian and Cilician Taurus and the Anti-Taurus are higher and steeper, with no good roads for the interior.

Mesopotamian Theatre.—This is divided by the railway Adana-Mosul into two halves. The northern one, in the possession of Turkey, is inhabitable and with sufficient roads. On the north it is dominated by the Armenian Taurus, standing between the Euphrates and Tigris like a snow-covered wall in face of the immense plains of Syria and Mesopotamia. The possession of this wall between Bitlis and Kharput ensures the sally-ports from the Anatolian plateau towards Aleppo and Mosul. The southern half of this theatre includes the territory south of the railway, which is part semi-desert, part of desert and mountainous character. The territory between Birejik-Meskene-mouth of the river Khabur to Jeziret Ibn 'Omar, is of semi-desert character, although yielding good produce It is inhabited by nomad Arabs and Kurds.

Persian Theatre.—In its northern part it has a first-class route for movement This is the old road from the Iranian Plateau to the Black Sea, from Tehran, through Tabriz and Bayazid, to Trebizond. The other routes are of secondary importance and do not lead to important centres; besides, they pass often through waste land From Tehran to Van there are two roads, the one going through Tabriz-Dilman and the other through Urmia-Bash Qal'e In a general way, this theatre has a relative importance if only for use in connection with operations from the Caucasus to Angora or from Armenia to 'Iraq (P. Da.)

Navy.—The sea power of Turkey had already decayed when the catastrophe of Sinope in 1853 shattered it completely From time to time since then efforts have been made, generally, before the World War, with British assistance, to build up a navy, and Abd-ul-Aziz created a sizeable fleet of ironclads, built in British and French yards But his successor, Abd-ul-Hamid, deliberately reduced the fleet to impotency, because he was afraid that it might turn on him as it had on his predecessor.

In 1910 the Turkish fleet consisted of seven armoured ships, of which the biggest were two ships of the "Torgud Reiss" class of 10,000 tons, armed with six 11 in guns, originally the battleships "Wiesenberg" and "Worth" Except for some small gunboats and destroyers no important additions were made to the fleet before the World War When they took refuge in the Dardanelles Turkey nominally acquired the German battle cruiser "Goeben" and light cruiser "Breslau," but in fact these ships remained German throughout the war The "Goeben" was badly damaged and ran ashore in the Straits to save her from sinking She was afterwards salvaged and is still in existence as the "Sultan Selim" The "Breslau" was mined and sank off Imbros.

Repeated efforts have been made by the Turks to put the "Sultan Selim" into a state of repair, but it is doubtful whether she will ever be an efficient fighting unit again In any case she is now very obsolete compared with modern ships of her class.

The Turkish Navy of to-day (1928) consists of. 1 battleship, 2 old cruisers, 1 old battleship used as a training ship, 3 destroyers, 6 torpedo boats and 8 miscellaneous craft

A programme of new construction has been drawn up and it is proposed to proceed with it when funds are available (X)

ETHNOLOGY

For ethnological purposes it is convenient to group together those parts of the old Ottoman empire usually known as Turkey in Asia, Armenia and Cyprus, the two latter of which formed a kingdom in mediaeval times, and have been long connected.

The racial history of this region is obscure There are two basal stocks in the population; the oldest is probably a short, long-headed type, akin to the inhabitants of most of the Mediterranean coastal region, and called from this fact Mediterranean. Von Luschan, on the other hand, was of opinion that the oldest inhabitants of the region were the round-headed people he called Armenoids He found groups of these people living in endogamous communities and never marrying with the outside world. These little groups were all of a single type, and very round-headed, whereas in the normal population there is a great deal of admixture and both types are found side by side He argued, therefore, that these communities represented the broken relics of former aborigines who had been able to preserve their racial type by strict endogamy, while the newcomers had mixed with the aborigines except in a few cases, and had produced a mixed type. It is true that nowhere in this region is the long-headed type found in any purity, but it seems from a general study of the Armenoid peoples that they are comparatively late comers into the west, and possibly the pure communities on which von Luschan has laid such stress have kept their purity simply by not mixing with the people of the land into which they have come The earliest graves from this area were opened by Buxton in 1913 (Cyprus) They belong to the middle bronze age, probably the second mil-

lenium B.C. and already at this period the two types are mixed, or possibly at that time were living side by side. At the end of the bronze age the people practised a curious type of cranial deformation, flattening the tops of their heads in childhood, a practice which also appears in Crete and is probably of considerable ethnological significance Since that time the physical form of the people has not altered materially The principal groups of this region depend entirely on religious differences, and the practice of a certain type of religion is, or was, in most cases sufficient to determine a man's social status The Muslims are usually considered to be Turks. The Christians, in general terms, are either Greeks or Armenians. There are also certain minor sects, especially some Crypto-Christians, who practised openly Muslim, and secretly Christian rites, but large numbers of these have now definitely decided on a single religion There are also certain heretical sects, such as Bektash and Tadchadsky, but these peoples come under the general heading of Greeks or Turks according to whether they are heretical Christians, as in this case, or Muslims

The social organization is largely dependent on these religious features The Turks were at least nominally polygamous, the Christians monogamous, and the Turkish women wore the veil. The villages are governed by an elected headman, and frequently in those villages where there are both Greeks and Turks there is a headman for each religion (For changes in law and custom under Mustafa Kemal Pasha, see *The New Turkey*, p 615 et seq)

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HISTORY

The first appearance of the Ottoman Turks in history dates from A D 1227 In that year a horde, variously estimated at from two to four thousand souls, driven originally from their Central Asian homes by the pressure of Mongol invasion, were returning under their chief Suleiman Shah to their native land They were crossing the Euphrates, not far from the castle of Jaber, when the drowning of their leader by accident threw confusion into their ranks. Those who had not yet crossed the river refused to follow their brethren and decided to remain under Ertoghrul, son of the drowned leader. Ertoghrul first camped at Jessin, east of Erzerum, but obtained from the Seljukian sultan Ala-ud-din lands near Angora The help afforded by Ertoghrul to the Seljukian monarch on a critical occasion led to the addition of Sugut to his fief. Here Ertoghrul died in 1288 at the age of 90, being succeeded in the leadership of the tribe by his son Osman When, exhausted by the onslaughts of Ghazan Mahmud Khan, ruler of Tabriz, and one of Jenghiz Khan's lieutenants, the Seljukian empire was at the point of dissolution, most of its feudatory vassals helped its downfall in the hope of retaining their fiefs as independent sovereigns Osman remained firm in his allegiance, conquered Karaja Hissar (1295), and received investiture of the lands he thus acquired from the sultan Ala-ud-din Kaikobad II He became master of Aīnēgeul, Bilejik and Yar Hissar, but it was only after the death of his protector and benefactor Sultan Ala-ud-din II. that Osman declared his independence, and accordingly the Turkish historian dates the foundation of the Ottoman empire from this event Osman reigned as independent monarch until 1326. He pursued his conquests against the Greeks, and established good government throughout his dominions, which at the time of his death included the valleys of Sakaria and Adranos, extending southwards to Kutaiah and northwards to the Sea of Marmora. Infirmity had compelled him towards the end of his life to depute the chief cómmand to his younger son Orkhan, by whom in 1326 Brusa was captured after a long siege.

Orkhan, 1326–59.—Orkhan's military prowess secured for him the succession, to the exclusion of his elder brother Ala-ud-din, who became his grand vizier At that time a number of principalities had replaced the Seljukian State. Though Yahsha Bey, grandson of Mohammed Karaman Oghlu, had declared himself the successor of the Seljukian sultans, the princes of Aidin, Sarukhan, Menteshē, Kermian, Hamid, Tekkē and Karassi declined to recognize his authority. Their example was followed by the Kizil Ahmedli Emir Shems-ed-din, whose family was afterwards known as the house of Isfendiar in Kastamuni. At his accession Orkhan was practically on the same footing with these, and avoided weakening himself in the struggle for the Seljukian inheritance, preferring at first to consolidate his forces at Brusa Thence he continued to win territory from the Greeks, taking Aīdos, Nicomedia, Hērēkē and, after a siege, Nicaea; Tarakli and Gemlik fell to his arms, and soon the whole of the shore of the Marmora up to Kartal was conquered, and the Byzantines retained on the continent of Asia Minor only Ala Shehr and Biga In 1338 Orkhan achieved his first conquest from Muslim hands by the capture of Karassi.

To this advance the Byzantine empire could offer no effective resistance On the death of the emperor Andronicus III in 1341 he was succeeded by John Palaeologus, a minor; and Cantacuzenus, the mayor of the palace, appealed to Orkhan for assistance to supplant him, giving in marriage to the Ottoman prince his daughter Theodora Orkhan lent the desired aid; his son Suleiman Pasha, governor of Karassi, crossed into Europe, crushed Cantacuzenus's enemies, and penetrated as far as the Balkans, returning laden with spoil In 1355 Suleiman crossed over from Aīdinjik and captured the fortress of Gallipoli, which was at once converted into a Turkish stronghold, from this base Bulaīr, Malgara, Ipsala and Rodosto were added to the Turkish possessions Suleiman Pasha was killed by a fall from his horse near Bulaīr in 1358; the news so affected his father Orkhan as to cause his death two months later The institution of the Janissaries (*q v*) holds a prominent place among the most remarkable events of Orkhan's reign, which was notable for the encouragement of learning and the foundation of schools, the building of roads and other works of public utility.

Murad I., 1359-89.—Orkhan was succeeded by his son Murad After capturing Angora from a horde of Turkomans, in 1361 Murad prepared for a campaign in Europe At that time the Greek emperor's rule was confined to the shores of the Marmora, the Archipelago and Thrace Salonika, Thessaly, Athens and the Morea were under independent Greek princes. The Bulgarians, Bosnians and Serbs had at different periods invaded and conquered the territories inhabited by them; the Albanians, original natives of their land, were governed by princes of their own When, on the death of Cantacuzenus, John Palaeologus remained sole occupant of the imperial throne, Murad declared war against him and conquered the country right up to and including Adrianople, the second capital of the emperors Three years later, in 1364, Philippopolis fell to Lala Shahin, the Turkish commander in Europe. These conquests produced a counter attack by an allied army of Serbs, Hungarians, Walachians and Moldavians, which was utterly defeated. In 1367 Murad made Adrianople his capital and enriched it with various new buildings. He continued to extend his territories in the north and west and took tribute from the king of Serbia and the rulers of Kiustendil, Nicropolis and Silistria. Lala Shahin Pasha was appointed feudal lord of the district of Philippopolis, and Timur Tash Pasha became beylerbey of Rumelia; Monastir, Perlepē, and parts of Bosnia and Herzegovina were next taken, and the king of Serbia consented to furnish to Murad a fixed contingent of auxiliary troops In 1381 Murad's son Yilderim Bayezid married Devlet Shah Khatun, daughter of the prince of Kermian, who brought him in dowry Kutaiah and its six dependent provinces. In the same year Bey Shehr and other portions of the Hamid principality were acquired by purchase from their ruler Hussein Bey, as the Karamanian princes were beginning to cast covetous eyes on them; but the Karamanians were unwilling to resign their claims to be heirs of the Seljukian sultans, and not until the reign of Mohammed II were they finally suppressed. Ali Bey, the prince at this time, took advantage of Murad's absence in Europe to declare war against him; but the Ottoman ruler returning crushed him at the battle of Konia. Meanwhile the king of Bosnia, acting in collusion with the Karamanian prince, attacked and utterly

defeated Timur Tash Pasha. The princes and kings who had consented to pay tribute were by this success encouraged to rebel, and the Serb troops who had taken part in the battle of Konia became insubordinate. Indignant at the severity with which they were punished, Lazarus, king of Serbia, joined the rebel princes. Murad thereupon returned to Europe with a large force, and sent Chenderēli Zadē Ali Pasha northwards; the fortresses of Shumla, Pravadi, Trnovo, Nicopolis and Silistria were taken by him; Sišman III., rebel king of Bulgaria, was punished and Bulgaria once more subjugated. Ali Pasha then joined his master at Kossovo. Here Lazarus, king of Serbia, had collected an army of 100,000 Serbs, Hungarians, Moldavians, Walachians and others. On Aug. 27, 1389, the greatest of the battles of Kossovo was fought The king of Serbia was killed and his army cut to pieces, but after the battle, while Murad was reviewing his victorious troops on the field, he was assassinated by Milosh Kabilovich, a Serb who approached him on the plea of submission.

Murad maintained a show of friendly relations with the emperor John Palaeologus, while capturing his cities The emperor gave one of his daughters in marriage to Murad himself and the other two to his sons Bayezid and Yakub Chelebi These princes were viceroys of Kermian and Karassi respectively, the youngest son, Sauji Bey, governed at Brusa during his father's absence. Led away by evil counsellors, Sauji Bey plotted with Andronicus, son of the emperor, to dethrone their respective fathers The attempt was foiled, Andronicus was blinded by his father's orders and Sauji was put to death (1387)

Bayezid I., 1389–1403.—After being proclaimed on the field of Kossovo, Bayezid's first care was to order the execution of his brother Yakub Chelebi, and so to preclude any repetition of Sauji's plot The young prince Andronicus, who had not been completely blinded, sent secretly to Bayezid and offered him 30,000 ducats to dethrone his father John Palaeologus and make him emperor. Bayezid consented, later on John Palaeologus offered an equivalent sum and, since he engaged to furnish an auxiliary force of 12,000 men into the bargain, Bayezid replaced him on the throne By the aid of these auxiliaries the fort of Ala Shehr was captured (1392), Manuel Palaeologus, son of the emperor, being allowed, in common with many other princes, the privilege of serving in the Turkish army, then the best organized and disciplined force extant. The principalities of Aidin, Menteshē, Sarukhan and Kermian were annexed to Bayezid's dominions to punish their rulers for having joined with the Karamanian prince in rebellion. The exiled princes took refuge with the Kizil Ahmedli, ruler of Kastamuni, who persuaded the Walachians to rebel against the Turks. By a brilliant march to the Danube Bayezid subjugated them; then returning to Asia he crushed the prince of Karamania, who had made head again and had defeated Timur Tash Pasha. Bayezid now consolidated his Asiatic dominions by the capture of Kaisarieh, Sivas and Tokat from Tatar invaders, the relics of Jenghiz Khan's hordes Sinope, Kastamuni and Samsun were surrendered by the prince of Isfendiar, and the conquest of Asia Minor seemed assured.

On the death of John Palaeologus in 1391 his son Manuel, who was serving in the Turkish army, fled to Constantinople, and assumed the imperial dignity. Bayezid therefore besieged Constantinople, and an army marched into Macedonia, capturing Salonika and Larissa (1395). The siege of the capital was interrupted by the advance of a crusading army which crossed the Danube and invested Nicopolis. While the fortress was holding out with difficulty Bayezid fell upon the besiegers and annihilated them (1396). To the usual letter announcing the victory the caliph in Egypt replied saluting Bayezid as the "Sultan of the lands of Rum"

After the victory of Nicopolis the siege of Constantinople was resumed, and the tower of Anatoli Hissar, on the Asiatic side of the Bosphorus, was now built. However, by sending heavy bribes to Bayezid and his vizier, and by offering to build a mosque and a Muslim quarter, and to allow Bayezid to be named in the weekly prayer, Manuel induced Bayezid to raise the siege. Between 1397 and 1399 Bayezid overran Thessaly, while in Asia his lieutenant Timur Tash was extending his conquests. Meanwhile Timur (Tamerlane) had started from Samarkand on his victorious career. After devastating Georgia in 1401 he marched against the Turks. Some of the dispossessed princes of Asia Minor had begged Timur to reinstate them. Bayezid replied to a request to this effect from Timur in terms which made war inevitable. An attack in force was postponed by Timur's activities in Syria and Mesopotamia. But in 1402 in a great battle near Angora the Turks were defeated, and Bayezid was taken prisoner. Eight months later he died at Ak Shehr

This disaster checked the Turkish advance for more than a decade. Timur reached Brusa, and there laid hands on the treasure of Bayezid; one after another the cities of the Turks were seized and plundered by the Tatars Meanwhile Timur sent letters after the fugitive sons of Bayezid promising to confer on them their father's dominions, and protesting that his attack had been due merely to the insulting tone adopted towards him by Bayezid and to the entreaties of the dispossessed princes of Asia Minor Timur did not cross into Europe, and returned to Samarkand after capturing Smyrna (1405). For some time further, disputes between the sons of Bayezid delayed the Turkish revival. In 1413, Mohammed I., the survivor, was recognized as sultan, and in his reign of eight years recovered all his father's territories Two years after his accession he overcame a rebellion of the prince of Karamania and recaptured his stronghold Konia (1416), and then, turning northwards, forced Mircea, voivode of Walachia, to pay tribute The Turkish dominions in Asia Minor were extended, Amasia, Samsun and Janik being captured, and an insurrection of dervishes was quelled. In 1421 the sultan died His services in the regeneration of the Turkish power can hardly be over-estimated Amid the cares of State he found time for works of public utility and for the support of literature and art; he is credited with having sent the first embassy to a Christian power, after the Venetian expedition to Gallipoli in 1416, and the Ottoman navy is first heard of in his reign.

Murad II., 1421–51.—At the time of Mohammed's death his eldest son Murad was at Amasia Shortly after his accession the emperor Manuel, having applied in vain for the renewal of the annual subsidy, paid him by the late sultan for retaining in safe custody Mustafa, an alleged son of Bayezid, released the pretender. He was defeated at last at Ulubad (Lopadion) on the Rhyndacus in Asia Minor, and Murad thereupon laid siege to Constantinople to avenge himself on the emperor. The siege was raised because the appearance of another pretender, in the person of Murad's 13-year-old brother Mustafa, under the protection of the revolted princes of Karamania and Kermian, called the sultan to Asia. Mustafa, delivered up by treachery, was hanged (1424); but Murad remained in Asia, restoring order in the provinces, while his lieutenants continued the war against the Greeks, Albanians and Walachians. By the treaty signed on Feb. 22, 1424, shortly before his death, the emperor Manuel II, in order to save the remnant of his empire, agreed to the payment of a heavy annual tribute and to surrender all the towns on the Black sea, except Selymbria and Derkos, and those on the river Strymon. Peace was also made at the same time with the despot of Servia and the voivode of Walachia, on the basis of the payment of tribute By 1426 the princes of Kermian and Karamania had submitted on honourable terms; and Murad was soon free to continue his conquests in Europe. Of these the most conspicuous was that of Salonica. Garrisoned only by 1,500 Venetians, the city was carried by storm (March 1, 1428); the merciful precedent set by Mohammed I was not followed, the greater part of the inhabitants being massacred or sold into slavery, and the principal churches converted into mosques.

By this time it was widely recognized that a further Turkish advance could only be prevented by the combined action of the northern peoples now definitely threatened. In 1442 a force of Slavs and Magyars under the voivode János Hunyadi (*q.v.*) drove the Turks from Hermannstadt and in the following year they were expelled from Semendria which they had conquered a few years previously Meanwhile, again confronted by a rebellion of the prince of Karamania, Murad had crossed into Asia and reduced him to submission, granting him honourable terms, in view of the urgency of the peril in Europe. On July 12, 1444, a ten years'

peace was signed with Hungary, whereby Walachia was placed under the suzerainty of that country; and, wearied by constant warfare and affected by the death of his eldest son, Prince Ala-ud-din, Murad abdicated in favour of his young son Mohammed, and retired to Magnesia (1444) The pope urged the king of Hungary to take advantage of this favourable opportunity, and 19 days after the truce had been concluded a large army headed by Ladislaus I., king of Hungary, Hunyadi, voivode of Walachia, and Cardinal Cesarini crossed the Danube and reached Varna In this emergency Murad was implored to return to the throne; to a second appeal he gave way, and crossing over with his Asiatic army from Anatoli Hissar he hastened to Varna and routed the allies. Murad is said to have abdicated a second time, and to have been again recalled to power owing to a revolt of the Janissaries. In 1446 Corinth, Patras and the north of the Morea were added to the Turkish dominions. The latter years of Murad's reign were troubled by the successful resistance offered to his arms in Albania by Scanderbeg. In 1448 Hunyadi, now governor of Hungary, collected the largest army yet mustered by the Hungarians against the Turks, but he was defeated on the famous field of Kossovo. In 1451 Murad died at Adrianople, being succeeded by his son Mohammed

Mohammed II. the Conquerer, 1451–81.—After suppressing a fresh revolt of the prince of Karamania, the new sultan gave himself up entirely to the realization of the long-cherished project of the conquest of Constantinople. After completing his preparations Mohammed began the siege in 1453. Constantine Palaeologus, the last emperor, failed to obtain support from the West, the defenders of the city were vastly outnumbered by the Turks and on May 29, 1453, it was carried by assault The sultan triumphantly entered the palace of the emperors, and the next Friday's prayer was celebrated in the church of St. Sofia (*see* ROMAN EMPIRE, LATER).

Secure in his possession of Constantinople the sultan proceeded northwards and entirely subdued the southern parts of Serbia. A siege of Belgrade was unsuccessful, owing to the timely succour afforded by Hunyadi (1456). Two years later internal dissensions in Serbia brought about the conquest of the whole country by the Turks, only Belgrade remaining in the hands of the Hungarians. Walachia was next reduced to the state of a tributary province. Venice having adopted a hostile attitude since Turkey's conquests in the Morea, greater attention was devoted to the fleet; Mytilene was captured and the entrance to the straits fortified. The conquest of Bosnia, rendered necessary by the war with Venice, was next completed, in spite of the reverses inflicted on the Turks by the Hungarian king Matthias Corvinus, the son of János Hunyadi. The Turks continued to press the Venetians by land and sea; Albania was overrun; and Venice was forced to agree to a treaty by which she ceded to Turkey Scutari and Kroïa, and consented to pay an indemnity of 100,000 ducats (Jan. 25, 1478). The Crimea was next conquered and bestowed as a tributary province on the Tatar khan Mengli Girai. Mohammed now endeavoured to strike a blow at Rhodes, the stronghold of the Knights of St. John, preparatory to carrying out his long-cherished plan of conquering Italy. A powerful naval expedition was fitted out, but failed, though a land attack on southern Italy at the same time was successful, Otranto being captured and held for a time by the Turks. In 1481 the sultan died at Gebzé. He is said to have been of a merry and even jocular disposition, to have afforded a generous patronage to learning, and, strange to say for a sultan, to have been master of six languages.

Mohammed II was the organizer of the fabric of Ottoman administration in the form which it retained practically unchanged until the reforms of Mahmud II. and Abd-ul-Mejid. He raised the regular forces of the country to a total exceeding 100,000. Under him the independent princes of Asia Minor were finally subjugated. Many educational and benevolent foundations were endowed by him, and it is to Mohammed II. that the organization of the ulema, or legist and ecclesiastical class, is due. (X.)

MODERN HISTORY

Bayezid II. (1481–1512).—Bayezid reached the capital before his brother Jem and ascended his father's throne. To win over the followers of his brother he paid an accession present to the janissaries: this became an established custom. Jem's attempts to seize the throne were defeated: he took refuge with the Knights of Rhodes, but they were paid to keep him in custody, and after 13 years' captivity he died in Naples. He was said to have been poisoned by Pope Alexander Borgia, who received 300,000 ducats from Bayezid, but from *Taj-ut-Tevarih*, the most reliable history of the period, his illness sounds like erysipelas

Surnamed the "Saint," Bayezid was a man of peace by nature, but failed to curb the warlike tendencies of the young empire He made attempts to withdraw from Otranto, and exempted Venice from her yearly tribute by imposing instead a 4% customs duty on Venetian goods imported. In 1492 the armies of the Turks invaded Laibach in Carniola and Cilli in Styria In 1494 they were driven out of Styria by the Emperor Maximilian. While Bayezid was fighting against his brother's claims, Moldavians attacked Turkish territory in Wallachia and he was forced to lead another Turkish army into Moldavia. The khan of the Crimea, Mengli Girai, fought in this army, and through his influence political correspondence was opened between Russia and Turkey, and the first Russian ambassador, Michel Belsetchev, arrived in Constantinople. Moldavia became a vassal state after two years of war. John Albert, King of Poland, invaded Moldavia in 1496, and this was followed by a counter-invasion of the Turks, but they were forced to return by the severe winter. In 1496 Hercegovina was annexed to the empire, and in 1500 the Polish wars ended with an armistice Rome and the Italian States had encouraged the sultan to crush the Venetian republic. On July 28, 1499, the Turks gained over Venice their first great naval victory at Lepanto, and concluded peace on Dec. 24, 1502: a part of Morea and a few islands passed to Turkey, Venice retaining Cephalonia. On the Asiatic side Ismail Safevi, the shah of Persia, inspired with religious zeal for the propagation of Shia doctrines, raided the empire (1501). The sultan attempted a pacific solution but failed to restrain his warlike son Selim from fighting the Persians. Shah Ismail's propaganda rooted the Shia doctrines so firmly in Anatolia that in spite of the sanguinary repressions during the reign of Selim the Grim the Shia sects survive in Anatolia to this day as the Kizil-Bash. Bayezid had also to fight the Egyptian armies under the Mamelukes who had invaded Adana, and he drove them out.

Selim then turned upon his father and, having won the janissaries to his side with promises of conquest, he forced him to abdicate. Bayezid died on his way to his retreat at Dimetoka The political influence of the janissaries on the frequent change of sultans dates from this episode. While the Ottoman empire under Bayezid, the largest Muslim State in Europe, was reaching its zenith, another Muslim State, that of the Moors in Spain, was declining

Selim I. the Grim (1512–1520).—The severe disposition of Selim earned him the name of the "grim." True to his promise he kept the janissaries in action throughout his reign. After defeating his brother's claims, he attempted to exterminate Shi-ism not only in Anatolia but in Persia which was its centre. In 1515 he annihilated Ismail Safevi's forces at Chaldran and conquered Azerbaijan and Kurdistan. His most important conquest was Egypt, which he added to the empire, after overrunning Syria and defeating the Mamelukes in 1517. According to most Turkish and Western historians he obtained from the last of the Abbasid Caliphs, Mutuwakil, the title of Caliph. (After the fall of the Caliphs of Baghdad in 1258, the descendants of the Abbasids took refuge in Cairo and enjoyed a purely titular authority under the protection of the Egyptian rulers.) But the important authority of the *Taj-ut-Tevarih* implies that Selim did not base his Pan-Islamism on the prestige of the Caliphate, for the *Fetih-Namé* (the declaration of conquest) of Selim himself, as there quoted, has no reference to Caliph or Caliphate. Another contemporary historian, Hassan Touloun, a Mameluke and an admirer of Selim, in his *History of Egypt* (*see* the ms. in British Museum) also implies that Selim meant to realize Pan-Islamism through force rather than through the assumption of the title of Caliph. He assembled

the *ulema* in Egypt and referring to the fact that the Mamelukes always had their sultan consecrated by the Caliph, asked whether this was necessary: the *ulema* declared that the sultanate depended on force rather than on consecration. The sherif of Mecca, Ebul-Bereket, sent his son with the holy relics and the keys of holy places to Selim But though these relics are the emblems of the Caliphate it is probable that Selim wished virtually to abolish the Caliphate. The later sultans, however, added the title of Caliph to their names.

An important revolt, led by Jelal who pretended to be the Mahdi, broke out at Yozgad in Anatolia, but was at once suppressed and from this date all risings in Anatolia are known as Jelalli revolts

Selim who died in 1520 never fought against the Christian West. Possessed by the ideal of uniting the Moslem East he directed his campaigns accordingly. During his reign of eight years the empire nearly doubled its extent. Although he uprooted corruption and the people enjoyed a severe but just administration, his cruelty in executing eight grand viziers is alluded to in the popular saying. "May you be vizier to Sultan Selim." He was a distinguished Turkish poet and wrote both in Persian and Turkish His love of culture and learning was shown by his preference for the company of the learned Although among his subordinates he punished small offences with death, his Sheikh-ul-Islam, Ali Jemali Effendi, who was fearless and outspoken, was able to make him desist from his plan of converting the Greeks to Islam by the sword if necessary, by reminding him of the Conqueror's (Selim's grandfather's) Firman, which gave religious freedom to the Greeks At one time Selim tried to make Arabic the official language, to further his Pan-Islamic policy

Soliman I. the Magnificent (1520–1566).—Soliman I, known as the "Magnificent" in the West and the "Lawgiver" in Turkey, being an only son, was saved from the wars of succession which his predecessors had to fight He began his reign with the magnanimous act of freeing all the prisoners of war and restoring the goods confiscated from the merchants who traded with Persia in Selim's time But this record is marred by the murder of his sons, although this was due to his wife's influence, the famous Hurrem Sultana, known as Roxelana (the daughter of a Russian priest) With her began the influence of women in affairs of state, Soliman having committed this crime in order to leave Hurrem's son without a rival She also instigated the execution of the able Grand Vizier Ibrahim Pasha in order that his power might pass to Rustem Pasha, her son-in-law

Soliman's conquests were mostly in the West, though he had some Asiatic campaigns The causes which provoked his invasions were either trifling or invented for the purpose. He first marched into Hungary in 1521 because his envoy had been slighted and because he received no congratulations on his accession. He captured Belgrade, which remained a base throughout the Turkish wars in Europe. In 1523 Rhodes and Cos were conquered In 1526 the Hungarians were severely defeated at the battle of Mohács (*see* Hungary, *History*), their king, Louis II, killed, and the greater part of Hungary including Budapest taken The Turks appointed Zápolia, the voidode of Transylvania, to be king of the Magyars The sultan then left Hungary to put down a Shia rising in Tabriz. Ferdinand, the brother of Charles V., then claimed the Hungarian throne as the brother-in-law of Louis II, invaded Budapest, and drove out Zápolia, who naturally appealed to Soliman. In 1529 Soliman with Zápolia marched into Hungary, seized Budapest, defeated the Austrians, and Zápolia was reinstated Encouraged against Charles V. by Francis I. of France, Soliman laid siege to Vienna, but after three weeks was obliged to abandon it. Part of the Turkish army went as far as Ratisbon in Germany In 1532 Soliman again marched against Charles V., and approached Vienna, but in 1533 a truce was signed and Hungary was divided between Zápolia and Ferdinand.

During his Persian wars Soliman retained the friendship of Ferdinand; but in 1539 Zápolia died and Ferdinand marched on Budapest. Soliman decided to uphold the claims of Zápolia's son and of his wife Isabella. He marched into Hungary, defeated Ferdinand and placed the young king on the throne under the regency of his mother. Soliman refused all overtures of peace and war continued both on land and sea. In 1542 an alliance between Francis I. and Soliman led to a combination of the Turkish and the French fleets against Charles V. On land, Soliman took Gran, Vizegrád, Székesfehérvár, and a part of Hungary which became a Turkish province consisting of 12 sanjaks. On June 15, 1547, a truce of five years was signed in Adrianople between Soliman, Charles V and Ferdinand which recognized the Turkish conquests, and bound Ferdinand to pay a yearly tribute of 30,000 ducats to Turkey for the territory left to him John Sigismund, the son of Zápolia, was recognized as the independent prince of Transylvania and of the 16 adjacent Hungarian countries, Queen Isabella to act as regent during his minority.

The terms of the treaty were soon ignored. Ferdinand being in league with Frater Gregory (*see* Martinuzzi) to free Transylvania from the Turkish suzerainty, Soliman sent a large army under Sokolli Mohammed Pasha into Hungary. Lippa and Temesvár were taken but a victory of the Persians in the East forced Soliman to sign an armistice in 1553 and invite Austrian delegates to Constantinople to negotiate for peace The negotiations failed and war continued with atrocities on both sides till 1561. On June 1, 1562, peace was concluded between Soliman and Ferdinand, who had been crowned emperor. Ferdinand undertook to pay all his arrears of tribute to Turkey and to continue a yearly payment of 30,000 ducats, to leave Temesvár and other towns to Soliman, to recognize the independence of John Sigismund in Transylvania and to withdraw all his Habsburg claims to interference in Hungary

In 1564 Ferdinand died and Maximilian II succeeded him Maximilian attacked Tokaj which was in Turkish possession and let the tribute fall into arrears Sokolli Mohammed Pasha, the new Turkish grand vizier, desired to wipe out the disgrace of a naval defeat in Malta which had ended in the death of Admiral Torgout, and Soliman in 1566 led an army into Hungary, although 72 years old He died during the siege of Szigétvár, but his death was kept secret by Sokolli till the fortress fell Thus Soliman, after ruling 46 years in life, ruled 46 days after his death, until his son Selim ascended the throne and reached Belgrade.

On the Asiatic frontier in 1526 Shah Tahmasep of Persia had taken Tabriz from the Turks while Soliman was fighting at Mohács On Soliman's return he set out for Persia with an army, conquered the Armenian plateau and joined another Turkish army commanded by Ibrahim Pasha which had already recaptured Tabriz The Persians retreated without fighting and in 1534 Soliman took Baghdad.

In 1535 the French Ambassador, Jean de la Forêt, negotiated a treaty between France and Turkey by which certain judicial and economic privileges were granted to France This marks the beginning of the capitulations, which, started when Turkey was a powerful empire, were only the means of procuring an easy market for Turkish goods in France, but led to political complications and became the pretext for exploiting Turkey in her decadent days In 1555 Soliman concluded a treaty of peace with the Persians at Amasia after conquering Georgia, the Armenian plateau and Erzerum

Mohammed the Conqueror began the building of the Turkish navy but it was during Soliman's reign that Turkey became a first-rate sea-power At no other time has Turkey had such a large number of famous admirals Soliman had conceived the idea of using the renowned corsairs who raided the Spanish and Irish coasts and he had engaged Haired-din Barbarossa (*see* Barbarossa) He was the son of a Turkish sepahi, Yacoub, a Macedonian, and his mother was Greek, his native place being Mitylene. He presented to Turkey Algiers which he had personally conquered, and he formed what was called *Garb-Ojaklari* (the States of Barbary). This was a military organization which administered Algiers, Tunis and Tripoli Barbarossa took Tunis but was driven out by the fleet of Charles V who devastated Tunis and destroyed mosques and valuable libraries because the Turks had converted churches into mosques in Hungary Barbarossa's greatest naval victory was in 1538 when he defeated the combined fleets of the emperor and the pope and of Venice under the com-

mand of Andrea Doria, off Preveza. He took Castel-Nuovo and a few islands of the Archipelago and he restored Morea to the Turkish empire. Torgout (known as Dragut in the west) was another famous corsair who had ravaged the Italian and Spanish coasts and was now engaged by Soliman He captured Tripoli from the Knights of Malta and was appointed its governor He died in 1565, after an unsuccessful attack on Malta Pialé Pasha, Piri Réis, Salih Réis, Seidi Ali Réis, were other renowned admirals of this period Piri Réis and Salih Réis conquered the coasts of Yemen and Aden as far as the Gulf of Basra Piri Réis compiled a detailed sea-atlas (*Bahrié*) of the Aegean sea and of the Mediterranean He also conquered Muskat and Ormuz but was finally defeated by the Portuguese and executed by the sultan in Egypt because of his defeat Seidi Ali Réis, a distinguished mathematician, succeeded him in the command of the fleet and was also defeated by the Portuguese He escaped to the Indian ocean with three ships on which he lived for three years; then he landed and reached Turkey by land He wrote his travels (*Mirat-ul-Memalik*), a mathematical book on the astrolabe and a book called *Muhit* (Ocean) on the navigation of the Indian Seas

The Ottoman State in the 16th Century.—Until the time of Soliman the Ottoman State gradually evolved from a society whose institutions were fundamentally nomadic The power was divided between two classes the military class representing force and the *ulema* representing religion The *ulema* was occupied with religious questions and civil transactions based on religious principles; the judges belonged to this class, but their judgments were executed by the military All executive power centred in the military, and the sultan himself whose autocratic person was the symbol of this power, was nominally a common soldier The viziers, the leading administrators, were also soldiers During war the governing body accompanied the army, this being the chief characteristic of a nomadic system Up to the time of Mohammed the Conqueror the *medresses* (the educational institutions where the *ulema* were educated), in addition to theology taught medicine, mathematics and physics, derived from Arabic sources. During the reign of Soliman these subjects received serious attention and had special institutions devoted to them The laws which preceded the time of Soliman and which were amended during his reign were mostly derived from the *sheria* (religious laws) or from nomadic traditions and customs The religious and the communal affairs of the *raya* (Christian subjects) were left in the hands of their own religious bodies The janissaries (*kapi kuli*—slaves of the palace) who comprised the most important part of the army received their military training in special barracks and received pay. The more intelligent among them were sent to a school attached to the palace called the Enderoun-i-Humayoun They were taught the Muslim humanities (Persian and Arabic), music and practical arts and crafts

Soliman's administration was, relatively, one of the best of his time The Christian population in Morea preferred the Turkish rule to that of the Venetians, and some Hungarian villages chose Turkish rule of their own accord. Financially Turkey was in a good position: she had been enriched by the addition of prosperous lands, the revenue was 183,000,000 aspres, and no new tax was levied during this reign The countries belonging to the empire were administered in two different ways One part was ruled by the central government and consisted of 24 *vilayets* (provinces), four of which were in Europe and 20 in Asia and Africa The second part was more or less self-governing under the suzerainty of the sultan and consisted of the kingdoms of Hungary and Transylvania, the principalities of Moldavia and Wallachia, the khanalik of Crimea and the sherifate of Hejaz The *Garb-Ojaklari* (the States of Barbary), consisting of the provinces of Tripoli, Algiers and Tunis, had semi-independent governors who selected their own administrative bodies and later were empowered to make independent treaties. The sherifate of Mecca was ruled by the descendants of the prophet under the sultan as suzerain.

After the conquest of Constantinople and the transfer of the capital to the imperial city the Turkish system was somewhat influenced by that of the Byzantine empire The affairs of state were discussed at the imperial Divan over which the sultan presided until the reign of Mohammed the Conqueror, after which the sultans thought it more in keeping with their imperial dignity to hear the proceedings from behind a grating. The permanent members of the imperial Divan consisted of seven viziers (pashas with three horse-tails), the grand vizier being the chief of these and invested with supreme power by the signet of the sultan. He held the title of *serdar-i-ekrem* (generalissimo) when in command of the army, in which case one of the other viziers remained behind as *kaimmekam* (lieutenant) The viziers in the Divan were called *kubbe* (cupola) viziers since they met under a cupola. The following dignitaries could attend the council:—

The *kadi-askers* of Rumelia and Anatolia (the two highest judges of the empire), the *kadi* of Stamboul (the judge of Constantinople), the *defderdar* (the minister of finance), the *nishanji* (keeper of the great seal), the *yenicheri agassi* (the chief of the janissaries, who was responsible for the administration of discipline of the corps). Later the office of Sheik-ul-Islam was instituted as the supreme authority relating to the *ulema* and the sacred law The general secretary of the Divan was called the *reis-ul-kutab* and later became the minister for foreign affairs and Captain Pasha (chief admiral of the fleet).

Each vilayet was governed by a pasha (two horse-tails) called a *beyler-beyi* These provinces were divided into sanjaks, each being governed by a pasha (one horse-tail) called a *mir-i-miran.* The sanjaks were divided into *kazas,* each being governed by a kadi and the landowners elected by the people

The Turkish army during Soliman's reign numbered between 200,000 and 300,000, and was one of the best disciplined and best equipped of the time The army consisted of, firstly, the janissaries who were recruited from among Christian boys and prisoners of war, and were trained and quartered in barracks and received pay; and secondly, the feudal levies called *jebelu*. The janissaries comprised the *jebeji* (infantry, artillery, transport), the *sepahi* (cavalry), *azarblar* (responsible for the maintenance and repairing of the warships in ports), the *bostanji* (the imperial life guards and garden guards), the *akinji* (troops numbering from 60,000 to 70,000 who carried out forays in the enemy's country) and the *serden kajdi* (storm troops)

The land was divided into several categories of fief —*khas*, *ziamet, timar, vakuf, yurklik-ojaklil.* The tithes (revenues) of these lands were apportioned to the princes, the viziers, beyler-beyis, the defterdars as salaries. They were not hereditary A fief which had more than 100,000 aspres of tithes was a *khas:* one from 20,000 to 100,000 a *ziamet:* one from 3,000 to 20,000 a *timar* During the war the fief-holders joined the army with the forces they raised known as jebelu The revenues of the fiefs known as *vakuf* were used for the upkeep of mosques, *medresses,* schools, hospitals, asylums and fountains The *yurklik-ojaklil* were the fiefs on the frontiers and their revenues were given to the frontier guards and were hereditary. The grant of a fief was conditioned by obligatory residence The peasants owned the land which they cultivated so long as they paid the tithes to their landlord. The security of tenure of the Turkish peasant has prevented any revolution centring around the land problems in Turkey

Selim II. (1566–1574).—Selim II., after pacifying the janissaries with payments, tried in vain to undermine the power of Sokolli, the grand vizier, and finally found himself obliged to let the country be ruled by that great statesman, who gave the period his name. The conquest of Samos was completed and the risings in Yemen suppressed by Sinan Pasha. In 1568 the peace between Austria and Turkey was renewed for eight years With the idea of joining the rivers Don and Volga by canal so that a fleet might be sent to the Caspian sea Sokolli attacked Astrakan but failed in his project. Turkish historians credit him also with the intention of opening a Suez canal. Cyprus was invaded by the Turkish army under the command of Lala Mustafa Pasha, who violated the Capitulations of Famagusta (1571) by executing the Venetian commander, Marco Antonio Bragadino, and aroused strong feeling against the Turks. Venice, Spain and the pope united in a Holy League against Turkey and their combined fleets under the command of Don John of Austria severely defeated the Turkish fleet at Lepanto (1571). A year later the advance of a new Turk-

ish fleet commanded by Kilij Ali Pasha caused Venice to break from the League and conclude a treaty with the Turks (March 7, 1573). In 1574 Sinan Pasha and Kilij Ali Pasha recaptured Tunis and ravaged Sicily. Selim died in 1574 He was known as the "sot," and passed his time in drink and debauchery The decadence which set in might have gone further if Sokolli had not administered the empire

Murad III. (1574–1595).—Murad, Selim's son, opened his reign by murdering his five younger brothers. He also tried to undermine Sokolli's power and in spite of his advice opened a war with Persia which lasted 12 years. The Turks conquered Shirvan, Tiflis and Daghistan and peace was concluded when Abbas, the successor of Tahmasep, was firmly established as shah of Persia Sokolli's efforts to build an observatory in Stamboul were opposed by fanatical opinion; and his assassination, which soon followed, is said to have been due to the sultan This threw the country into disorder, for there was no man who had Sokolli's strength and authority to oppose the harem intrigues and corruption. The janissaries, refusing to accept a debased coinage that was called "Jewish money" mutinied throughout the empire This mutiny had scarcely been suppressed when in 1593 the uncertain peace between Austria and Turkey degenerated into a regular war which is known as the "Long War" This was due to Hassan Pasha, the governor of Bosnia, raiding the Austrian frontiers and attacking Sissek The Austrians and the Hungarians together routed the Turks in Kulpa with great slaughter Sinan Pasha the grand vizier, marched on Hungary with a large army, and war continued for 14 years Bribery, which had become widespread in the country, corrupted the army as well, and there was no office which was not susceptible to the bribe of the highest bidder. Shemsi Pasha, one of Murad's counsellors, openly boasted of having made a sultan take bribes for the first time Véspérem and Raab were conquered by the Turks but the Moldavian and Wallachian revolts checked further victories The Sultan's Venetian wife, Safié Sultana (Baffo), for many years ruled as his only wife, accepted bribes and interfered in state affairs, influencing the Porte's relations with Venice In later years she had rivals and Janfreda Kadin, the chief palace woman, rose to power because of the many beautiful slaves she bought the sultan and the new forms of entertainment she introduced, including dwarfs and clowns. Murad had 103 children from different wives. He died in 1595 after a life of debauchery The capitulations with France were renewed in 1581, those with Venice in 1589 In 1578 capitulations were signed with the grand duke of Tuscany for the first time and with Great Britain for the first time in 1580 The first British Ambassador sent to Turkey was William Hairbone. Elizabeth in her letter to the sultan urges as a special claim to his friendship their common mission to fight the "idolaters," an interesting example of diplomacy.

Mohammed III. (1595–1603).—Safié Sultana (Baffo) who wielded such a strong influence as wife continued to do so as mother during this reign The new sultan began by murdering 19 of his brothers The war in Hungary became chronic and intrigues between Sinan Pasha and Ferhad Pasha for the position of grand vizier led to frequent changes of command in the army, with disastrous results. Sinan persuaded the sultan to command the army in person, with good results at first for in 1596 the Turks recaptured Erlau and in three days defeated the allied armies at Keresztes Because the sultan was anxious to return to his easy life in the capital and because the undue severity of Sicala Sinan Pasha was causing the Anatolian troops to desert, the Turks did not gain much by their victory Ibrahim Pasha, Safié Sultana's favourite, became grand vizier through her influence and she sold by proxy all the high offices of State In 1598 Raab, Totis, Vespérém and Pappa were lost by the Turks In 1599 overtures for peace were made by all sides without result. The unique military achievement of this campaign was that of Tiraki Hassan Pasha who in 1600 captured Kanizsa. A year later the attempt of the archduke Ferdinand to retake it at the head of 30,000 men was defeated. Military mutinies and Jelali insurrections broke out in the interior and Shah Abbas marched on Tabriz and Erivan, when the sultan died in 1603.

FROM THE 17TH CENTURY

Ahmed I. (1603–1617).—Ahmed I ascended the throne at the age of fourteen. The war with Persia continued fitfully during his reign. The Turks recaptured Gran in Hungary. Transylvania passed to the suzerainty of Turkey of its own accord. Stephen Bocsk, a member of its own aristocracy was appointed king But the continual mutinies of the janissaries and the reverses in Persia forced Turkey to sign for the first time at Sisvatorok a treaty of peace on terms of equality with Austria Austria was freed from future tribute to Turkey by paying 200 000 ducats down, and for the first time the emperor was referred to as *padishah* in the official Turkish documents A treaty of peace was also concluded between Turkey and Persia in 1611, Persia giving to Turkey as indemnity a million pounds of silk *Kuyuji* (pitman) Murad Pasha, so called because he threw the bodies of rebels into pits, suppressed the Jelalli risings in Anatolia. Friendly relations with Poland were restored.

Ahmed I. was of a religious disposition, and left the affairs of the state to his grand vizier His wife, Mihri-Mah Kussem Sultana, daughter of a Bosnian priest who entered the palace at the age of 14, is one of the most dramatic figures of Turkish history To prevent the usual murders of members of the dynasty it was decided that the eldest male of the family should succeed to the throne Ahmed died in 1617.

Mustafa I. and Osman II. (1617–1622).—Sultan Mustafa being an imbecile was declared incompetent to rule and Osman II ascended the throne Sokolli's idea that friendship with Persia would be politically to the advantage of the empire was adopted by the sultan and peace was concluded with Persia Moldavia revolted and joined the Poles and Osman marched on Khotin. The expedition was a failure and diminished the prestige of the sultan From his contact with them he knew how utterly degenerate and useless a body the janissaries had become and decided to discipline and reform them. He pretended to go on a pilgrimage to Mecca with the intention of marching back to the capital with a loyal and well disciplined army which he hoped to raise in Syria and Arabia When a rumour of this reached the janissaries they revolted After marching the sultan through the streets of Istamboul and exposing him to ignominious insults they killed him.

Mustafa I. (1622–1623), Murad IV. (1623–1640), Ibrahim I. (1640–1648).—Mustafa I was once more dragged to the throne by the janissaries but he soon abdicated in favour of his nephew Murad IV, still a minor Till the sultan was of age the empire was in the hands of his mother, Kussem Sultana, who had to cope as well as she could with the mutinous army and the corrupt state The army chose the grand viziers and massacred them when they wanted a change Kussem Sultana had to open the Treasury to appease these revolts, which depleted the finances still more. When Murad IV was of age he restored order by one of the bloodiest reigns of terror. Marching on Baghdad and Erivan he recaptured them from the Persians, repeating the atrocities which the Persians themselves had committed He concluded a peace with Persia which fixed the Turco-Persian frontiers still in existence On his return he murdered all his brothers with the exception of Ibrahim and continued to terrorize his officials by frequent executions. He died in 1640.

Already weak in mind Ibrahim I, his successor, was incompetent to rule He devoted himself to pleasure and was ruled by the women in the palace while his mother Kussem Sultana once more took the reins of power Sheker-Pare, the sultan's storyteller, enthralled the sultan with her stories and made her fortune, selling the highest positions of state The reign of Ibrahim, which is called the "sable and ambergris period," owes its name to a story of hers Even the high dignitaries of the empire were employed in collecting sables It is not surprising that complete anarchy reigned throughout the empire, the capital included. A campaign against Crete, which belonged to the Venetians who had burnt some Turkish ships, began during this reign, but continued for 25 years. For the first time the Dardanelles were closed by Venetian ships, which caused a famine and led to a revolt. Ibrahim wanted to massacre the Christians, but the *ulema* were able to restrain him. The change of the residence of the ambassadors

from Stamboul to Pera dates from this event. Ibrahim was dethroned during a mutiny and killed.

Mohammed IV. (1648–1687).—Mohammed IV., the seven-year-old sultan, succeeded his father and for another eight years the affairs of state were in the hands of Kussem Sultana, his grandmother. The janissaries had supreme power, monopolizing everything, even the sale of bread Mohammed's mother, Turhan Sultana, tried to get the power into her hands and the period of anarchy and mismanagement was prolonged by the struggle between the two women, each depending on a different military party. Turhan Sultana accused her mother-in-law of trying to poison the boy sultan and one evening she contrived that her party should invade the palace and surprise Kussem Sultana in her room Kussem Sultana's great oratorical powers, which had enabled her to control janissary risings, failed to save her life and she was strangled with the cords of her bed curtain Turhan Sultana now put Kuprullu Mohammed Pasha into power as grand vizier He restored order in the army by very drastic measures, rebuilt an efficient navy, defeated the Venetians and recaptured the island of Lemnos and other islands. The improved condition of the army led to the pacification of Transylvania which was in revolt. Kuprullu Mohammed Pasha died after being in office five years and his son Kuprullu Fazil Ahmed Pasha became grand vizier. In 1663 disturbances in Transylvania caused the Turks to attack the Austrians At first Turkish arms were victorious but the French, who had been alienated by the haughty demeanour of the Kuprullus, sent help to the Austrians under Montecuculli, the Austrian general and the Turks were defeated at the battle of St Gotthard abbey and were forced to consent to the Treaty of Vasvár (Aug 10, 1664), by which a truce of 20 years was agreed upon Transylvania was evacuated but remained tributary to Turkey The Turks retaliated on the French by depriving those Catholics who were under French protection of some of their privileges in the holy places and granting them instead to the Orthodox Church The Cretan campaign was still in progress and the French were helping the Venetians, but the Turks took Candia and a treaty was signed in 1669 between the Venetians and the Turks which left Crete in the possession of Turkey while the fortresses of Suda, Spinalonga and Grabusa remained Venetian.

Events in the Ukraine led Turkey into war with Poland in 1672 The Turks captured Kamenetz, Lemberg and Lublin The Poles sued for peace and a treaty was signed in 1672 at Buczacs whereby Podolia was ceded to Turkey, Ukraine left to the Cossacks, and Poland consented to pay Turkey an annual tribute of 22,000 sequins. But John Sobieski, who ascended the Polish throne, refused to abide by the terms of this treaty and war was renewed and continued till 1676 when the Treaty of Buczacs was reaffirmed, both parties abrogating the tribute clause

Kuprullu Ahmed Pasha having died, Kara Mustafa Pasha succeeded him as grand vizier. A man of great military ambitions, he led Turkey into a series of unnecessary wars The first was against the Russians, and, although the Turks conquered Cehrin at the beginning, their losses were so great that they signed a treaty at Radzin (Jan. 8, 1681) ceding the disputed territory to Russia. The internal disputes in Austria due to Protestant persecution caused Kara Mustafa Pasha to violate the truce signed by Ahmed Kuprullu and lead a vast army against Austria which laid siege to Vienna. The emperor and his court fled from the capital when John Sobieski of Poland saved the Austrian cause by attacking the Turks in the rear and defeating them This kindled the crusading spirit in Europe against Turkey and an alliance between Austria, Venice, the Pope, Poland, Russia, Malta and Tuscany was formed and some of them attacked different parts of Turkey. The Austrians made conquests in Hungary, the Venetians in Greece, the Russians in Crimea and the Poles in Podolia. Turkey tried in vain to get France to join her against this general alliance. The janissaries mutinied and Mohammed IV. abdicated in favour of his son.

Soliman II. (1687–1691), Ahmed II. (1691–1695), Mustafa II. (1695–1703).—Kuprullu Fazil Mustafa Pasha was made grand vizier, and, true to the tradition of his illustrious family, he restored order in the army and in the fleet, and by wise and tolerant administration won the sympathies of the non-Muslim subjects. Austria captured Erlau, entered Transylvania and reached Belgrade and Uskub, but Kuprullu Mustafa Pasha drove out the Austrians and recaptured Belgrade. He also defeated the Russians in Crimea Mustafa Pasha went as far as to distribute seeds for the crops of the people of the recaptured countries In 1691 while the Turkish army was fighting in Morea Soliman II. died and was succeeded by his brother Ahmed II

The Turks were defeated at Slankamen in Hungary under Kuprullu Mustafa Pasha who was slain on the battle-field. An attack on Peterwardein was equally a failure and the Venetians captured the island of Chios In 1695 Ahmed died and was succeeded by his brother Mustafa II

Chios was recaptured and the war with Austria continued under the command of the new sultan. The Turks conquered Lippa and defeated the Austrians and the Austrian field-marshal von Veterani was killed. But the Russians took Azov and in 1697 the Austrians under the command of Prince Eugene defeated the Turks at Zenta-on-Theiss. The war was ended, on the pressure of Venice, Holland and England by a series of treaties with Austria, Poland and Venice concluded at Karlowitz (Jan. 1699) By the terms of these treaties Turkey retained the Banat, Austria kept Transylvania, Poland restored the places captured in Moldavia but retained Kamenetz, Podolia and Ukraine, Venice retained the Morea and Dalmatia and a two years' truce was signed with Russia In 1700 Azov was ceded to her by a separate treaty During this time Hussein Pasha, again a Kuprullu, was grand vizier, but his efforts to introduce order into the country were frustrated, he was driven out of office, and a fresh revolt of the janissaries forced the sultan himself to abdicate He was succeeded by his brother Ahmed III

Ahmed III. (1703–1730).—Ahmed began his reign by conceding the demands of the janissaries and accepting their chosen grand vizier Charles XII. of Sweden, having been beaten by the Russians at Poltava, took refuge in Turkey and was invited to reside at Bender This involved Turkey in another war with Russia which had already sent troops across the frontiers in pursuit of Charles XII (1710) Baltaji Mohammed Pasha, in command of the Turkish army, was induced by her entreaties to grant the Empress Catherine a peace less to Russia's disadvantage than her defeat merited Azov was left to Turkey, Russian fortresses on Turkish frontiers were razed, Russia consented to the return of Charles XII. and renounced all claims over the Tatars in Crimea and in Polish territory As the hospodars of Moldavia and Wallachia had assisted Russia during the campaign they were punished and Phanar Greek notables (*see* PHANARIOTS) governed these principalities till the Greek insurrection of 1821 Venice was next to be punished for having incited the Montenegrins to revolt, and having invaded Bosnia and having captured Turkish ships in the Mediterranean. In 1715 Turkey declared war against Venice, quelled the Montenegrin revolt, captured Modon and Coron and with her fleet took the islands of Tinos and Cerigo, as well as the remaining Venetian fortresses in Crete. Austria intervened, urging Turkey to cede to Venice certain places in Dalmatia as compensation for her losses in Morea. This led to a declaration of war against Austria in 1716. The Turkish army was routed near Peterwardein, and pursued by the Austrian army led by Prince Eugene, which took Belgrade and overran the Banat (1717). The Turkish army then retreated to Adrianople By the mediation of England and Holland the Treaty of Passarovitz was signed on July 21, 1718: Belgrade, a part of Wallachia and Banat passed to Austria, and strongholds in Albania and Dalmatia to Venice. This treaty was signed by the grand vizier Ibrahim Pasha who is accused of having betrayed Turkey by accepting it, Ibrahim Pasha being a man of epicurean tastes which the sultan shared. The craze of the time in the capital was the cultivation of tulip gardens and has given to this period of Turkish history the name of the "Tulip Period." It created a definite literary school under Nedim, the greatest Turkish lyric poet. But popular murmurings against these costly pleasures became such that the grand vizier had to seize the occasion of the Persian defeat by the Afghans to annex several parts of Daghistan in Persia in order to appease the

bellicose spirit of the janissaries. This led to a complication with Russia, but the intervention of France resulted in a treaty between Russia and Turkey which was signed in Constantinople (June 30, 1724) The treaty allotted Baku and Derbend on the Caspian coast to Russia

The news of the defeat of the Turkish army by the Persian army under Nadir Kuli Khan led to a rising of the mob under the leadership of Patrona Khalil, a bath waiter The grand vizier was killed and the sultan forced to abdicate (1730) Mahmoud I. succeeded This is the only Turkish rising which had not originated in the army. The printing-press first came into use in Turkey at this time

Mahmoud I. (1730–1754).—Patrona Khalil was killed and his followers dispersed after the accession of Mahmoud I. The war continued with Persia and Nadir Kuli Khan, after his successes in 'Iraq and Erivan, seized the Persian throne In 1736 a Turco-Persian treaty was signed whereby all territory conquered since the reign of Murad IV was returned to Persia Russia also returned the Persian territory she had annexed, thus laying the basis of a Russo-Persian alliance against Turkey

The question of the Polish succession once more led Turkey into war France had put forward as her claimant to the Polish throne Stanislas Leszczynski, while Austria and Russia supported the claims of Augustus III, the elector of Saxony, although Russia had bound herself by the treaties of 1711 and 1720 to abstain from interfering with Poland The Russian candidate was forced upon Poland, whereupon France declared war on Russia and Austria, and then urged Turkey to join her Turkey had a grievance in that Russia had refused to allow the Crimean troops to march through Daghistan during the Persian campaign, so she declared war in spite of the joint efforts of England and Holland Before waiting for a declaration of war a Russian army under Marshal Munnich stormed the isthmus of Crimea, devastated the whole peninsula, and captured Azov and Kilburun, and a year later, Ochakov The sea Powers of the west mediated to restore peace and the representatives of the belligerents met in Niemirov in 1737 to arrange terms But Austria put forward new claims to the principalities and the Balkan peninsula which were refused by Turkey, whereupon she revealed the existence of a secret alliance with Russia and threatened to fight for her new claims Accordingly her army marched on Bosnia and Wallachia, capturing Nish in Serbia But the tide of war turned against both Russia and Austria, Ochakov and Kilburun being recaptured by one Turkish army while another crossed the Danube and penetrated as far as the Banat In 1739 Turkey consented to negotiate peace and a conference opened in the camp of the grand vizier who was marching on Belgrade The preliminaries were signed under the mediation of the French ambassador Villeneuve, for whose services the Porte reaffirmed the capitulations which France had already obtained After the entrance of the grand vizier into Belgrade the definitive treaties of peace were concluded with Austria and Russia (Sept 18, 1739) Austria gave up Belgrade and the rest of the territory south of the Save which she had gained by the Treaty of Passarovitz The treaty with Russia provided that the forts of Azov should be razed, and that Russia should have no warships on the Sea of Azov or on the Black Sea. The Kabardias were to remain independent as a buffer-state between Turkey and Russia Turkey consented to discuss the question of recognizing the tsar's claim to the imperial title of *padishah* and admitted his right to send representatives to Constantinople.

Two years after the Treaty of Belgrade war broke out with Persia because of Nadir Kuli Khan's attempt on Mesopotamia, and it continued from 1743 to 1746 with varying fortunes. When peace was signed Turkey retained the frontier fixed at the time of Murad IV. and Persia procured a few privileges for her pilgrims to the holy places. Turkey refrained from taking part in the War of Austrian Succession in spite of the efforts of France, and she maintained a peaceful attitude during the disorders which followed the death of Nadir Kuli Khan in Persia. The sultan died in 1754 and was succeeded by his brother Osman III. (1754–1757) The only noteworthy events of the latter's reign were the first Wahhabi rising and the issuing of the first order for veiling women's faces

Mustafa III. (1757–1773).—Koja Raghib Pasha, the grand vizier at the accession of Mustafa III, sent an envoy to Berlin and a treaty of friendship and commerce was signed on March 12, 1761. While he was alive Koja Raghib Pasha kept the sultan out of war He controlled Turkey's foreign affairs while the sultan, who was of a fanatical disposition, concerned himself with the dresses and the veils of women He projected an alliance between Turkey and France, but France and England having differences over the Indian possessions, such a treaty might have affected the English interests among the Muslims and in consequence Porter, the British ambassador in Istamboul, used his influence against it

Before long events in Poland drew Turkey into the general war Catherine II of Russia tried to put her favourite, Stanislas Poniatowski, on the Polish throne on the death of Augustus III The Poles complained to the Porte and urged Turkey to fight Russia The sultan at first contented himself with protests, but Russia had violated the neutrality of the Kabardia, while in Serbia, Moldavia and Montenegro the Russian monks carried on seditious propaganda against Turkey Turkey issued an ultimatum to Russia demanding that she withdraw her army from Poland On her refusal war was declared Turkey procured the neutrality of England, Holland and Sweden in this war, and Austria undertook to remain neutral in return for certain privileges Nevertheless Turkey had entered the war without preparations The Turks were first defeated by the Russian forces in Georgia, Crimea and Kabardia, and on the Dniester, the Russian Baltic fleet under Alexei Orloff reached Morea, and incited the inhabitants to revolt The Turkish fleet was burnt near Cheshme by the Russian fleet under the command of a Scottish admiral The Turks were defeated in Kartal by Russia, who invaded the principalities, and reduced the fortresses on the delta of the Danube and on the Dniester In 1771 the Crimea was conquered by the Russians Although the Austrians had undertaken to mediate and to assist the Turks, they preferred to take a share in the partition of Poland After a fruitless conference at Focshani, the Russian representative at the Conference of Bucharest (1773) issued an ultimatum demanding the free navigation of the Black sea and the Aegean sea for Russian trading vessels and warships, the cession of Kilburun, and the right to protect the Orthodox subjects of the Sultan Turkey refused these terms, and the war continued, the Turks fighting hard in Silistria and Varna Mustafa died in 1773

Abdul-Hamid I. (1773–1789).—Abdul-Hamid, his successor who had been kept in a cage for 43 years, was weak in his mind The abuses and disorders in the army and the palace were at their worst, and the situation at home gave no hope of retrieving the external misfortunes of the state. Turkey refused the mediation of Prussia, but when the Russian army reached Shumla she was forced to negotiate peace. The Treaty of Kuchuk Kainarji was signed on the anniversary of the Treaty of Pruth (July 21, 1774) which had been disastrous to Russia This was the most humiliating treaty the Turks had ever signed The treaty was the first political manifestation of the Eastern Question (*q v*), and the Turkish desire for reform on Western lines dates from this disastrous event The Tatars from Poland to the Caspian sea were given their independence, the sultan merely retaining his religious leadership as Caliph. Russia retained Kilburun, Kerch and Yenikale, while Akkerman, Ismail, Ochakov and Bessarabia were restored to Turkey Moldavia and Wallachia became semi-independent states under Turkey, excepting for the right of Russia to intervene in the appointment and dismissal of the hospodars The imperial title of *padishah* was definitively conceded to the Russian tsars. The Black sea and the Mediterranean were made free for commerce and navigation to both countries, and Turkey was to pay an indemnity of 15,000 purses to Russia The most important clause from the Turkish point of view was that which gave Russia the right to protect the Orthodox subjects of Turkey. Originally this treaty only accorded to Russia the right to build a church in Constantinople and the right of making representations for the protection of the officials of this church, and Turkey undertook to protect the Christians herself (Article 7.) This clause was later interpreted as an inclusive protection of the Orthodox

Christians, and played a disastrous part in the subsequent history of Turkey Poland, who originally caused the war, was not mentioned, having been partitioned in 1772

Turkey took advantage of the respite to strengthen her frontier defences and to reform the janissaries. Russia soon tried to annex Crimea, but a rupture was averted by French mediation, and also by the fact that Turkey was not ready for war. Turkey signed the Convention of Ainali-Kavak, March 10, 1770, whereby the Russian partisan Shahin Girai was recognized as the khan of Crimea, and the terms of the Treaty of Kainarji reaffirmed. Five years later Russia annexed Crimea and Kuban, and Turkey was forced to sign the Convention of Constantinople on Jan. 8, 1784, the stipulations as to the independence of the Tatars in the Treaties of Kainarji and Ainali-Kavak being abrogated Catherine II's triumphant entry into the Crimea and her interview with her ally Joseph II. to discuss the partition of Turkey together with the seditious Russian propaganda in Moldavia, Wallachia and Morea created a war party in Constantinople which was sustained and encouraged by the British and Prussian ambassadors War was declared. The Austrians joined the Russians but were driven back by the Turks from Mehadia, who overran the Banat (1789). The Russians captured Khotin and Jassy and Ochakov, all of whose inhabitants were massacred, including the women and children, by the order of General Suvorov The news affected Abdul Hamid I so deeply that he died

Reform had become so urgent and inevitable that of the two young sultans who succeeded Abdul-Hamid I, one gave up his life for it and the other had to carry out his designs for Westernization by the most sanguinary measures The ignorance, the despotism or the weakness of most of the sultans disorganised both the autonomous and the centrally governed provinces Between the Treaty of Karlowitz and the Treaty of Kainarji, the absence of discipline among the janissaries and their interference in the internal policy of the state upset the administrative machinery The partially self-governed States of Barbary (Tripoli, Tunis, Algiers) had become almost independent, keeping only a nominal connection with the empire, and choosing their own chiefs called *dayi*. The Mamelukes who were allowed to stay in Egypt by Selim the Grim had become stronger, and with the help of the janissaries were taking up a hostile attitude to the Porte. The Mamelukes in Baghdad did the same. The recurrence of the Jelalli insurrections brought forward headstrong governors who ruled the country like feudal lords. In European Turkey the locally elected notables, called *ayan,* interfered in the administration This general disorganization was partially remedied by the grand viziers belonging to the Kuprullu family, but it continued worse than ever after them. The system of land tenure of the time of Soliman was violated. The *khas, timar* and *ziamet* were seized by the central government, apportioned to the favourites of the sultans or the viziers and sometimes even sold to the highest bidder and to people who were not able to rule them or take part in their defence. The number of the officials increased, and their short terms of office led to continual disorder The officials received fees for their services, which made bribery prevalent on a large scale

During the "long war" of the time of Murad III. the army increased disproportionately, but its individual units were no longer trained in the barracks and their military value was next to nothing. The sultans isolated themselves in their palaces, and led lives of pleasure, thus losing contact with the army. They appointed incompetent commanders, and executed them if they were defeated, which paralyzed the initiative of those with a genuine ability to command As the supply of provisions and ammunition was also in disorder, many deserted from hunger and lack of munitions. Although the army decreased in numbers after the Treaties of Karlowitz and Passarowitz, the leaders of the janissaries would mark any man in the street as a regular soldier, register his name, and put the pay in their own pockets, while the man himself went on with his own work All attempts so far had failed to remedy these abuses. To make matters worse, the frequent change of sultans, often brought about by the janissaries themselves, meant accession presents which at times depleted the Treasury. Then the Treasury was refilled by debasing the coinage.

Science and Industry which were far advanced at the time of Soliman had taken no part in the progress of the 17th and 18th centuries but had remained hopelessly mediaeval. The official class was mostly illiterate, and the *cadis* who meted out justice were ignorant. The Turks refused to learn any European languages, and knew very little of what was going on in the world. When necessity arose they used the Christians and Jews as interpreters and became correspondingly dependent on them Few books on philosophy, mathematics and history were printed in Ahmed III's reign Only literature, especially poetry, flourished during this decadent age, and most of the greatest Turkish poets were of this time Textile industries, being patronized by the sultans, also flourished The manufacture of implements of war and ammunition continued, partly because of the artisans who inherited their craft, and partly because of the experts who were brought from the West for the purpose.

Selim III. (1789–1807).—Selim III. was the only prince of the last centuries who had not been caged, which gave him an opportunity of greater knowledge and a more normal view of the world He was a passionate admirer of French culture, and he wanted Turkey to be equal with the Western Powers in every branch of progress. It was in Selim's mind that New Turkey originated, and with him the struggle for reform and progress began seriously, at the price of so many Turkish martyrs He hoped to bring the war to a victorious end and so acquire the necessary prestige for his reforms But it was not to be When the news of the Russian victory of Kalas reached Constantinople he called a council, enumerated the causes of defeat and disaster, and proposed internal reform as the only remedy He insisted that the people should elect their own *kethudas* (mayors) and notables (*ayans*) without the interference of the governors, that an end should be put to the unlawful tribute which the *rayas* were made to pay, that the army and the administration should be organized on a Western basis

In the meantime one Austrian army defeated the Turks in Serbia and captured Belgrade, while another in conjunction with the Russian army captured Foschani On Aug 4, 1791, the new Austrian emperor, Leopold, who was unfavourable to the Russian alliance, made a peace with Turkey at Sistova through the mediation of England, Prussia and Holland, by which Belgrade was restored to Turkey But Russia, after defeating the Swedes, who were Turkey's allies with Prussia, was free to carry out her policy of extension in Turkey, and the war continued It was about this time that William Pitt in England proposed the policy of preserving the integrity of the Turkish empire It appeared first in the form of friendly advice to Russia to make peace with Turkey, which was rejected by Catherine II. Turkey after several reverses on the field, made peace with Russia in 1792 at Jassy, the Dniester becoming the Turkish frontier in Europe

Selim continued his reforms, especially in the army He formed a new corps, but in order to disarm the jealousy of the janissaries he affiliated the new corps to them. Military schools were opened, the fleet reorganized, and instructors brought from Europe But his progress was interrupted by the war with France (1798) Bonaparte attacked Egypt, more indeed as a move against England than against Turkey, as his aim was the closing of the route to India. Turkey fought against France in Alliance with England and Russia. Napoleon was beaten in Syria, the French fleet destroyed by Nelson at Aboukir, and the Ionian islands captured by the Turkish and Russian fleets. Peace was concluded with France in 1802. The reactionary governors whose interests were injured by the new reforms continued to cause disorder in every part of the empire. Pasvan Oglou, the governor of Vidin, drove the peaceful *rayas* to revolt by his persecutions, and the insurgents chose Kara George (George Petrowitz) as leader and succeeded in taking Belgrade. An army was sent to punish Pasvan Oglou, without result. The revolt of the Wahhabis in Nejd became another source of anxiety which continued till the time of Mahmoud II A marked renewal of trouble broke out with Russia over the principalities. Constantine Ypsilanti and Alexander Murusi, hospodars of Wallachia and Moldavia, two instruments

of Russia, had caused risings against the Porte which had led Turkey to dismiss them without the consent of Russia, thus violating the agreement of 1802. Russia and England protested, and the two were replaced. But, encouraged by the French ambassador, General Sebastiani, Turkey declared war against Russia, although the British ambassador threatened to join Russia against Turkey (Nov. 6, 1806) The British fleet passed the Straits, anchored off Istambouf and delivered an ultimatum, ordering Turkey to dismiss the French ambassador within 24 hours and to make peace with Russia The Porte, encouraged by Sebastiani and by popular indignation at the presence of the ships, decided to resist. The entire population of Constantinople helped to range a thousand guns along both sides of the Bosphorus in one day. The British fleet retired considerably damaged

In the meantime the reforms and the progress of the new army were leading the janissaries and the corrupt officials to make desperate efforts in opposition, and they were supported by most of the reactionary governors In 1807 the garrisons on the Black Sea rose, under Kabakji Mustafa, and killed their officers and all those who were known to be reformists. The rebellion became general and the abolition of the new troops was demanded. The concessions made by the sultan in the hope of preventing further bloodshed only encouraged the rebels to make greater demands, and finally they dethroned him General Sebastiani is charged by the Turkish historians with inciting the janissaries

Mustafa IV. and Mahmoud II., 1808-1839.—Selim's successor, Mustafa, abolished all the reforms, and anarchy continued during his reign of 14 months In 1807, during the negotiations between the Russian emperor Alexander and Napoleon at Tilsit for the partition of Turkey, Napoleon undertook to mediate peace between Russia and Turkey, if Alexander would withdraw his troops from Wallachia and Moldavia An armistice was signed in Aug 1807, the Turkish army retiring to Adrianople In the winter of 1807 a committee composed of the adherents of reform in Rusjuk, persuaded Alemdar Mustafa Pasha, who had distinguished himself in the Russian war, to march on Constantinople with an army of 20,000 Kirja-Ali troops, with the object of reinstating Selim and his reforms Selim was killed by the janissaries before Alemdar's army could enter the palace His nephew Mahmoud, a youth brought up in the tradition of reform, was saved by Jevri Kalfa, a woman in the palace who threw ashes in the eyes of the murderers and enabled the future Sultan to escape by the roof Mustafa IV. was dethroned and Mahmoud II, the last survivor of his line, ascended the throne Mahmoud II. appointed Mustafa Pasha grand vizier and issued a royal proclamation ordering him to treat the people and their *rayas* with justice and to re-establish order As the Russian question was not settled and the principal governors were all trying to instigate revolts by declaring the reforms to be anti-religious, and thereby exciting fanatical resistance, Mahmoud II. based his arguments on religious grounds and demonstrated the necessity of education and reform in the name of Islam Alemdar Mustafa Pasha called a council in Constantinople to which he invited notables and influential men from all over the country. The council decided that the new troops, under European instructors, were to be re-established under the name of "Seymen-i-Jedid". that the janissary organization was to be retained but reformed, those only nominally on the register and receiving pay without serving to be dismissed; and that the authority of the sultan was to be permanent. The new grand vizier managed to restore comparative order and began his reforms seriously, but while the Kirja-Ali troops who were loyal to him were on their Bairam leave the janissaries attacked his home at night. He pretended to parley with them asking to have his womenfolk removed to a safe place, after which he promised to give himself up. But when the women had been removed he opened fire on the rebels from his windows and fought them to the last shot, after which he blew himself up in the powder-magazine under his house. The janissaries, once more masters of the situation, resumed their massacres of the new troops, and forced the sultan to cancel all the reforms

The truce signed with Russia in 1807 had had no result, and the war continued fitfully France had encouraged the Porte to resume the Russian wars but the misfortunes of these wars aroused public opinion in Turkey against France and turned it in favour of England. On June 5, 1809, a treaty was signed in Chanak between England and Turkey, the British representative being Sir Robert Adair. A peace with Russia was also concluded on May 28, 1812, in Bucharest by the mediation of Stratford Canning, the British ambassador who played a great part in the Anglo-Turkish friendship The treaty gave Khotin, Bender and Akkerman to Russia, and confined the Eastern frontiers of Turkey to the lines of the River Pruth The clause which restored Serbia to Turkish suzerainty was vague and gave rise to disputes The Turkish army marched into Serbia and appointed one Milosh Obrenovitch as the governor of his district, he however raised a successful revolt against Turkey and ruled Serbia in semi-independence Kara George. who had returned, was killed by him and in 1817 he was designated hereditary prince of Serbia

During the war with Persia Russia had acquired the right from Turkey to use temporarily the road from the Black sea to Tiflis by way of the valley of Rion-Phasis Russia desired to have this district ceded to her by a secret clause in the Treaty of Bucharest, and the sultan had refused to ratify it But within a few years she acquired the high land between the Caspian and the Black sea and the low lands along the coast between Anapa and Poti, which were nominally under the suzerainty of the sultan

Such was the situation when a European guarantee of integrity of Turkey was proposed at the Congress of Vienna, in the belief that break-up of the Turkish empire would endanger the world's peace. It was decided, with the consent of the tsar Alexander, that England, France and Austria should trace clearly the frontiers of the Turkish empire, whose integrity the Powers would undertake to guarantee The Porte, deeming the proposal to be a humiliating foreign intervention, refused The return of Napoleon threw the question into the background and the Turkish empire thus remained outside the European concert This Eastern Question (*q v*) which occupied the political history of the 19th century can be summed up as the result of the conflict of the following desires Russia's and Austria's desire to reach the Mediterranean; the British desire to prevent Turkey from obstructing the route to India; the desire of the non-Muslim Turkish subjects for independence which was often concealed under the demands for reform

Mohammed Ali Pasha, the governor of Egypt, who had become known during the war with Napoleon, had proved his strength by putting to an end the Mameluke risings, and his successful expedition against the Wahhabis in Hejaz had made him a popular hero as the saviour of the holy places. Another Ali Pasha, the *tepedelenly*, the governor of Morea, who was keeping the Greeks quiet in Morea by drastic measures but taking a rebellious attitude to the Porte, was executed

The Greek Rising.—The Greeks found this an opportune moment to realize their ideal of national independence Their hopes had begun at the time of Peter the Great and were considerably strengthened by the attitude of Catherine II. (*see* GREEK INDEPENDENCE, WAR OF) Their secret revolutionary society, the Hetairia, was founded in Bucharest by the Greek poet and patriot, Constantine Rhigas, and, four years after his arrest and execution in 1798, it was revived in Odessa The society passed into action with the help of Alexander Ypsilanti, son of hospodar Ypsilanti, a Greek who had become general in the Russian army and used his forces to support the Greek insurgents in 1821 The emperor Alexander's aversion to supporting a revolutionary, even against the infidel Turks, together with the preference of the population of the Danubian principalities for the Turkish rule rather than that of the hated Phanariotes, considerably weakened the cause of the insurgents This, the first serious rising was put down at the battle of Dragashani on June 19, 1821. But the Greek rebels in Morea had massacred almost to extermination the native Muslims and the sultan retaliated by executing the Greek patriarch in Constantinople on the charge of being instigator of the slaughter Russia, taking this up as an insult to the Orthodox Church, broke off relations with Turkey The European Powers used every

effort to avert a Russo-Turkish conflict Metternich hoped that with time and the moral and material assistance of European peoples the Greeks would of themselves achieve national independence On March 25, 1823, however, Canning induced England to recognize the Greek insurgents as a belligerent party The Russian emperor, jealous of this new influence in favour of the Orthodox Christians of the East, called as a counterpoise a conference in St Petersburg, in April 1824 Neither the Turks nor the Greeks would abide by its decisions and the sole outcome of the conference was an offer of the joint mediation of Austria and Russia, which the Porte refused The sultan, finding himself unable to put down the Greek revolt, asked the aid of Mohammed Ali Pasha, the governor of Egypt, promising him the general governorships of Morea, Syria and Damascus in return The well-disciplined Egyptian army and fleet entered the Morea under the command of Ibrahim Pasha, the son of Mohammed Ali The Greeks were defeated in June 1827, Athens once more was in the hands of the Turks, and Ibrahim Pasha was sending crowds of Greeks as captives to Egypt and replacing them by the *fellahin* (Egyptian peasants) An isolated Russian intervention, for which Russia was concentrating in the south, was prevented by the death of the emperor Alexander in 1825 Canning persuaded the new tsar Nicholas I to call another conference in St Petersburg on April 4, 1826, as a result of which England was empowered to offer Turkey a settlement of the Greek question based on the establishment of Greece as a vassal and tributary State In case of refusal the two Powers, whether separately or in common, would take the earliest opportunity of enforcing a settlement. Russia, meanwhile, issued a separate ultimatum to the Porte for the satisfaction of her other grievances The Porte, though it resented new demands being made before the others were dealt with, was unable to resist and signed the Convention of Akkarman accepting the Russian demands which were. the confirmation of the Treaty of Bucharest, the opening of the navigation of the Black sea to Russian ships; seven years' term of office for the hospodars of Wallachia and Moldavia, as well as the consent of the Russian ambassador in Constantinople before they could be dismissed, and the recognition of the autonomy, where no Muslim was to reside except in the fortresses.

Mahmoud II, by a wholesale massacre on June 15, 1826, had crushed the janissaries, and the defence of the empire was now in the hands of the new army The famous General Moltke was among the large number of French and Prussian instructors engaged for it Mahmoud also abolished what remained of the feudal system in the provinces The taxes were to be gathered by the Central Government. The execution of individuals by the viziers without trial and the confiscation of the property of wealthy persons deceased, or of persons executed by the State, was forbidden by new regulations. Mahmoud II himself discarded the turban and adopted the fez and the European costume, and ordered all the officials to do the same The fez remained the official headgear of the Turks till the passing of the "hat law" by the Turkish republic in 1925.

The Greek question was still unsettled In 1826, the Greeks formally asked for the mediation of England Canning's objection to intervening unasked having thus been removed, he invited the co-operation of Russia in making representations to the Porte which should be based on the protocol of St. Petersburg and suggested measures of coercion in case of refusal; to this the tsar consented The coercion was to take the form of a pacific blockade of Morea, so as to force Ibrahim Pasha to evacuate the country by cutting off his supplies. Austria and Prussia, in the conference of the five Powers of the Grand Alliance in London in 1827, protested against coercion of the Porte for revolutionary purposes, and withdrew; but on the suggestion of France the protocol was made into a treaty, and as the Treaty of London was signed by the three Powers on July 6, 1827. By its public articles the Powers agreed to secure the autonomy of Greece under the suzerainty of the sultan without any breach of friendly relations with Turkey. But by additional secret articles it was agreed that in the event of the Porte not accepting the offered mediation, consuls should be established in Greece and an armistice proposed to both belligerents and enforced by the Powers.

The armistice, accepted by the Greeks, was refused by Ibrahim Pasha, pending instructions from Constantinople, though he consented to keep his ships in the harbour of Navarino In the meantime the Greeks destroyed a Turkish flotilla off Salona and Ibrahim, taking this as a breach of the convention, set sail from Navarino northwards. The Russian and French fleets joined the British fleet at Navarino, and on Oct. 20 attacked the Turkish and Egyptian fleets and destroyed them (*see* NAVARINO, BATTLE OF) Turkey broke off diplomatic relations with the three Powers concerned, and the sultan issued a proclamation denouncing the cruelty and perfidy of the European Powers and summoning the Muslims to a holy war. Canning had died and England had gone back to her policy of preserving Ottoman integrity, so the struggle that followed was restricted to Russia and Turkey. Although Turkey was in the midst of confusion due to the destruction of the janissaries, and the new army was small and hardly formed, the resisting power of the Turks was raised to its utmost by the attitude of the Powers, and Russia had to fight two very hard and difficult campaigns before General Diebitsch could dictate terms of peace at Adrianople, Sept. 14, 1829 The Treaty of Adrianople between Turkey and Russia provided that the Danubian principalities were to become practically independent, that the districts of Anapa and Poti were to be ceded to Russia; and the Greek question was to be settled according to the terms of the Protocol of March 22 But in order that Russia should not enjoy the prestige of having emancipated Greece unaided, the other Powers decided to give further concessions to Greece, and this was expanded into the Treaty of London of May 7, 1832, by which Greece became an independent kingdom under the Bavarian prince Otto (*see* GREECE. *History*)

Turkey suffered a series of serious internal revolts after the reverses had reduced her prestige Bosnia and Albania revolted In 1830 the French occupied Algiers Mohammed Ali Pasha, the governor of Egypt, was found to have intrigued in the revolt of Albania and in Damascus. He was recalled and replied by open revolt, sending his army under his son Ibrahim Pasha to invade Syria Mohammed Ali Pasha's hope was to seize the Sultanate and to start a new dynasty—a hope which seemed feasible when, after capturing Damascus and Aleppo and defeating the Turkish army in Konia, Ibrahim invaded Kutahia. As France was supporting Egypt, Turkey endeavoured to draw England into an alliance against Egypt. Palmerston refused in spite of the efforts of Stratford Canning, and Mahmoud II in desperation asked for help from Russia The Treaty of Unkiar Skelessi was signed July 8, 1833, and the Russian army came to the Bosporus to help the Turks against the Egyptian army, which was now threatening to march on the capital England and France, suspicious of a Russian army at the gates of Constantinople, now mediated. They forced Mohammed Ali to stop the march of the Egyptian army, and made the sultan accord the hereditary governorships of Adana, Crete, Tripoli and Damascus to Mohammed Ali, which put a temporary end to the war. The Treaty of Unkiar Skelessi had included clauses which permitted Russian warships to pass through the Straits, and to land troops if necessary, and which closed the Straits to warships of all the other Powers, clauses which seemed to place Turkey in the power of Russia. After securing peace under these humiliating conditions Mahmoud once more began to prepare his army while Mohammed Ali increased his with recruits from the provinces which had been given him. In 1839 Mahmoud sent a Turkish army against the Egyptians in Syria, but was badly beaten by the forces of Ibrahim Pasha at Nezib in the north of Syria. Mahmoud died in Constantinople while the battle was actually in progress (July 23, 1839).

Mahmoud II.'s reign opened seriously the period of Westernization in Turkey. In addition to the army reforms already mentioned, the medical school was opened by experts from Europe, and the civil service was set on foot on a modern basis. A number of students were sent to Europe for the first time, a newspaper and the first official printing press were established. The Ministry of Foreign Affairs, and the Ministry of the Interior were organized, as well as the Ministry of Public Works and the supreme council

of legal affairs. The naval and military schools and the school of engineering founded by Selim III. were reorganized, and in 1838 a council of public instruction was formed. The basis of compulsory elementary education was laid down by a royal proclamation which forbade children who had had no elementary education to take up any craft And the Pious Foundations were unified and organized into a Ministry.

Abdul-Mejid I. (1839–1861).—Abdul-Mejid ascended the throne at 16 when Mohammed Ali Pasha of Egypt seemed on the verge of seizing Turkey and the empire seemed about to dissolve into its elements The army, the Government and the sultan were helpless and the Turkish fleet was handed over to Mohammed Ali Pasha by the treachery of Admiral Ahmed Pasha But to prevent Russia from using the Treaty of Unkiar Skelessi for her own purposes the great Powers decided to intervene in the Turko-Egyptian conflict and called a conference in London France, who had supported Mohammed Ali Pasha, took no part in the final settlement, but Russia for the purpose of breaking the *entente* between England and France waived her claims under the Treaty of Unkiar Skelessi and joined the concert. By the "protocol de clôture," which was signed on July 10, 1840, the governorship of Egypt became hereditary in Mohammed Ali's family without undermining the sovereign rights of Turkey The same conference signed the "protocol des détroits," on July 13, 1840, by which the sultan was to close the Straits to warships of all the Powers, and the Black sea to Russian warships

The schemes for reform which Selim III and Mahmoud II had only been able partially to realize were to be more fully worked out by Abdul-Mejid I Mustafa Reshid Pasha, the Turkish foreign minister and ambassador to London, returned He was the greatest statesman and Westernizer of the reform period, and he personally prepared a *tanzimat* or vast plan of reforms and made the sultan sign and issue it under the name of *Gulhané-hatti-humayoum* (royal decree of Gulhané) as it was publicly announced from the park of Gulhané From this decree dates the fundamental change of Turkey from the old system based on nomadic principles to that of a modern state. Like the preceding decrees, in order that it might disarm fanatical opinion, it also emphasized that all progress was in accordance with Islam It undertook to issue laws conforming with the age, to establish security of life, property and honour (no one was to be punished without trial), to remodel every branch of the administration, and to accord perfect equality to all Ottoman subjects of whatever race or creed This meant a great difference for the Christians Though they had religious and communal freedom by the *firman* of the conqueror, the political complications caused by the Separatist tendencies, and the massacre of the Muslims in Morea by the Greeks, had aroused intense hatred and made their position difficult, and even dangerous. The attempt of the *tanzimat* to establish them as equal citizens helped to unite them with the ruling race and before long the Christians shared all the offices in the administration, even up to the rank of cabinet minister Mustafa Reshid Pasha with a few convinced and Westernised men around him made gigantic efforts to enforce the new principles in every department.

Mahmoud's military organization was extended by engaging more foreign instructors and opening more military schools. The most important change was the recruiting law, which reduced military service, which had hitherto been for an indefinite time, to a limited period. The Christians were exempted from military service. A body of gendarmerie was instituted

In addition to the only existing educational institutions, that of the *ulema* and the schools maintained by private donations, the council of education founded and multiplied State schools, both primary and secondary, and tried to unify and centralize education by sending superintendents to the provinces to carry out the state system. Commercial courts were opened. As the civil and penal cases were sent to the Sheria courts, a school for judges was opened and attached to the Sheik-ul-Islam's office.

Permanent ambassadors were appointed from among the best statesmen and sent to European capitals; this helped to create friendly relationships with the western Powers. The success of the reforms, which were carried out for the first time without resorting to terrorist methods, was forming a centralized and efficient government, which naturally aroused great sympathy for Turkey and hope for her future. The only international controversy arose when in 1848–1849 Turkey, true to her traditions, refused to give up the Polish and Hungarian refugees. She had England's support in this act. The difference with Persia over the frontier question was settled for the time being by the Treaty of Erzerum (1848), by English and Russian mediation.

The Holy Places and the Crimean War.—The possibility of a strong and reformed Turkey made Russia uneasy Since the time of Peter the Great and Catherine II she had considered herself the rightful heir to the declining Turkish State. The tsar, who went to London in 1844, proposed to England the partition of Turkey. England was to receive Crete and Egypt, Constantinople was to be a free city, and the Balkan States were to be autonomous under Russia. Suspicious of the Russian designs, England refused to solve the Eastern Question by so drastic a measure But the question came up again in 1850 through a quarrel between the Catholic and Orthodox monks about the Holy Places in Palestine.

The capitulations signed on May 28, 1740, by Mahmoud I, according certain rights to the Roman Catholic (Latin) ecclesiastics in the Holy Places, had placed the French pilgrims, together with the pilgrims of the other Catholic nations, under the protection of the French flag This stipulation of the treaty had fallen into desuetude during the French Revolution In the meantime every advance of Russia had been marked by encroachments of the Orthodox Church on the Roman Catholic Church. The quarrels of the monks of the two churches would have passed unnoticed if Napoleon III had not seized the opportunity to win over to his side the clericals in France and to humiliate Russia who had given to his title of emperor only an equivocal recognition The French ambassador handed to the Porte a formal demand for the restitution to the Catholics of all their rights The Ottoman Government proposed a mixed commission of inquiry and France agreed with the condition that no documents later than 1740 should be admitted as evidence As this suggestion excluded the Treaty of Kainarji, the tsar demanded that nothing should be altered in the *status quo* This was a contest between Russia and France for paramount influence in the East, in which England was inevitably involved, and she took the side of Turkey. The Porte arrived at a compromise in March 1852 by issuing a *firman* which accorded privileges to both sides, and she took on herself the right of "protection" Neither France nor Russia accepted this as neither desired a settlement Napoleon III wanted a war for dynastic reasons, and the tsar thought the moment opportune to drive out the infidel from Europe The tsar spoke to the British ambassador in St Petersburg about the Turkish empire as the "sick man" and renewed the proposals of partition Russia had made in 1844.

In 1853 Prince Menshikov was sent to present the Russian ultimatum to Constantinople. He demanded the recognition of the *status quo* and of the tsar's right under the Treaty of Kainarji to protect the Orthodox subjects The Porte turned for advice to Lord Stratford de Redcliffe, the British ambassador, who was both popular and influential He grasped the situation at once and persuaded Menshikov to present the two demands separately. On April 22, the question of the Holy Places was settled by the British, Russian and French ambassadors Then when the question of the Russian protectorate over the Christians was raised, Menshikov found himself opposed by the ambassadors of the other Powers. Menshikov demanded that the Porte should give a note reaffirming the Russian rights, and this the Turkish cabinet seemed inclined to accept. But that cabinet fell; Mustafa Reshid Pasha came into power and, advised by Lord Stratford de Redcliffe, refused the Russian demand Menshikov left Constantinople and on June 22, 1853, the Russian army under Prince Gorchakov attacked the Danubian principalities, explaining by a circular that this was not with the purpose of attacking Turkey but in order to obtain material guarantees for the enforcement of the existing treaties. In August a conference of the four Powers assembled in Vienna, but the settlement proposed conceded everything to Rus-

sia except the protectorate, and the Porte would not agree to it. Turkey declared war on Russia in October, and the French and English fleets passed the Dardanelles. Lord Aberdeen, hoping to keep peace, informed Russia that as long as she abstained from passing the Danube or attacking a Black sea port there would be no *casus belli.* But Russia bombarded Sinope on the Black sea coast and destroyed a Turkish squadron, and the French and English fleets entered the Black sea and demanded that the Russian fleet should retire

The conflict at Sinope had been more like a slaughter than a battle, and the excellent behaviour and initial successes of the Turkish land forces aroused sympathy and admiration throughout Europe. The belief in the rejuvenation of Turkey seemed justified. On March 27, 1854, Great Britain and France declared war on Russia, with the strong support of public opinion; they were later joined by Sardinia Austria occupied the Danubian principalities and by a convention with the Porte undertook to resist by arms any Russian attempt on them

The main operations of the Crimean War (*q v*) were confined to the Crimea. The allied troops landed on Sept 14, 1854, and the campaign lasted till Dec. 1855, when the threatened intervention of Austria forced Russia to accept terms which were ultimately embodied in the Treaty of Paris, March 30, 1856 Russia abandoned her pretensions to protect the Christians in Turkey, and renounced her right of exclusive interference in the Danubian principalities, to which a fragment of Bessarabia was restored; the navigation of the Danube became free under the supervision of an international commission; the Black sea was to be open to commercial ships of all countries and closed to all warships except a limited number of small warships belonging to Turkey and Russia; Turkey was admitted to the European concert and the contracting parties were to respect her independence and the integrity of her territory; the *tanzimat* was reaffirmed by a decree of the sultan cited in the Treaty The addition of this clause prepared the way for future interference of the Powers in the internal affairs of Turkey.

The new era following the Paris Conference opened with several outbursts against the reforms It is noteworthy that the Christians, even the clerical class, opposed it, either for fanatical reasons or at the instigation of Russia, who did not want reform to be realized in Turkey In 1859, the Danubian principalities, encouraged by Russia, united and, choosing Col. Cusa as their ruler, formed the principality of Rumania (*See* RUMANIA) In 1860 a disturbance in Lebanon involving the Druses and the Christians led to a French occupation, which Fuad Pasha, seconded by Ahmed Vefik Effendi, the Turkish ambassador in Paris, contrived to restrict and to terminate as soon as possible. A *règlement* was signed in Constantinople on June 9, 1861, instituting an autonomy for Lebanon under a Christian governor to be chosen by the Powers with the consent of the Porte This agreement lasted till the World War

Towards the end of Abdul-Mejid's reign a secret committee was formed in Constantinople which propagated the idea of a constitutional regime for Turkey.

Abdul-Aziz (1861–1876).—Abdul-Aziz on ascending the throne on Abdul-Mejid's death in 1861 reaffirmed by decree the principles of the *tanzimat.* Pan-Slavism, which had its centre in the University of Moscow, began to penetrate Montenegro and Hercegovina which rose in revolt. These revolts were put down, but the Serbians also revolted demanding the expulsion of the Muslims who lived in the fortresses In 1862 this revolt was pacified by ceding a few more fortresses to the Serbians, and five years later, through the mediation of England and Holland, the Turkish troops were withdrawn altogether. The Cretans, aided by Greece, revolted and declared their union with Greece. Thereupon Aali Pasha, the grand vizier, went to Crete with an army and quelled the revolt; the episode led to a diplomatic rupture with Greece and in 1869 a conference of ambassadors in Paris accorded local autonomy to Crete under Christian governors. In 1863 Ismail Pasha, the governor of Egypt, a man given to unrestrained expenditure, obtained loans from France and England, bribed a large number of influential men in the Porte, and made the sultan agree to the establishment in Egypt of a succession from father to son, which he did by issuing the *firman* of May 27, 1866, and June 8, 1867, the latter according to the governor of Egypt the title of khedive. Abdul-Aziz yielded so easily because he was desirous of bringing about the same alteration in the succession in Turkey in favour of his eldest son. The introduction of a regular budget system for the first time revealed the deplorable state of the Treasury. New loans, internal and external, had to be raised in order to pay the interest on the old debts.

The regime of Midhat Pasha, the father of the Turkish constitution, as the governor of Nish, was so popular with all races and creeds that his methods were introduced into other Roumelian vilayets The people elected their provincial councils and criminal and civil courts were first opened in those provinces. On March 10, 1870, a *firman* instituted the Bulgarian exarchate, thus severing the Bulgarian Church from the jurisdiction of the Greek patriarch of Constantinople. In 1871, Russia, taking advantage of the weakened state of France, declared herself no more bound by the Treaty of Paris, which had restricted the number of Russia's warships on the Black Sea. An International Conference which met in London in 1871 recognized this by abrogating both the restrictions on Russia and Turkey. The passage of the Straits remained interdicted to warships.

A law promulgated on June 18, 1867, for the first time allowed foreigners to hold landed property throughout the empire except in Hejaz, on condition of their being divested of their right to the protection of their own authorities concerning such property. The grand vizier, Aali Pasha, also made the first amendment to the capitulations by inducing the Powers to accept Turkish jurisdiction over small cases for their subjects who lived at a distance from consular towns. In 1866 a Bulgarian insurrection, instigated by Russia, broke out in Tirnova on the pretext that the reforms promised by the *firman* quoted in the Treaty of Paris had not been carried out. Although Midhat Pasha pacified the rising, its real motive, which was nothing less than a desire for national independence, remained unaltered After the death of such able statesmen as Aali Pasha and Fuad Pasha, Abdul-Aziz became despotic and began to exile people without trial The palace expenses increased and financial conditions became worse Mahmoud Nedim Pasha, who was wholly under the influence of the Russian ambassador Ignatieff, declared that the Government could pay only a 50% annuity on her debts, whereupon Europe considered Turkey bankrupt, and she began to lose the prestige she had gained after the reforms The agrarian conflict between the Muslim land-owners and the Christian peasantry in Hercegovina now spread to the Serbians and Bulgarians The atrocities committed by the Bulgarians during this rising led the Turks to most sanguinary reprisals in 1875–1876, which turned public opinion in the West against Turkey still more

A secret revolutionary society, formed at the time of Aali Pasha, and called "the Young Ottomans," was spreading its ideas and influencing public opinion. The great Turkish poet and patriot, Namik Kemal Bey and Zia Pasha, another poet and satirist, fled to Paris and published pamphlets inciting the people to demand a constitutional government and succeeded in smuggling them into every part of Turkey. Midhat Pasha, who shared the opinions of the Young Ottomans, succeeded in winning over other members of the cabinet for constitutional change, and obtained a *fetva* for the deposition of Abdul-Aziz, who was accordingly dethroned in 1876 with the purpose of establishing a constitutional regime. A few days after his deposition he committed suicide His brother, Murad V., who ascended the throne, became insane after reigning three months and was deposed.

Abdul-Hamid II. (1876–1908).—At Abdul-Hamid's accession, a constitution derived from the French system and prepared by Midhat Pasha, the grand vizier, was proclaimed by a decree on Dec. 23, 1876. Six weeks later Midhat Pasha was dismissed from office and forced to leave Turkey. Almost at the same moment a conference of the delegates of the great Powers gathered to discuss the Bosnian, Serbian and Bulgarian questions in Constantinople. Its final proposals were that an international commission of investigation should be formed and that a governor general,

elected by the sultan, and approved by the Powers, should be appointed over the provinces in question. This proposition was rejected by the Porte and Russia declared war on April 24, 1877 The Rumanians joined Russia and Austria declared her neutrality. Public opinion in Europe was anti-Turkish, especially in England, because of the sanguinary repression of the Bulgarian revolt, and not a single voice was raised in favour of Turkey, especially when the new Turkish parliament which was to carry out the reforms incessantly promised by previous sultans was swiftly dismissed. The Turks were defeated both in Europe and in Anatolia, and the Russian army reached Adrianople where both a truce and the preliminaries of peace were signed on Jan 31, 1878. The preliminaries of peace signed in Adrianople were incorporated in the peace treaty, which was concluded in San Stefano on March 5, 1878. Rumania and Serbia were to become independent, while Bulgaria was to become a vast principality, its frontiers reaching both to the Mediterranean and the Black Sea The provinces of Kars, Ardahan and Beyazid were to be given to Russia as a war indemnity. England objected to the treaty as violating the terms of the international treaty signed in Paris, and proposed a new congress. At first only Germany, France and Italy were represented, but when Austria, who was in a position to endanger the retreat of the Russian army, came in, Russia was obliged to do likewise Turkey contracted a defensive alliance with England at the price of giving her the island of Cyprus on July 4, 1878.

On July 13, 1878, the Congress of Berlin ended the Russo-Turkish conflict It modified the Treaty of San Stefano; recognized the independence of Rumania, Serbia and Montenegro; reduced the frontiers given by the Treaty of San Stefano to Bulgaria, and further divided the territory into two parts, one of which became a self-governing Turkish province named Eastern Rumelia Turkey had the sanjak of Beyazid in Anatolia restored to her but she was to pay an indemnity of 300,000,000 roubles to Russia The most important clause of the treaty was the formal engagement of Turkey to introduce reforms in the Rumelian provinces as well as in the eastern provinces which had Armenian minorities Abdul-Hamid who immediately after the Congress engaged a number of European experts on the pretext of reorganisation and reform, before long dismissed them; he also dissolved parliament with the remark that Turkey was unfitted for parliamentary government Apart from the occupation of Egypt by England (1881) which is dealt with elsewhere (*see* EGYPT), the chief interest of Turkish history now lies in the steps by which Abdul-Hamid secured his predominance The power of the Porte was slowly transferred to the palace through the machinations of Said Pasha, the first secretary of Abdul-Hamid, who before long was an absolute monarch Midhat Pasha, the veteran reformer, was lured back by a free pardon and appointed governor of Smyrna Soon after, on the pretence that the suicide of Abdul-Aziz was really a murder committed by Midhat Pasha, a sham trial was opened in the palace, and, on the evidence of false witnesses procured by Abdul-Hamid, Midhat Pasha was condemned to death Abdul-Hamid changed the death sentence to exile and prison in Taif, near Mecca, but a few years later he had Midhat Pasha strangled in prison. Midhat was the last grand vizier strangled by the orders of the sultan in Turkish history. At the same time, as the finances had become worse after the war, and the payment of debts was falling into arrears, Said Pasha, now grand vizier, founded the Ottoman Public Debt administration which gave the control of the payment of debts to European delegates. (Decree of Muharrem, Dec. 1881)

In 1885 a rising took place in the province of Eastern Rumelia, which was united to Bulgaria. Turkey appointed Prince Alexander of Battenberg (the prince of Bulgaria) governor of Eastern Rumelia, a diplomatic way of accepting the annexation. Revolts in Crete had been in progress since 1890, and Greece hoped to annex the island. The series of independent non-Muslim governments which had been founded in succession within the empire raised the hopes of all the other natiónal minorities. The Armenians in the eastern *vilayets,* who enjoyed freedom of education in their schools, succeeded in permeating all the Armenian communities with the desire for national independence. Two revolutionary Armenian committees, called Hinchak and Dashnaksutioun, who were in close touch with European centres, were formed Abdul-Hamid's foolish patronage of the Kurdish communities encouraged them to persecute the Armenians. This, as well as the severity with which the taxes were collected, gave the Armenians two pretexts to rise in revolt in 1894 These revolts were repressed with such sanguinary measures that England and France prepared a programme of reforms for the eastern *vilayets* and forced Turkey to accept it No effect was given to the Turkish promises and in 1896, when Lord Salisbury tried to enforce reform on those *vilayets,* the other powers would not agree to the coercion of Turkey The Armenian revolutionaries in despair adopted a form of revolt which would force the attention of European political circles They revolted in Constantinople and attacked the Ottoman Bank, a European institution The repression was once more sanguinary In 1904 the Armenian revolutionary committee made a vain attempt on Abdul-Hamid's life and won the sympathy of the "Young Turks"

On the ground that Greece had inspired the revolts in Crete the Porte declared war on April 17, 1897, and the Turkish Army, after inflicting a severe defeat on the Greeks, marched on Domekos The Powers, becoming anxious, intervened and ended the war A peace was concluded which involved a slight rectification of the frontier and the payment of an indemnity of four million Turkish pounds by Greece Crete was put under international control. "en depot," and much of the capitulations which benefited Greek citizens was cancelled In 1898 Prince George, the son of the king of Greece, was appointed governor of Crete and a national assembly called The refusal of Austria and Germany to take part in the anti-Turkish settlement of the Cretan question, marks the beginning of Germany's "Drang nach Osten" policy As a result of her apparent pro-Turkish policy she obtained a concession to construct the Anatolian railway and in 1899 the Baghdad line Abdul-Hamid's preference for Germany was due partly to the friendly attitude of the German kaiser and partly to the fact that he feared the liberal influence which France and England would have over the intellectuals in Turkey

During the latter part of Abdul-Hamid's reign the Macedonian question became most important The independent Balkan States carried on anti-Turkish propaganda among their own races in the Turkish Balkans and it is through this movement that the "comitajis" appeared in the Balkans Comitajis were armed bands of political partizans, who have ever since devastated the Balkan peninsula Their activities caused risings and slaughter, which were avenged by equal if not greater ferocity, which added to Turkish ill-repute in Europe In 1903 after the Bulgarian insurrection in Macedonia, Turkey accepted the Marszteg programme, which was prepared by Austria and Russia According to this programme the three *vilayets* of Salonika, Monastir and Uskub were placed under a Turkish inspector-general (Hussein Hilmi Pasha) who in turn was under the supervision of Russian and Austrian civil agents The gendarmerie was given a foreign commander, and French, English and Italian instructors.

In spite of these reforms Macedonia could not be pacified and the work of the Comitajis went on The agreement of King Edward VII. of England and Tsar Nicholas II at Reval in 1907 was widely rumoured to be a new plan for the partition of Turkey The Turkish officers in Macedonia, partly affected by this rumour, made an attempt to settle this vexed question once for all They joined a secret society, called the "Committee of Union and Progress" which was formed to restore the constitution.

The "Young Turks."—These "Young Turks" were the successors of the Young Ottomans, who after the closing of the first parliament had worked in secret for the restoration of the constitution by means of publications and secret societies both in Europe and in Turkey, mostly among the students in the military and medical schools. From 1882 onwards Abdul-Hamid had put the press under a strict censorship and by an elaborate network of spies had abolished freedom of speech. The obscurantist educational system was preventing the spread of modern ideals, the Christian schools alone not being affected by this system Under these conditions Talaat Bey, a chief clerk of the Salonika post

office and a student of law, and Rahmi Bey, a local notable, together with a few others, had formed "the Secret Society of Union and Progress" on the model of the Freemason lodges. The Turkish revolutionary societies in Europe were affiliated to the Salonika society through their leader Dr. Nazim When the intellectuals and officers of Macedonia such as Niazi, Enver, Mustafa Kemal and Jemal Bey joined the committee, the organization had an active force at its command in the Macedonian army. Captain Niazi first led an armed rising in Resna and the other conspirators followed in Monastir The revolt shot though the cities of the empire, and Abdul-Hamid was informed on July 23, 1908, that he had no alternative but to restore the Constitution This bloodless revolution aroused enthusiasm even among the Serbian, Bulgarian and Greek Comitajis, and among the Armenian revolutionaries Representatives of nearly all these came to Salonika and joined the Union and Progress, which ceased to be secret after the proclamation of the Constitution. It seemed for the minute as though all the different racial elements of the empire would really unite in a constitutional Turkey. But the separatist and nationalist ideals of the different races were too deeply rooted to be swept away by momentary enthusiasms The restoration of the constitutional regime postponed indeed the Reval Programme. But both Austria, who thought Turkey an obstacle to her expansion towards the Aegean sea, and Russia, who found a strong Turkey a hindrance to her plans of expansion, felt uneasy. On Sept. 15, 1908, the Russian and Austrian foreign ministers met at Buchlau and agreed on a partition programme by which the Straits were to be in the Russian zone and Bulgaria a Russian sphere of influence; Macedonia was to be in an Austrian zone, and Serbia an Austrian sphere of influence, Albania was to be in an Italian zone and Greece an Italian sphere of influence. Fifteen days after this meeting Austria annexed Hercegovina (Oct. 5, 1908), and Bulgaria declared her complete independence Turkey recognized the Bosnia-Hercegovina annexation, for which Austria paid £2,200,000 and evacuated the sanjak of Novi Bazar. For Turkey's recognition of Bulgarian independence Russia cancelled £20,000,000 of the Turkish indemnity Before long these foreign blows were followed by the recrudescence of internal conflicts The Albanians revolted against the new regime in Macedonia, and the Kurds attacked the Turks, the Armenians and the Nestorians in eastern Anatolia In Adana the reactionaries attacked the Armenians, and Yemen rose in revolt. Izzet Pasha was sent to Yemen to pacify the region, which he was able to do by a friendly agreement with the Imam Yahia, 1912 The reactionary opposition in the capital incited fanatical opinion against the new regime, and was greatly aided by two political murders in Constantinople committed by adherents of the new regime Finally the movement passed into a military revolt on April 13, 1909 A great number of officers and adherents of the new regime were massacred, parliament was raided and several deputies murdered. Abdul-Hamid pardoned the leaders of the revolt and formed a new cabinet. In reply an army under Mahmoud Shevket Pasha, sent by the Young Turks from Salonika, marched on the capital and punished the insurgents Although there was and is no documentary evidence of Abdul-Hamid's part in the reactionary rising, his evident desire to restore absolutism led parliament to procure his dethronement by a *fetva* and Mohammed V. took his place.

Abdul-Hamid had tried to revive the political influence of the Caliphate in the hope of retaining the non-Turkish Muslim elements of the empire This Pan-Islamic ideal of Abdul-Hamid was favoured by Kaiser Wilhelm II. who, during his visit to Jerusalem, spoke of himself as the friend of the "Caliph of three hundred million Muslims" Abdul-Hamid constructed the Hejaz railway to further the same ideal

The Constitutional Regime.—Now that the Government of the Young Turks was firmly established the Committee of Union and Progress became a political party and efforts were made to stop the interference of the army in internal politics. In spite of the great losses of territory the empire over which the Young Turkish Party was to rule extended from the Adriatic to the Indian ocean, and from the Caucasus to Tunis. Thirty-three years of mismanagement under the despotic reign of Abdul-Hamid had reduced Turkey to such a state that in any case a new government had a difficult task; and although the Young Turks were full of patriotic zeal and well-versed in Western culture, they had had no experience in governing. The army was put under intensive German instruction, the navy was put under instructors led by Admiral Sir Douglas Gambles. A French expert, Charles Laurent, was engaged for the financial department, though it was Djavid Bey, the minister of finance, who first succeeded in establishing a finance department on European lines. A great change took place in public works through the concessions given to European companies, which brought foreign capital into the country. In every branch a serious and fruitful activity began.

The evacuation of Crete in 1909 by the four controlling Powers led to an acute difference between Turkey and Greece In 1910 the Cretans elected deputies to the Greek parliament in Athens, but Venizelos, the Greek premier, refused to admit them, an act which prevented war.

The Italian and Balkan Wars.—Italy, having been assured of the neutrality of the Powers, gave the Porte an ultimatum of 24 hours on Sept 28, 1911, and occupied Tripoli, Cyrenaica and the Dodecanese islands, and then bombarded Prevaza, without any provocation. Without a strong navy Turkey was unable to defend Tripoli, but Enver and Fethi Beys organized a defence by the natives, who were thoroughly roused, and the invaders were confined to the coast till the Balkan War forced Turkey to make peace at Ouchy on Oct. 15, 1912 Tripoli and Cyrenaica were left to Italy, but the sultan was permitted to send a representative, called "naib-u-sultan" The fate of the Dodecanese islands was not decided till the Lausanne conference A little time before the Treaty of Ouchy, a faction in the army, opposed to the Union and Progress Party, had brought about a change of Government, and the cabinet formed was composed mostly of the members of the old regime, including Kiamil Pasha, the well known Hamidian grand vizier. Russia offered to help Turkey in case of an attack on the Dardanelles on the condition that the Russian fleet was allowed to pass the Straits. The Porte refused

To stamp out the comitajis Turkey had embarked on an attempt to disarm the people in the Balkans Greece, Serbia, Montenegro and Bulgaria in reply reconciled their conflicting interests in the Balkans, and formed an alliance against Turkey (March–Oct 1912). Turkey was unaware of this alliance for a long time, but on Oct 8, 1912, Montenegro declared war on Turkey; and on Oct 14, Greece, Serbia and Bulgaria first issued ultimatums demanding reforms and the demobilization of the Turkish army in the Balkans, and then declared war. The political dissensions which affected the command and the organization of the army proved disastrous to Turkey, and the Turkish army was defeated, though it made a fine and prolonged defence of Scutari (in Albania), Yanina and Adrianople. Adrianople was still in the hands of the Turks when the advance of the Bulgarian army was stopped at the last defences of Constantinople, the Chatalja lines The Turkish cruiser "Hamidie," under the command of Rauf Bey, escaped through the lines of the Greek fleet at the Straits, and wandered in the Adriatic, Aegean and Mediterranean, bombarding enemy ports, hampering their transports and raising the Turkish morale. At the beginning of the war the Powers had declared that whatever the military results of the war might be the territorial *status quo* would be maintained in the Balkans. Turkey hoped that this declaration would apply as much in the event of Turkish defeat as of Turkish victory. Kiamil Pasha, known for his pro-English views, was made grand vizier. He accepted the post confident of English support during the negotiations, and relying on the assurances which Sir Gerald Lowther (the British ambassador) had given to his son. The Powers called a conference in London after the Turkish defeat. But since Kiamil Pasha's acceptance of office did not alter the situation, and as the *status quo* was clearly going to be changed in favour of the Balkan States, contrary to the declaration of the Powers, and since Kiamil Pasha's Government was about to cede Adrianople even before that city had fallen, the Young Turks determined to seize power again. They raided the Sublime Porte and forced Kiamil Pasha to resign. A Young Turkish cabinet was formed under Mahmoud Shevket

Pasha. Although at first the new cabinet refused the terms of peace of the London conference, the intervention of Russia and Austria and the fall of Adrianople enforced their acceptance. This brought the Turkish frontiers in Europe to the line Midia–Enos.

Meanwhile Greece and Bulgaria, on the question of territory, declared war on each other, and this caused the Second Balkan War. The Rumanians, with the purpose of annexing the Dobruja, also marched on Bulgaria This moment was seized as opportune by the Turkish army to march on Adrianople, and on Sept. 29, 1913, it was recaptured. A treaty of peace was signed with Bulgaria in Constantinople by which Adrianople passed to Turkey. On November 13, 1913, peace was concluded with Greece by which she was given Crete and the rest of the Aegean islands, except Tenedos and Imbros and the Dodecanese islands, which latter were under Italian occupation. On March 14, 1914, peace was signed with Serbia. The net result of the series of treaties contracted with the Balkan States, was the loss to Turkey of all her possessions to the west of the Maritza river.

Mahmoud Shevket Pasha's cabinet then attempted a general settlement of all the differences with England and France. Hakki Pasha, ex-grand vizier, was sent to London to come to an understanding over the Persian gulf controversy, and to negotiate for the modification of the financial capitulations; Djavid Bey, the ex-minister of finance, was sent to France to settle the railway questions, to modify the financial capitulations, and to raise a loan But during these negotiations the opposition (the *Entente Liberale*) murdered Mahmoud Shevket Pasha and the Young Turks passed repressive measures against the opposition. A new cabinet was formed under Said Halim Pasha A military mission was brought from Germany under General Liman von Sanders, who was also appointed commander of the army corps in Constantinople. The navy was under Admiral Limpus. A detailed programme of reform for the eastern vilayets was prepared. As the Powers refused to provide experts, inspectors were engaged from Sweden, the Ministry of the Interior, however, employed British inspectors.

The policy of the Young Turks had begun by being a policy of "Ottomanism," which aimed at uniting all the racial and religious elements of the empire The risings in Macedonia had proved that the nationalism of each element, encouraged by outside Powers, could not be assimilated by such a weak State as Turkey. Turkey through the Balkan War lost her Albanian, Bulgarian, Serbian and most of her Greek subjects, and the Arabs, incited by France, also manifested separatist tendencies, although to give the right to use Arabic officially in the courts in Arabia was the only decentralizing measure the Young Turks had taken. The failure of Ottomanism was followed by the revival of Abdul-Hamid's Pan-Islamist policy, a decision encouraged by the sympathy which the Indian and the Egyptian Muslims had shown during the disasters of the Italian and Balkan Wars. It was this Pan-Islamism which later led the Young Turks to proclaim *jihad* (holy war) in the hope of influencing the Muslim combatants in the Allied Armies, during the World War This revival was led by Enver Pasha, opposed by a larger group which adhered to pure nationalism, led by Keuk-Alp Zia, the poet and philosopher, who was helping the cultural-nationalist institutions called the "Turk Yurds," and the "Turk Ojaks" (opened 1912). The influence of Turkish refugees from Russia caused the nationalism of the Union and Progress Party to take a Pan-Turanist form.

The disagreement between England and Germany over the Baghdad railway and that between France and Germany over their respective railway spheres, were settled by two agreements signed respectively in June between England and Germany and in Feb. 1914, between France and Germany.

The World War.—In 1913 Enver Pasha, formerly Enver Bey, became minister of war. His policy was to give the high commands in the army to younger men; the military organization continued to be under the German mission. There were secret negotiations between Germany and Turkey known only to the grand vizier, Talaat Bey and to Enver Pasha. A secret alliance was signed on August 2, 1914, when war was breaking out between Germany and Austria on one side, and England, France and Russia on the other Turkey declared her neutrality but mobilised at the same time. There were war and anti-war factions in the Party. The anti-war faction tried to come to an understanding with the Allies, declaring that Turkey would remain neutral if the financial capitulations were modified and a loan granted Djavid Bey, the minister of finance, was at the head of the anti-war faction. The Allies made no promises, but they demanded the dismissal of the German commanders and the expulsion of the crews of two German warships which had taken refuge in the Dardanelles The British Government commandeered the two Turkish dreadnoughts which were then being constructed in England with the money raised by popular subscription, an act which caused general surprise and disappointment. And when Germany offered the dreadnoughts "Breslau" and "Goeben" to the Turkish navy the anti-war faction was weakened The war faction argued that Turkey had lost by her political isolation since the Crimean War, that she should join Germany who was fighting against the hereditary enemy of Turkey, tsarist Russia, and that should she become victorious, she might become free from the capitulations and even regain some of her lost territories On Sept. 8, 1914, Turkey declared the capitulations abolished, which raised protests from all the Powers, including her ally, Germany When the two German warships, which had become units of the Turkish navy though still under German command, attacked Russian ships and ports in the Black sea, Russia declared war, and England and France did the same Turkey thus found herself at war with the Allies on the Egyptian, Mesopotamian and Caucasian frontiers as well as at the Dardanelles (*see* MESOPOTAMIA, OPERATIONS IN, PALESTINE, OPERATIONS IN, and DARDANELLES CAMPAIGN) The Dardanelles were successfully defended by Turkey, but the Russians took Trebizond, Erzerum and Erzinjan and marched towards Sivas, while Turkey failed in her attack on the Suez canal As Turkey had mobilised to her utmost limit it became almost impossible to sustain the army; the civil population suffered privation hitherto unknown; martial law was proclaimed everywhere The Communist Revolution led Turkey and her Allies to conclude a Peace Treaty with Bolshevik Russia at Brest-Litovsk, March 3, 1918, by which all her lost territory was restored to her, even those districts which she had ceded to Russia in 1877. But the Arab nationalists, supported by England, drove out the Turks from Hejaz, except from Medina The British army occupied Syria On Oct 30, 1918, an armistice was signed at Mudros, on the British warship "Agamemnon," between Admiral Calthorpe and Rauf Bey, the Turkish minister of marine Although the armistice aimed at ending the World War, it did not end yet for Turkey; she had to fight for four years more actually against Greece though virtually against the Allies themselves In 1917 Mohammed V had died and his brother Mohammed VI, known as Vahideddine, had ascended the throne. During the war secularization in education and other departments had taken place. The university had been extended and its principal chairs were occupied by German professors The Sheria courts were taken from the Sheik-ul-Islam and given to the Ministry of Justice A "family law" issued in 1916, reformed marriage and divorce regulations. Women, who already had equal education with men, now filled public posts, and the university opened its doors to them.

During the Turco-Russian battles on the Caucasian Front, the Armenians created disturbances behind the Turkish lines and threatened to cut the lines of communications The Turkish government began a general deportation in which atrocities were committed on a large scale When General Antranik, the Russo-Armenian general, entered eastern Anatolia, the Armenian soldiers under his command, the so-called "Christian Army of Revenge," replied by similar atrocities.

The Armistice and the Nationalist Movement.—The Turks welcomed the armistice as being the end to the great suffering of long years. But they soon forgot this suffering in the humiliation and persecution to which the armistice exposed them The Allied fleets and armies occupied the Straits, Constantinople and even places outside the armistice line, and the terms of the armistice were stretched to the point of violation Under these conditions, the Turks had a bitter foretaste of the peace they

would receive at the hands of the Allies. Both in Stamboul and in the provinces, officers and intellectuals met in secret and began to discuss how to secure a tolerable peace, and as the nationalists appeared in the forefront of the general reaction against the Allies, this agitation received the general name of the "nationalist movement." Meanwhile the Allies could not come to an agreement among themselves over the Turkish Peace. Finally, the Greek army was landed in Smyrna under the protection of the British, French and American fleets, and the Greeks inaugurated their occupation by massacres committed in full view of the Allied fleets, on May 15, 1919. (Italy, having retired from the peace conference for the moment, did not take part. By the inter-allied agreement of St Jean de Maurienne in 1917, Smyrna and Adalia had been apportioned to Italy, and she had landed troops in Adalia April 1918) The Greek massacres in Smyrna aroused general indignation in Turkey which ended in the national determination to resist to the last, even if this meant total disintegration. Mass meetings in Constantinople were the first manifestation of this feeling.

But meanwhile Turkey was in a state of anarchy The responsible leaders of the Union and Progress Party had escaped to Germany, and the Party was dissolved Mohammed VI., a personal enemy of the Young Turks, forced Izzet Pasha's cabinet, which to some extent was able to keep order, to resign; and the *Entente Liberale* came into power Certain nationalist leaders wanted to save the country from disintegration by co-operating with the sultan, and using his prestige as sultan-caliph Among these was Mustafa Kemal Pasha. But Mohammed VI. preferred to sacrifice the existence of his nation to his personal security, and this he did by bringing Damad Ferid Pasha into power, and through him giving the reins of the Government to the high commissioners of the Allies In western Anatolia organizations for a national defence against the Greek invasion were rapidly arising In eastern Anatolia, especially in Trebizond and Erzerum, associations, under the guidance of Kiazim Kara Bekir Pasha, were preparing to oppose any attempt of the Allies to create an Armenia out of the territories which, even before the deportations and atrocities, they claimed had been predominantly Turkish. The sultan with the allied assent, in order to control these organizations and disperse them if necessary, sent Mustafa Kemal Pasha to eastern Anatolia as the military inspector general But as he was already in correspondence with these organizations, he met Rauf Bey, Ali Fuad Pasha and Colonel Refet at Amasia on his way to Erzerum, and signed the Amasia protocol on June 19, 1919; Kiazim Kara Bekir Pasha also signed by telegram. This protocol is the first document that formally declared the national determination to resist both the Allies and also the sultan, as the instrument of the Allies. A national congress assembled in Erzerum, on July 23, 1919, and Mustafa Kemal Pasha, having resigned from the army, presided. Another congress assembled in Sivas on Sept. 4, 1919, to which the national associations of Western Anatolia sent representatives. This congress reaffirmed the decisions of the Erzerum congress, added plans for the detence of eastern Thrace, and chose a representative body to control the movement in Anatolia. No president was chosen, but Mustafa Kemal Pasha's leadership was generally recognized. This manifestation of the national will forced the sultan to dismiss Damad Ferid Pasha. A new cabinet with nationalist tendencies came into power. In Jan 1920 a new parliament assembled in Constantinople composed of a Nationalist majority. The parliament issued the national pact as accepted by the two congresses.

This "national pact" formulated the demands which the nationalists made during the whole struggle, and which they obtained eventually at Lausanne It proposed self-determination for the Arab provinces south of the armistice line; it agreed to the opening of the Straits to commerce; it proposed to grant to non-Turkish minorities the same rights as they had secured in Europe under various post-war treaties. The pact also demanded, either explicitly or implicitly, that Turkey should retain all territories inhabited by non-Arab Ottoman Muslim majorities, which meant not only Anatolia but eastern Thrace and the Mosul vilayet; that Constantinople should be given military security; that the capitulations should be abolished; and that there should be a reasonable settlement of the public debts.

The Allies were watching with some anxiety the nationalist activities which consisted mostly of smuggling in arms and ammunition and organizing the defence. Mustafa Kemal Pasha stayed in Anatolia to conduct these activities. The Allies, in conjunction with the sultan and the *entente liberale* Party, decided to strike at the Nationalist movement through the persons of the leading deputies and intelligenzia in Constantinople. On March 16, 1920, the Allied forces in the capital seized a large number of nationalists, including Rauf Bey, the leader of the Nationalist Party in parliament, and Kara Vasif Bey, the head of the nationalist organization in Constantinople, arresting them in the parliament house itself. Parliament was then closed by the orders of the sultan. Some deputies and a few of the intelligenzia escaped to Angora, which had become the Nationalist centre

The Great National Assembly.—Mustafa Kemal Pasha issued a proclamation inviting Anatolia to elect its deputies for the new assembly which might become a constituent body The assembly was opened in Angora and on April 23, 1920, Mustafa Kemal Pasha was elected president both of the assembly and of the Government. Thus came into existence a new Turkish Government over all territories not under foreign occupation. A new constitution proclaimed the sovereignty to belong to the nation without restriction, and the Great National Assembly to be the sole and lawful representative of the nation, and to exercise sovereignty in the name of the nation. But Mustafa Kemal Pasha tried to make use of those who were still loyal to the sultan by declaring in his speeches that the sultan-caliph was a prisoner in the hands of the Allies, and that he would be restored after the realization of the national ideal The Government of Constantinople, controlled by the Allies, condemned the leading nationalists to death by extraordinary courts, and issued a *fetva* denouncing them as outlaws. The Anatolian Government retaliated by issuing corresponding *fetvas.* The Sultan's Government sent forces under the name of the Caliphate army and roused counter-revolutionary outbreaks around Angora, which, however, were put down by the nationalists. When the Allies found themselves embarrassed by the nationalist success, they accepted the offer of Venizelos that the Greek army should advance beyond the area allotted to it in order to deal with the nationalists In the months of June and July 1920 the Greek army occupied eastern Thrace, and marched on to Brusa and Ushak. On August 10, 1920, the Allies concluded with the sultan's Government in Constantinople the Treaty of Sèvres, which aimed at destroying the independence of Turkey In Europe, eastern Thrace nearly as far as the Chatalja lines, including Gallipoli, was assigned to Greece, and provisionally Greece was also given Smyrna and a zone around it A tripartite agreement between England, France and Italy laid out French and Italian spheres of influence in parts of those Anatolian territories which under the peace treaty were nominally left to Turkey. The outlines of the Armenia which was to be formed in eastern Anatolia were left to President Wilson to define. The Treaty strengthened the nationalist cause by arousing unanimous indignation. The British forces in Eskishehir withdrew under the pressure of Ali Fuad Pasha's forces. In Cilicia and Aintab the nationalist forces were struggling successfully against the French army and against the Armenian legions under them.

The continual raids by the Armenians of the Armenian republic on the Turkish frontier villages, accompanied by killings and burnings, as well as the necessity for a direct route to Russia, led Turkey to attack the Armenian Republic. The Turkish army captured Kars and Alexandropol, and a victorious peace was concluded with Armenia at Alexandropol, Jan. 3, 1921. A Turkish delegation sent by the Angora Government signed a treaty of friendship with Russia by which Russia recognized the Government of Angora. This, the first recognition of the Angora Government, united her with Russia against the West. The Menshevik government of Georgia was overthrown, and Turkey with the consent of Georgia occupied Ardahan, Artvin and Batum. When the Caucasian republics were federated to Russia, a treaty signed in Kars Oct. 16, 1921, between Russia, the Government of Angora,

and the three Caucasian republics, left Kars, Ardahan and Artvin to Turkey and restored Batum to Russia.

The defeat of Venizelos in the general elections in Greece and the return of King Constantine alienated the Allies, especially France. The Greek army in Anatolia started a new offensive, but was twice checked by the Turkish army at Inn-Eunu (Jan.–April 1921). The Allies called a conference in London to which representatives of both the Government of the sultan and the Government of Angora were invited (Jan.–Feb. 1921). At this conference it became clear that the Allies realized the necessity of amending the Treaty of Sèvres: the Angora delegates initialled agreements with the French and Italian Governments which were not accepted by Angora. These agreements nevertheless were the first signs of the difference of opinion between the Allies on the Turkish question. The allied high commissioners at Constantinople as a result of this dissension announced the neutrality of their Governments on May 18, 1921, and designated neutral zones forbidden to the belligerents on each shore of the Bosphorus and the Dardanelles On July 10, 1921, the Greek army once more passed to the offensive and drove the Turkish army east of the Sakaria At the suggestion of a commission of inquiry sent by the Great National Assembly to the front, Mustafa Kemal Pasha was now appointed generalissimo, and after a pitched battle which lasted 20 days the Greeks were defeated and retired to the east of Eskishehir. Mustafa Kemal Pasha was made marshal and was given the title of *Ghazi* by the Great National Assembly.

M. Franklin Bouillon was delegated by France to negotiate an agreement which was signed in Angora on Oct 20, 1921. It recognized the Angora Government and traced the Turco-Syrian Frontier, as later reaffirmed in the Lausanne Treaty. On March 24, 1922, the Allies intervened in common to propose a truce between Turkey and Greece, but the Turks declared that they could only negotiate after the evacuation of Anatolia. However the Angora Government sent to Europe, first the commissary of foreign affairs, and then Fethi Bey, the commissary of the interior, to seek a peaceful solution. Fethi Bey, especially, arrived in London with conciliatory proposals, but during his three weeks' stay, he was not received by any cabinet minister. The Angora Government concluded that the question could be settled only by force of arms. The Greeks, to raise their *moral,* demanded permission to occupy Constantinople, which the Allies refused. On July 30, 1922, Sterighiadis, the Greek high commissioner in Smyrna, proclaimed the autonomy of the Anatolian territory under Greek occupation, apparently with the intention of continuing the Anatolian war in the guise of a local Greek national movement, in the case of the Greek army being compelled to evacuate Anatolia by diplomatic pressure. The Allies proclaimed their neutrality for the second time on August 10, 1922, by the decision of the Supreme Council of War

The Turkish offensive began on Aug 26 and the Greek army was completely routed. On its way from Ushak to Smyrna, it burnt to the ground the most prosperous towns in the west of Turkey, and atrocities were committed on a large scale. Nearly a million people were homeless The Turkish army entered Smyrna on September 9, and the masses of native Christians left the town in great disorder. The burning of the town on Sept. 13 deepened the general tragedy.

The annihilation of the Greek army brought the Allies face to face with the Turkish army on the Asiatic shores of the Straits, the neutrality of which had been proclaimed by the Allies The situation was dangerous At first England and France agreed to act in concert in case of necessity by opposing any Turkish violation of the neutral zones. On Sept 16, England further announced that the British Dominions, Yugoslavia and Rumania, had been asked to promise military support for maintaining the freedom of the Straits. This announcement incited the Turks to action, both by its threatening tone and because it contained no reference to the Nationalists' territorial demands in eastern Thrace. In consequence, the Turkish army advanced towards the neutral zone. France and Italy withdrew their troops, and M. Franklin Bouillon was sent to Smyrna from Paris to mediate with Mustafa Kemal Pasha, and so arrest the march of the Turkish army. The British troops remained alone On Sept. 23, Lord Curzon came to an agreement with M Poincaré which accepted the British view regarding the temporary question of the neutral zones, and the French view regarding the definitive peace terms. On the same day, in accordance with this agreement, the principal allied powers invited the Angora Government to a peace conference on two bases; that Turkish sovereignty should be restored in Thrace up to the river Maritza, and that during the interim period, pending the negotiations and entry into force of the Peace Treaty, the inviolability of the neutral zones should be maintained Meanwhile the Turkish cavalry had advanced almost up to the British wire at Chanak, and only the tact and the firmness of General Harington, as well as his sincere desire to prevent war, averted a disaster The Nationalists accepted the Allied invitation of Sept. 2 which satisfied the Turkish demands for the territorial settlement in Europe, and suggested a preliminary conference on Sept 29 On Oct. 13 a military convention was signed at Mudania between the Angora delegates, the Allied generals in Constantinople and Greece

The Allies had also invited the sultan's Government to the peace conference Tewfik Pasha, the last grand vizier of the Ottoman empire, wrote to the Great National Assembly, proposing joint action, and this made it necessary for the assembly to face the dilemma of having two Governments in one country In consequence the caliphate was separated from the sultanate; the sultanate was abolished, and the sovereignty of the nation without any restriction, already inserted in the new constitution, was reaffirmed on Oct 1, 1922 But it was decided to keep the caliphate in the house of Osman. The governmental departments in Constantinople then passed to the Angora Government, which formality was accomplished by Refet Pasha, the Angora Government's high commissioner for Thrace. Thus the house of Osman, which had reigned for seven centuries, came to an end through the treason of its last Sultan, Mohammed VI ; and for the first time in its history Constantinople was no longer the capital of the State to which it belonged On Nov. 17, 1922, Mohammed VI. took refuge in the British warship "Malaya" and escaped to Malta The commissary of Sheria deposed the refugee Caliph by a *fetva,* and elected Prince Abdul-Mejid, the son of Abdul-Aziz, as Caliph The new Caliph recognized the sovereignty of the Great National Assembly, and gave up his claims to the sultanate by a written document This was the last time the Turks used the *fetva*

The Lausanne Conference met on Nov 20, 1922, and signed a peace treaty on July 24, 1923 By it the Turks procured the demands they had put forward in the national pact, except that concerning Mosul The capitulations were abolished To realize racial unity in new Turkey the Orthodox Greeks in Anatolia were exchanged for the Muslim Turks in Greek Macedonia · the Greeks of Constantinople and the rest of the Christian minorities were to have the same rights as were secured to other minorities in Europe under the post-war treaties. The tracing of the Turko-'Iraqi frontiers was to be discussed between England and Turkey at a future date, and if necessary to be submitted to the League of Nations. Turkey also concluded treaties with America and Poland which restored diplomatic relations with these countries

The New Turkey.—The Ottoman empire, which had tried to end the war in 1918 by the armistice of Mudros, was no more. The Turks, the principal element of the defunct empire, had created a new independent Turkish State The new Turkey had abolished the capitulations and contracted treaties with all the other States Released from external troubles she was free to begin a new era of progress and reconstruction The new constitution was not complete, and the position of the president of the national assembly, who was the head of the State at the same time, was vague. Taking advantage of this, during a difficulty in forming a new council of commissaries, Mustafa Kemal Pasha proposed a constitutional amendment by which Turkey would become a republic (Oct. 29, 1923). This amendment was accepted and Mustafa Kemal Pasha was elected the first president of the Turkish republic, and Ismet Pasha, his right hand man, formed a cabinet

Like all the reformers preceding him, Mustafa Kemal Pasha accepted the clause in the new constitution which declared the State religion to be Islam. But there was a growing conviction

that radical reform would be possible only after freeing the State from religion. Turkey after adopting the republican form of Government was determined to complete the partial secularization of the preceding regime, and to prevent all interference of religious influence, which was regarded as having been the principal obstacle to modernization The clause in the constitution in declaring Islam the State religion and the position of the *fainéant* caliph were accordingly the first objects of attack On March 3, 1924, Mustafa Kemal Pasha succeeded in passing three laws at one sitting expelling the Ottoman dynasty; abolishing the Caliphate, the commissariat of *sheria* (the recognized office for the religious affairs) and *eykaff* (pious foundations); and attaching all the educational and scientific institutions, including the *medresses* (religious colleges), to the commissariat of Public Instruction. By these laws the Turkish republic put an end to Pan-Islamism in Turkey and also paralysed the Khilafat movement in British India. The most important step in secularization was the clause of one of the three laws which withdrew the "civil transaction" section of the *sheria*, which so far had dominated the Turkish code through the *mejelle* (Turko-Islamic code). The dispatch of all concerns and cases which related to dogma and religion passed to an office called the "Presidency of Religious Affairs." Thus for the first time Turkey tried to separate religion from the State. Of the two classes, the *ulema* and the military, which had dominated the Turkish State, the *ulema* were no more. The military, from the time of the *tanzimat*, had nominally ceased to interfere in internal politics But in spite of this, the deposition of Abdul-Aziz (1876), the re-establishment of the constitution (1908), the nationalist movement (1918) were all brought about through the army. And although during the last and most important changes of regime, including State secularization, military influence was not obvious, the force behind the throne in the Turkish state was still the army. A month before the passing of these laws Mustafa Kemal Pasha assembled the commanders of the army in Smyrna and discussed these questions with them, thus diplomatically shifting the responsibility to the shoulders of the army in case of any public opposition A new constitution which was more democratic than that of England was adopted on April 20, 1924 To win over the peasantry, who constituted the majority and who did not regard these radical measures favourably, the tithes, which lay heavily on the agricultural classes, were abolished and military service was reduced to 18 months The deficit in the revenue, due to the abolition of the tithes, was met by a heavier taxation of the urban population.

Although constitutionally the national sovereignty was in the hands of the national assembly, Mustafa Kemal Pasha, through his personal prestige won in the field, and through his hold over the army, showed decided tendencies towards a personal dictatorship. This created an opposition under Rauf Bey and Kiazim Kara-Bekir Pasha, which attempted to keep the republic on a democratic and liberal basis, and was called the Republican Progressive Party (Nov. 1924) Ismet Pasha's cabinet fell and Fethi Bey, a liberal and moderate statesman, formed a new cabinet. The Kurdish provinces revolted, because they resented the extreme centralization and the harsh measures of the Government in carrying out new reforms, and because of the separatist tendencies of some of the leading chiefs Mustafa Kemal Pasha seized this as a pretext to strike at the opposition. Pretending that the liberal clause in the Progressive programme which advanced liberty of conscience had encouraged this rising, he, after a long discussion in the party meeting, during which he spoke for six hours, forced the Fethi Bey cabinet to resign, on the ground that it had refused to carry out drastic measures in the peaceful parts of Turkey. Ismet Pasha formed a cabinet for the second time. The "law of maintenance of order" was passed.

The Dictatorship.—With the passing of this law, the tribunals of independence, which had functioned during the nationalist struggle against the anti-nationalists, were revived. A reign of terror both against the Kurdish insurgents and the members of the opposition began. The opposition Party was suppressed. The freedom of speech which the new constitution had accorded to the Turkish nation was evaded through the very vague terms of the Law. Mustafa Kemal Pasha was able to establish his dictatorship, despite a most democratic assembly, by the absence of any clause in the constitution which would place the president of the republic above parties. Therefore Mustafa Kemal Pasha, as the active president of his own Party, could wield unbounded power. The Kemalist Party (People's Party), like Abdul-Hamid and the Committee of Union and Progress, believed that the Turkish nation was not yet ready for a liberal regime. Although the Kurdish insurrection was put down by tribunals and military operations, the disturbances continued in Van, Bitlis and Diarbekir, and led the republic to begin a partial deportation of the Kurds. The reforms of the republic were carried out by the terrorist methods of Mahmoud II. The religious orders were abolished and the *tekkes* (monasteries) were closed as having influenced the Kurdish rising. A decree ordered the army to adopt a képi and the civil servants to wear hats. A law passed in Nov. 1925 abolished the fez and obliged everybody to wear hats. (Women were not included.) This law provoked several counter-revolutionary risings in the eastern provinces, which the tribunals suppressed by death sentences and imprisonments. On Feb. 17, 1926, the assembly adopted a new civil code which was almost a translation of the Swiss code; and this is the most fundamental of the recent changes. By the adoption of this code Turkish legislation was wholly freed from Islamic influence The laws concerning marriage, divorce and inheritance, which had been totally different from those of the West, were altered, and polygamy was legally prohibited. This radical secularization led the non-Muslim minorities to renounce of their own accord the minority rights which they had procured at the Lausanne conference. The secular republic had now only two points of contact left with religion; the clause in the constitution which states that the religion of the State is Islam, and the law which attached the Presidency of Religious Affairs to the prime minister's office The former of these was broken on April 9, 1928, by a decree of the assembly annulling the clause in question and also that by which the assembly has to execute the *sheri* (holy law). The decree also substituted the oath "by Allah" by the oath "by my honour."

On May 19, 1924, a conference assembled in Constantinople to trace the Turko-'Iraqi frontier, which had been left over by the Lausanne Conference. No result was achieved and in accordance with the decision of the Lausanne Conference, England and Turkey submitted the question to the League of Nations. On Dec. 16, 1925, the League of Nations decided to give the vilayet of Mosul to 'Iraq. To this the Turks would not consent and in protest, the Turks, on Dec. 17, 1925, concluded in Paris a treaty of mutual neutrality for three years with Chicherin, the Russian commissary of Foreign affairs Turko-Russian relations, which had become distant since the Lausanne Conference, once more became very close. To reassure Russia, who watched Pan-Turanianism in Turkey with some anxiety, the Turk Ojaks (national clubs) issued a declaration, stating that Turkish nationalism was cultural and local and had no Pan-Turanian aims. Finally in the summer of 1926, the British, Turkish and 'Iraqi representatives met in Angora and signed a treaty on June 5, which ceded the vilayet of Mosul to 'Iraq with a slight rectification of the frontier in favour of Turkey: for a period of 25 years from the coming into force of the Treaty, the 'Iraq Government was to pay Turkey 10% on all royalties it received from the exploitation of the Mosul oil. On April 22, 1926, a treaty of neutrality was concluded with Persia. A treaty of perpetual peace and friendship was signed with Afghanistan in Angora on May 27, 1928, and a treaty of non-aggression and arbitration with Italy on May 30, 1928.

On the pretext of a conspiracy against Mustafa Kemal Pasha's life, "discovered" in the summer of 1926, all the members of the suppressed Opposition Party, both in and out of the assembly, as well as the leading members of the Union and Progress Party, were arrested by the tribunal of independence. At the trial political opponents were assumed to be conspirators by the mere fact of their being in the Opposition. Kiazim Kara Bekir Pasha, Ali Fuad Pasha and Refet Pasha were acquitted by the pressure of the army. Several members of the assembly, whose parliamentary immunity was violated and who had been in the forefront of the

nationalist movement, were executed. Djavid Bey, the foremost Turkish financier, Shukri Bey, Dr. Nazim Bey and Janpoulant Bey, all ex-ministers of the Unionist regime and some of them deputies, were also executed. The ex-prime minister Rauf Bey who was in Europe at the time, was condemned to ten years' imprisonment. All these terrorist and illegal measures aimed at extinguishing every form of opposition.

The economic policy of the republic, a reaction to that of capitulations under which the Turks had suffered so much, was ultra-nationalist. State construction of railways was begun, and lines between Angora and Caesarea, and between Samsoun and Amasia were completed in 1927.

In the summer of 1927 the general elections took place; Kemalist Party candidates were all elected and Mustafa Kemal Pasha was elected president of the republic for the second time. In April, 1928, the article of the constitution declaring Islam the official religion of the republic was eliminated by a unanimous vote of the Assembly. The same body enacted a bill substituting Roman characters for the Arabic in all official documents. After a 15 year period of education it is intended to make the general use of the new alphabet compulsory

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(A. A. A.)

TURKEY, an abbreviation for turkey-cock and turkey-hen, a large domestic gallinaceous bird, so called from the mistaken idea that it came from Turkey They (*Meleagris*) are all American, and were not introduced into Europe before 1530 The northern (*M. gallopavo*) is extinct in the settled parts of Canada and the north-eastern parts of the United States It is a beautiful bird, with bright, metallic gloss on its plumage. The southern species (*M mexicana*, Gould), now rare, differs in having its tail-coverts and quills tipped with white On the borders of Guatemala and British Honduras is a third species, *M. ocellata,* whose plumage vies in splendour with that of the peacock, while the bare skin of the head is blue, studded with orange warts. The turkeys form the subfamily *Meleagrinae* of the *Phasianidae* and extend back to the Miocene, when they were present in Colorado.

The turkey (the South American *M. Mexicana*), domesticated by the peoples of Mexico and Peru, was introduced into Europe by the Spaniards soon after the discovery of America From Europe, most probably, the earliest domesticated turkeys were taken to North America by colonists from Europe and little admixture of wild blood (*M. Gallopavo*) occurred until after the middle of the last century when livestock began to be improved. By 1865, the original Mexican stock was known in England as the Cambridge Bronze, and there were also the Black Norfolks, Whites and Fawns (buffs). Of these the Cambridge Bronze was the largest, the Black Norfolks the most popular.

Later there arose a demand for a turkey of greater size and so there was imported from North America the American Bronze, with less white and more brilliant colouring. These were bred with the Cambridge and with the general turkey population of the continent. But the great size of the American Bronze is unsuited to-day of small incomes and small families. The marketable bird now is one of 10–15 lb. and the older European varieties have come into their own again. The White turkey, called for reasons unknown the Austrian White in Europe, the White Holland in America, is exceedingly popular, and Blacks and Fawns are also kept. Infrequently the other colour varieties are imported from America into Europe, the Slate, the Narragansett and the Bourbon Red All these pigments are ingredients of the Bronze colouration and the breeder, by isolating and forming new combinations of them, has produced the different varieties

(F. A. E. C.)

United States.—From colonial days the turkey has been the *pièce de résistance* at the feast of the national Thanksgiving Day.

The Bronze turkey is the largest and most popular. The standard weights in pounds are: adult cock, 36; yearling cock, 33, cockerel, 25; hen, 20; pullet, 16. The plumage is distinguished by a rich brilliant, bronze sheen with white barring of the wings and edging of tail feathers

The White Holland is the second most popular turkey. It is, perhaps, more easily handled in confinement than the other varieties. The standard weights in pounds are. adult cock, 28; yearling cock, 24, cockerel, 20; hen, 18; pullet, 14 The White Holland is pure white and the plumage should be free from black flecks or ticking in all sections.

The Bourbon Red is the newest standard American variety, with growing popularity The standard weights in pounds are: adult cock, 30, yearling cock, 25; cockerel, 20, hen, 18; pullet, 14 The general plumage colour is a rich brownish red, with the primary and secondary feathers of the wing and the main tail feathers of pure white. (M. A. J)

TURKHEIM. At the end of 1674 the imperial army under Bournonville had crossed the Rhine at Strasbourg and invaded Alsace (*see* DUTCH WARS and TURENNE) After an indecisive battle at Enzheim, Turenne, the French commander, withdrew northwards as if for the defence of Lorraine; thereupon the imperialists spread themselves into winter quarters over southern Alsace. This was exactly what Turenne wanted; leaving only a screen of cavalry posts in northern Alsace, he re-entered Alsace from the south at Belfort. The imperialists were taken by surprise; several bodies were captured or dispersed, and a rapid thrust at Strasbourg might have been decisive But the long march in winter had exhausted Turenne's men, and when at last he did move northwards the allies had had time to concentrate their army, 50,000 strong, in a formidable position between Colmar and Turkheim With only 35,000 men, Turenne saw that a pitched battle might end in failure; he therefore decided to manoeuvre his enemy out of position. Giving half his force to the Comte de Lorge, he ordered him to demonstrate particularly against the town of Colmar, on their left

As he had hoped, the imperialists at once began to move troops from their right and centre for the defence of Colmar, whereupon Turenne, who had moved the rest of his army under cover of some hills close up to the enemy's right, sent Foucault forward with 12 battalions and some cavalry and guns to cross the stream near its junction with the Fecht This attack was timed to begin an hour before sunset, because Turenne did not wish to be drawn into a general engagement but only to frighten the imperialists into withdrawing in a night panic Foucault advanced too soon, however, and had to wait for some time under heavy artillery fire, while the imperialists had time to move some of their troops back towards the right At 3 P M. (on Jan 5, 1675) Foucault attacked and brilliantly forced the imperial right back upon their centre As Turenne had anticipated, the imperialists, fearful that their flank was turned, fell back upon Strasbourg The losses were unimportant, but the battle was decisive, Alsace being cleared of its invaders.

TURKI, strictly speaking an Arabic or Persian adjective formed from Turk, used by European writers in two rather different senses. (1) It is applied to tribes or languages which are Turkish as opposed to Aryan, Semitic, etc (2) It is used as the special designation of the tribes and languages of Kashgaria and Eastern Turkistan (*See* TURKS.)

TURKI LANGUAGE. The dialects of the Turkish language may be roughly divided into four main groups, namely (1) the oriental dialects of the Altai, (2) the western dialects including Kirghiz, Bashir, and the Tatar of the Volga, (3) the dialects of Central Asia with which this article will deal, and (4) the

southern dialects, including Turkoman, Azerbaijani, Anatolian, Crimean and modern Ottoman Turkish (Osmanli). These dialects differ in a remarkably small degree from one another. There are, however, two Turkish dialects, namely, the Yakut and the Chuvash, which, owing to their isolation, have undergone considerable modification. The Central Asian dialects which are spoken from the eastern frontiers of Persia as far as Hami on the edge of the Gobi desert include Taranchi, the Turki of Hami, Aqsu, Kashgar, Yarkand, Sart, the dialect of Kokand, and the Uzbeg of Bokhara and Khiva. The literary language of Chinese Turkestan is known as Eastern Turki or Jaghatai from the name of one of the sons of Jenghiz Khan who founded a Khanate in this region at the beginning of the 13th century. The first monuments to be discovered of the ancient Turkish language were those contained in the Orkhon inscriptions dating from the 8th century which were written in a Runic character. They were known to exist in 1730, but were only deciphered in 1893 by the Danish scholar Vilhelm Thomsen. Since then a vast manuscript literature in a similar language, both in Runic and in other alphabets notably the Uighur (derived through Sogdian from the Aramaic) has been rescued from under the sands of Central Asia. (Documents have also been found in Estrangelo [two forms], Brahmi, and even Tibetan.) When the Uighur alphabet was introduced is not exactly known, but it must, at a later stage, have overlapped with the Runic alphabet which was certainly employed in the 6th century of our era. Although with the submission and consequent conversion of Chinese Turkestan to Islam a vast number of Arabic words were introduced into the Turki language, the number of these was far smaller than was the case with Osmanli Turkish, and consequently old roots have been preserved in Turki which have almost entirely disappeared from the westerly dialects. The Uighur alphabet was still in use in the 12th century and mss. have been found dating from the 15th century, but owing to the influence of the Arabian culture, it was finally discarded in favour of the Arabic alphabet. The Turki language spoken to-day from Yarkand to Hami is practically identical with the Turki of the 10th century. Down to the 14th century very few literary works were produced in Turki, but in the 15th, 16th and 17th centuries there appeared a large number of distinguished writers in that language among whom may be mentioned the great poet and patron of poets Mir Ali Shir Navai, the Sultan Babur and the historian Abul-Gazi Bahadur Khan. The characteristics of the Turkish languages have been described elsewhere (*See* TURKISH LANGUAGE AND LITERATURE.) Turki is rich in verbal affixes which modify the root meanings. Shaw cites an example which illustrates the manner in which these affixes may be multiplied in a single word—in *Birilishturalmaidurman*. *Birmaq* is "to give", *almaq* is "to take", *biralmaq* is "to be able to give"; *biril* is "to be given"; *birilish* is "to be given to one another"; *birilishtur* is "to cause to be given to one another"; *mai* is the negative; *dur* is the present tense; *man* indicates 1st person singular. The whole thus means "I am unable to cause (them) to be given to each other."

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TURKISH LANGUAGE AND LITERATURE. Turkish, now generally understood as referring to the Osmanli or Ottoman Turkish speech of Europe and Asia Minor, is correctly the name of a family of tongues. The Turks were known to China in the 6th century A.D., and the Turkish inscriptions from the Orkhon river district in northern Asia bear dates from before the middle of the 8th century. The best known divisions of the Turks are the Uigurs, the Seljuks, and the Osmanlis. The last-named took Constantinople in 1453 and set up the Ottoman empire. (*See* TURKEY.)

The root of the name is *türk*, meaning "power" (or, as some authorities have it "to arrive at maturity"). The name is found in many languages from China to the Caucasus, but was not used by the Turks until the beginning of the present century. The Turkish languages are spoken over 140 degrees of longitude, from Macedonia to Siberia, and are characterized by a remarkable homogeneity. These languages are everywhere easily identifiable and leave ineffaceable marks on surrounding tongues (*e.g.*, in Mongolia and Siberia). The Asiatic Turks were at different periods decidedly forceful and their languages made attacks on other speech systems, analogous to those physical assaults made by the Turks on surrounding peoples.

A prominent feature of the Turkish languages is the vocalic harmony (prevailing throughout the family) upon the eight vowels, *ä, ı, ö, ü; a, i, o, u*. The Turkish tongues are sweet-sounding and a comprehensive scheme of vowel-attractions governs the euphonic interests of the family. Nouns are declined and compounds can be built up by adding suffix to suffix: from *chal-(mak)*, "play a musical instrument" *chal-gi*, "a musical instrument"; *chal-gi-ji* "a musician," and with *-lär* (a sign of the plur.), *chal-gi-ji-lär*, "musicians." This building up from a stem is seen to perfection in the verb. The declension of nouns now comprises genitive, dative, accusative, locative, and ablative, although in earlier times there were other cases. The plural (marked by the suffixes *-lär*, *-tär*, *-där*, and *-När*) is not invariably used: bir tavuk satmak, "to sell $\left\{\begin{matrix}\text{a}\\ \text{one}\end{matrix}\right\}$ hen," *tavuk satmak*, "to sell hens." The copula is frequently omitted, in which event the order of words reveals the sense: *oglan ogsüz* (lit. "boy orphan"), the boy is an orphan, and *ögsuz oglan*, "a boy orphan."

The usual copula in the Turkish languages is the aorist of *durmak*, "to stand up." "The boy is an orphan" with the copula expressed would be *oglan ogsuz tur-ur*. The construction of the sentence is accomplished by use of pronouns both before and after the predicate in accordance with the following table. (In the post-predicate position the pronoun is merely an enclitic.)

Verb and Pronoun Prefixes and Suffixes

Number and person	Independent personal pronouns	Copula suffix	Imperative suffix	Possessive suffix
Singular				
1st. pers	*ban, man, min*	*-ban, -van* *-man, -min, etc*	*-av, ayin* *-iyin, etc*	*-m*
2nd pers	*san, sin*	*-sin*	*-kil*	*-ng*
3rd pers	*ol, ul*	*-durur, -dir*	*-sin, zin*	*-(s)i, -i*
Plural				
1st pers	*biz, bis*	*-biz, bis*	*alim*	*-biz*
2nd pers	*siz, sizler*	*-siz, -sizler*	*-iniz, -igiz*	*-ngiz*
3rd pers	*olar, ular*	*durur, dirlar*	*-sin, -sinlar*	*-lari*

Suffixes to the general verb are of two kinds, (*a*) those forming nouns of action (*tran*), or in Osmanli *-dik* and (*b*) predicative suffixes which form other tenses or moods of the verb. These are added to the base, *e.g.*, from *atmak* (to throw), base *at*+suffix *-in* or *-iniz* gives the imperative *atin, atiniz*, "throw!" Frequently, however, the base alone is used as an imperative and, except in its written form, the Turkish language in whatever dialect it is found is far from stable.

The Turkish numeral system is decimal. It is nearly, but not quite, uniform throughout the languages; it is possible that the parent idiom had not developed a complete system before the break-up of the primal family. In certain cases the colloquial has borrowed one or two number-names from surrounding peoples. The Osmanli Turkish numerals are:

1, *bir*, 2 *iki*, 3 *uch*, 4 *dört*, 5 *besh*, 6 *alti*, 7 *yedi*, 8 *sekiz*, 9 *doquz*, 10 *on*. Eleven is *on bir*, and so regularly to 20, which is *yirmi*; 30 *otuz*; 40 *kerk*; 50 *elli*; 60 *almish*; 70 *yetmish*, and so regularly to 100 (*yuz*). One thousand is *biñ*.

The general outlines of the language have remained unchanged throughout the centuries, but in details there are wide differences between the languages of the different localities. The modern Ottoman (Osmanli) Turkish differs very widely from the Turkish tongues of northern Asia. It is much more harmonious to the

ear and much simpler in grammatical structure. It is a difficult task to trace the development of written Turkish from the *kök-türk* or pseudorunic script of the Orkhon regions through the Uigur script of Mongolia and Turkestan to the modern use in Turkey and central Asia of the Arabic script adapted to Turkish needs. For Turkish has used several different scripts, writing in Syriac characters (*Estrangelo*) and a modified form of this script called Manichaean, in Brahui (*q.v.*), in Tibetan, in Armenian Greek and Hebrew. The most modern development is the decision of the decree of the Turkish government in 1928 that the Roman alphabet should be universally substituted for the Arabic script.

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LITERATURE

During the rule of the Ottoman Sultans the Turks gave little sign of literary inventiveness and the two great schools, the old and the new, into which we may divide their literature were closely modelled, the one after the classics of Persia and the other after those of modern Europe, and more especially of France. The last 30 years have seen a steady development of the new school which, from being at first imitative or adaptive, has now struck out a line of its own Turkish literature has not however yet had time to manifest its reaction to recent drastic political and religious changes. Its most modern writers all belong to the period preceding the rise of Mustafa Kemàl Pasha, and even the most advanced thinkers among Turkey's men of letters have never ventured under former régimes even to hint at such reforms as have been carried out by the order of one man The old school may be conveniently divided into three periods, which may be termed respectively the pre-classical, the classical and the post-classical Of these the first extends from the early days of the empire to the accession of Suleimān I., 1301–1520 (700–926); the second from that event to the accession of Maḥmūd I, 1520–1730 (926–1143); and the third from that date to the accession of 'Abd-ul-'Azīz, 1730–1861 (1143–1277)

The Pre-classical Period.—The works of the old school in all its periods are entirely Persian in tone, sentiment and form. Some two centuries before the arrival of the Turks in Asia Minor the Seljūḳs, then a mere horde of nomads, had overrun Persia, where they settled and adopted the civilization of the people they had subdued. Thus Persian became the language of their court and Government, and when by-and-by they pushed their conquests into Asia Minor, and founded there the Seljūk empire of Rūm, they carried with them their Persian culture, and diffused it among the peoples newly brought under their sway. It was among the descendants of those Persianized Seljūḳs that so-called Ottoman Turks rose to power in the middle of the 13th century (*see* TURKS). The Ottomans naturally absorbed the culture of the Seljūḳs, and an extraordinary love of precedent, apparent in all Islamic literature, was sufficient to keep their writers loyal to their early guide for centuries till at length the allegiance, though not the fashion of it, changed and, about the middle of the last century, Paris replaced Shīrāz as the shrine towards which the Ottoman scholar turned. The poetry of the old school is greatly superior to the prose.

Ottoman literature may be said to open with a few mystic lines, the work of Sultān Veled, son of Maulānā Jelāl-ud-Dīn, the author of the great Persian poem the *Mathnawī*. Sultān Veled flourished during the reign of 'Osmān I., though he did not reside in the territory under the rule of that prince. Another mystic poet of this early time was 'Āshiḳ Pasha, who left a long poem in rhyming couplets, which is called, inappropriately enough, his *Dīvān.* The nocturnal expedition across the Hellespont by which Suleimān, the son of Orkhan, won Gallipoli and therewith a foothold in Europe for his race, was shared in and celebrated in verse by a Turkish noble or chieftain named Ghāzī Fāzil. Sheikhī of Kermiyān, a contemporary of Moḥammed I. and Murād II., wrote a lengthy and still esteemed mesnevī on the ancient Persian romance of Khusrev and Shīrīn; and about the same time Yaziji-oghlu gave to the world a long versified history of the Prophet, the *Muhammedīya.* The writers mentioned above are the most important previous to the capture of Constantinople; but there is little literature of real merit prior to that event The most notable prose work of this period is an old collection of stories, the *History of the Forty Vezirs,* said to have been compiled by a certain Sheikh-zāda and dedicated to Murād II. A few years after Constantinople had passed into the hands of the Ottomans, some ghazels, the work of the contemporary Tatar prince, Mīr 'Alī Shīr, who under the *nom de plume* of Nevā'ī wrote much that shows true talent and poetic feeling, found their way to the Ottoman capital, where they were seen and copied by Aḥmed Pasha, one of the viziers of Mohammed II. The poems of this statesman, though possessing little merit of their own, being for the most part translations from Nevā'ī, form one of the landmarks in the history of Ottoman literature They set the fashion of ghazel-writing; and their appearance was the signal for a more regular cultivation of poetry and a greater attention to literary style and to refinement of language In Sinān Pasha (d. 1420), another minister of Mohammed the Conqueror, Ottoman prose found its first exponent of ability; he left a religious treatise entitled *Tazarru'āt* (Supplications), which, notwithstanding a too lavish employment of the resources of Persian rhetoric, is as remarkable for its clear and lucid style as for the beauty of many of the thoughts it contains Twenty-one out of the 34 sovereigns who have occupied the throne of 'Osmān have left verses, and among these Selīm I. stands as the most gifted and most original poet The most prominent man of letters under this sovereign was the legist Kemāl Pasha-zāda, who left a romantic poem on the loves of Yūsuf and Zuleykhā, and a work entitled *Nigāristān,* which is modelled both in style and matter on the *Gulistān* of Sa'di His contemporary, Mesīhī, whose beautiful verses on spring are perhaps better known in Europe than any other Turkish poem, deserves a passing mention

Classical Period.—With the accession of Selīm's son, Suleimān I, the classical period begins. Fuzūlī (d 1563), showed far more originality than any of his predecessors; for, although his work is Persian in form and in general character, he struck out a new line for himself Bākī (d 1599) of Constantinople, though far from rivalling his contemporary Fuzūlī, wrote much good poetry. The Ottomans have been particularly successful with elegies; one by Bāḳī on Suleiman I. has never been surpassed Rūhi, Lāmi'ī, Nev'ī, the janissary Yahya Beg, the muftī Ebū-Su'ūd and Selīm II. all won deserved distinction as poets. During the reign of Ahmed I. arose the second of the great poets of the old Ottoman school, Nef'ī of Erzerūm, who owes his pre-eminence to the brilliance of his kasīdas Nābī (d. 1712), who flourished under Ibrāhīm and Moḥammed IV. was a prolific author who imparted into Ottoman literature. a didactic style of ghazel-writing which was then being introduced in Persia by the poet Ṣā'ib, indeed, it is not always easy to know that his lines are intended to be Turkish. A number of poets took Nābī for their model. The glory of the classical period ending with Nedīm, dates roughly from the accession of Aḥmed I 1603 (1012), to the deposition of Aḥmed III., 1730 (1143)

We will now glance at the prose writers of this period. Under the name of *Humāyūn Nāma* (Imperial Book) 'Alī Chelebi made a highly esteemed translation of the well-known Persian classic *Anvār-i Suheylī,* dedicating it to Suleiman I. Sa'd-ud-Dīn (d 1599), the preceptor of Murād III., wrote a valuable history of the empire from the earliest times to the death of Selīm I. This work, the *Tāj-ut-Tevārīkh* (Crown of Chronicles). is reckoned, on account of its ornate yet clear style, one of the masterpieces of the old school, and forms the first of an unbroken series of annals

which are written, especially the later among them, with great minuteness and detail Of Sa'd-ud-Dīn's successors in the office of imperial historiographer the most remarkable for literary power is Na'īmā. His work, which extends from 1591 (1000) to 1659 (1070), contrasts strongly with that of the earlier historian, being written with great directness and lucidity, combined with much vigour and picturesqueness Evliyā, who died during the reign of Moḥammed IV., is noted for the record which he has left of his travels in different countries About this time Ṭash-kōprizāda began and 'Atā-ullāh continued a celebrated biography of the legists and sheikhs who had flourished under the Ottoman monarchs. Ḥājī Khalīfa, frequently termed Kātib Chelebi, was one of the most famous men of letters whom Turkey has produced. He died in 1658 (1068), having written a great number of learned works on history, biography, chronology, geography and other subjects. The Persianizing tendency of this school reached its highest point in the productions of Veysī, who left a *Life* of the Prophet, and of Nergisī, a miscellaneous writer of prose and verse. The first printing-press in Turkey was established by an Hungarian who had assumed the name of Ibrāhīm, and in 1728 (1141) appeared the first book printed in that country; it was Vanḳulı's Turkish translation of Jevheri's Arabic dictionary.

Post-classical Period.—Coming now to the post-classical period, we find among poets worthy of mention Belīgh, Nevres, Ḥishmet and Sunbuli-zāda Vehbī, each of whom wrote in a style peculiar to himself Three poets of note—Pertev, Neshet and Sheikh Ghālib—flourished under Selīm III The last-named is the fourth great poet of the old school. *Ḥusn u 'Ashḳ* (Beauty and Love), as his great poem is called, is an allegorical romance full of tenderness and imaginative power. Ghālib's style is as original as that of Fuzūlī, Nef'ī or Nedīm.

When we reach the reign of Mahmūd II, the great transition period of Ottoman history, during which the civilization of the West began to struggle in earnest with that of the East, we find the change which was coming over all things Turkish affecting literature, along with the rest, and preparing the way for the appearance of the new school The chief poets of the transition are Fāzil Bey, Wāsif, 'Izzet Molla, Pertev Pasha, 'Ākif Pasha, and the poetesses Fitnet and Leylā In the works of all of these, although we occasionally discern a hint of the new style, the old Persian manner is still supreme

More intimate relations with western Europe and a pretty general study of the French language and literature, together with the steady progress of the reforming tendency fairly started under Maḥmūd II, resulted in the birth of the new or modern school, whose objects are truth and simplicity The transformation of Turkish literature and the creation of the Young Turk party were alike due to three great men, Shināsī, Kemāl and Ziyā Shināsī's small volume of translations from various French poets appeared in 1859. In the following year he founded the first non-official journal in Turkey, in which he published in simple language articles dealing with the scientific and social questions from a modern European point of view The first work of fiction ever translated into Turkish was Fénélon's *Télémaque* which appeared in 1862, the translator being Yusuf Kemāl Pasha. It was Ahmad Midhat who conceived the idea of writing stories depicting Turkish life and manners The first collection of national tales appeared in 1870 In 1869 Ahmad Vefiq Pasha published translations of three of Molière's comedies, adapting the scenes and the names to suit local conditions In 1871 appeared the first original Turkish drama, a form chosen by Abd-ul-Haqq Hāmid for his best poetry

The Revolution of 1908.—The turning point in Turkish national conscience came with the Revolution of 1908, which marks the beginning of a new era. With the rise of democracy there naturally was felt the need of a closer collaboration between the cultivated classes and the people who had for centuries been kept at a distance from one another for the reason that men of letters only wrote for a small circle of intellectuals in a language and on subjects which were untelligible to the lower classes. The battle cry of the new school was *Khalqa doghru*, "towards the people," and societies were formed like the Türk Derneyi at Constantinople and the Yeni Lisanjilar at Salonica, whose object was to introduce a new literary language adapted to the understanding of the people and a literature free from foreign influences Among the foremost workers in this new field were 'Alī Jānib, Omar Saifeddīn, and Ziyā Gok Alp (1875–1925), the real founder of the new Turkish nationalist movement, and last but not least Mehmed Emīn, a religious poet who came of lowly stock and as spokesman for the people has enjoyed very special popularity The new movement found its first expression in newspapers, and all the new writers began as journalists or novelists or as poets contributing to newspapers. Among those who have attained the highest rank may be mentioned the following writers: Tewfiq Fikret (d 1915), Jenāb Shehāb ad-Din (b 1877), Nigar Khanum, a distinguished poetess (1871–1918), Mehmed 'Ākif (b 1870), Khalīd Ziyā, Ahmad Hikmet (b 1879), Mehmed Ra'uf (b 1875), Ya'qub Qadrı (b. 1889), Khalidé Edib Hanum (b. 1883) and Husein Jahid (b. 1875) Literary criticism is notably represented by Kopruli Zadé Mohammed Fūad Bey, one of the professors of Constantinople university, an ardent scholar who is engaged in compiling a new history of the Ottoman literature. (E D R)

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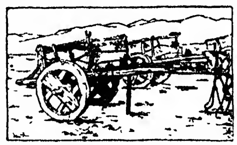
TURKISTAN, a name conventionally employed to designate the regions of Central Asia which lie between Siberia on the N and Tibet, India and Afghanistan on the S, the western limit being the Caspian Sea and the eastern Mongolia and the Desert of Gobi Etymologically the term is intended to indicate the regions inhabited by Turkish races The regions called Turkistan not only contain races which do not belong to the Turk family, but exclude races which do, *e g*, the Turks of the Ottoman Empire What was formerly called Eastern Turkistan is now mainly the southern portion of the Chinese dominion of Sin-kiang (*q v., see* also Tarim, etc.), while the former West Turkistan is included in the Uzbek, Turkmen, Kazak, Kirghiz and Tadzhik Socialist Soviet Republics (*qq v*)

HISTORY

Our knowledge of the history of Turkistan is very fragmentary until about the beginning of the Christian era It may be that at a very early period East Turkistan was inhabited by an Aryan population When the Huns (Hiung-nu) occupied west and east Mongolia in 177–165 B C they drove before them the Yue-chi (*q v.*), who divided into two hordes, one of which invaded the valley of the Indus, while the other met the Sacae in East Turkistan and drove them over the Tian-shan into the valley of the Ili. Thus, by the beginning of our era, the Tarim region had a mixed population of Aryans and Ural-Altaians, some being settled agriculturists and others nomads There were also several independent cities, of which Khotan was the most important. One portion of the Aryans emigrated and settled in what is now Wakhhan (on the Pamir plateau), the present language of which seems very old. Between 120 and 101 B.C. the Chinese extended their rule westwards over East Turkistan as far as Kashgar. By the end of the 5th century the western parts fell under the sway of the "White Huns" (Ephthalites, or Tochari), while the eastern parts were under Tangut (Thygun) dominion. An active trade was carried on by means of caravans, corn and silk especially being mentioned at a very early date.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

A NATIVE TRANSPORT CART USED ON THE PLAINS OF ZUNGARIA

The civilization and political organization of the country were

dominated by the Chinese, but were also influenced to some extent by Graeco-Bactrian civilization, which had probably secured a footing in the country as early as the 3rd century B.C. From the 2nd century to the first half of the 7th our knowledge is slight, and is derived chiefly from the *Journeys* of the Chinese pilgrims, Fa-hien in 399–415, Song-yun and Hwei-seng in 518–521, and Hsüan-Tsang in 629–645. By this time Buddhism had reached its culminating point: in Khotan there were 100 monasteries and 5,000 monks, and the Indian sacred literature was widely diffused. In the 7th century the Tibetan king, Srong-btsan, with the help of the western Turks, subjugated the western part of the Tarim basin. In 712–713 the Mohammedans, after excursions into West Turkistan, invaded East Turkistan. In 790 the Tibetans were masters of East Turkistan, but later (9th century) the territory fell under the rule of an Uighur people. In the 11th century Mongol hordes overran East and West Turkistan and in the 14th, Tughlak Timur accepted Islam and shifted his capital from Aksu to Kashgar. His son reigned at Samarkand, but in 1389 Timur devastated Dzungaria (*q.v.*) and East Turkistan.

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

A SERKOLIS MERCHANT OF SOUTHERN CHINESE TURKISTAN WEARING HIS NATIVE DRESS

Chinese Turkistan.—In the 14th and 15th centuries Bukhara and Samarkand became centres of Muslim scholarship and sent great numbers of their learned doctors to Kashgaria. Rubruquis, who visited East Turkistan in 1254, Marco Polo between 1271 and 1275; and Hois in 1680 all bore witness to great religious tolerance, but this entirely disappeared with the invasion of the Bukharian mullahs or Mohammedan priests. In the 17th century a powerful Kalmuck confederation arose in Dzungaria, and extended its sway over the Ili and Issyk-kul basins, having its capital on the Ili. To this power or to the Kirghiz the "Whites" and "Blacks" alternately appealed in their struggles, in which Yarkand supported the latter and Kashgar the former. The Chinese entered Dzungaria in 1758, the Kalmucks fled, and Dzungaria became a Chinese province, with a military colonization of Sibos, Solons, Dahurs, Chinese criminals and Muslim Dzungars. The Chinese next re-conquered East Turkistan, marking their progress by massacres and transporting 12,500 partisans of independence to the Ili (Kulja) valley. Hereupon the dissentient khojas fled to Khokand in West Turkistan and there gathered armies of malcontents and fanatic followers of Islam. Several times they succeeded in overthrowing the Chinese rule—in 1825, in 1830 and in 1847—but their successes were never permanent. In 1857 another insurrection broke out; but a few months later the Chinese again took Kashgar. In the course of the Dzungarian outbreak of 1864 the Chinese were again expelled, and Yakub Beg became master of Kashgar in 1872. But five years later he had again to engage in war with China, in which he was defeated, and East Turkistan once more became a Chinese province; it is now known under the general name Sinkiang, together with Kulja and Kashgaria.

Old Russian Turkistan.—Soviet Central Asia comprises some part of Turkistan. Since Russia conquered Turkistan about 1865, Tashkent and Samarkand were occupied and further territory was absorbed and the whole united into Russian Turkistan. Until 1917 Russian Central Asia consisted of several territories, including the governor-generalship of Turkistan. After the revolution the Soviet Government established its power in these districts, and the khanates of Khiva and Bukhara were destroyed (1920). In the same year was set up a Peoples' Soviet Republic and the former governor-generalship of Turkistan became an Autonomous Socialist Soviet Republic within the R.S.F.S.R. in 1921. In 1925 a redistribution took place and the new States of Uzbekistan, Turkmenistan and Tajikistan, together with several autonomous regions, were set up. The remaining Turkistan areas were linked with the Autonomous Kirghiz Socialist Soviet Republic.

Afghan Turkistan.—Afghan Turkistan, now called the Mazar Province, the northern province of Afghanistan, is bounded on the east by Badakhshan, north by the Oxus river, north-west by Russia, and south by the Hindu Khush, the Koh-i-Baba, and the northern watershed of the Hari Rud basin, which separates it from the Herat Province. Its northern frontier was decided by the Russo-Afghan Agreement of 1873, and delineated by the Russo-Afghan Boundary Commission of 1885, which gave rise to the Panjdeh incident. With a length of some 500 m. and an average breadth, north to south, of 114 m., it comprises about 57,000 sq.m., or two-ninths of the kingdom of Afghanistan. Except in the river valleys it is a poor territory, rough and mountainous towards the south, but subsiding into undulating wastes and pasture lands towards the Turkman desert, and the Oxus riverain, which is highly cultivated. The population, which is mostly settled in and around its towns and villages, is estimated at 800,000. The principal town is Mazar-i-Sharif.

The bulk of the people are of Persian and Uzbeg stock, interspersed by Mongol Hazaras and Hindus, with Turkoman tribes in the Oxus plains. Ancient Balkh or Bactriana was a province of the Achaemenian empire. About 250 B.C., Diodotus (Theodotus), governor of Bactria under the Seleucidae, declared his independence and commenced the history of the Graeco-Bactrian dynasties, which succumbed to Parthian and nomadic movements about 126 B.C. Traces of the Buddhist era which succeeded remain in the rock-cut topes of Haibak. Devastated by Jenghiz Khan, it belonged to the Delhi empire for about a century, and then fell into Uzbeg hands. In the 18th century its khanates—Kundaz, Tashkurgan, Balkh with Akcha, and the four western khanates, or "Chahar Vilayet" of Saripul, Shibarghan, Andkhui and Maimana—formed part of the dominion of Ahmed Khan Durani, and so remained under his son Timur, but relapsed on Timur's death to the independent rule of various Uzbeg chiefs, dominated by Bukhara. Between 1850 and 1859 Amir Dost Muhammad re-established Afghan influence, but sovereignty over the Chahar Vilayet was disputed by Bukhara until settled in favour of Afghanistan by the Anglo-Russian Agreement of 1859.

Under the strong rule of Abdur Rahman these territories were more closely welded to Kabul, some relaxation of authority under Amir Habibullah having been made good by King Amanullah, who in 1927, together with his queen, visited Maimana, Mazar-i-Sharif, Tashkurgan and Kataghan, and by royal decree gave the district the name of the Mazar Province. In 1926, a dispute between Russia and Afghanistan regarding Urta Tagai, an island in the Oxus, was settled in favour of Afghanistan. A motor road and telegraph line linking the Mazar Province to Kabul were under construction in 1928. There are aerodromes, on the main Kabul-Tashkent air route, at Mazar-i-Sharif and Haibak. Half of Mazar-i-Sharif was destroyed by fire in June 1927. The Province is administered by a governor directly responsible to the Central Government. Schemes for the extension of cotton cultivation are under consideration. Mazar-i-Sharif is an important centre of the trade in astrakhan and furs.

TURKMEN REPUBLIC, an administrative division of Asiatic Russia, created in 1924. Area 491,216 sq.km. Pop. (1926) 237,570. Boundaries, the Caspian Sea to the west, Persia and Afghanistan to the south, the Uzbek S.S.R. to the east and Kazakstan, with the Kara-Kalpak Autonomous Area to the north. The oasis of Khiva, incorporated in the Uzbek S.S.R. forms an island of separate territory in the north-east.

The changes in the course of the Jaxartes (Syr-darya) and the Oxus (Amu-darya), and the supposed periodical disappearance of Lake Aral, are problems in geography and it is here that we must look for a clue to the physical changes which transformed the Euro-Asiatic Mediterranean—the Aral-Caspian and Pontic basin—into a series of separate seas, and desiccated them,

powerfully influencing the distribution of flora and fauna, and centuries ago compelling the inhabitants of Western and Central Asia to enter upon their great migrations.

A mountain chain, comparable in length to the Alps, separates the deserts of the Transcaspian from the highlands of Khorasan. It begins in the Krasnovodsk peninsula of the Caspian, under the names of Kuryanyn-kary and Great Balkans, whose masses of granite and other crystalline rock reach an altitude of some 5,350 ft. Farther south-east they are continued in the Little Balkans (2,000 ft) and the Kopepet-dagh or Kopet-dagh. The latter rises steep and rugged above the flat deserts over a stretch of 600 m. In structure it is homologous with the Caucasus chain; it appears as an outer wall of the Khorasan plateau, and is separated from it by a broad valley, which, like the Rion and Kura valley of Transcaucasia, is drained by two rivers flowing in opposite directions—the Atrek, which flows north-west into the Caspian, and the Keshef-rud, which flows to the south-east and is a tributary of the Murghab On the other side of this valley the Alla-dagh (Aladagh) and the Binalund border-ranges (9,000 to 11,000 ft) fringe the edge of the Khorasan plateau Descending towards the steppe with steep stony slopes, the mountain barrier of the Kopet-dagh rises to heights of 6,000–9,000 ft to the east of Kyzyl-arvat, while the passes which lead from the Turkmen deserts to the valleys of Khorasan are seldom as low as 3,500, and usually rise to 5,000, 6,000 and even 8,500 ft

While the Alla-dagh and Binalund border-ranges are chiefly composed of crystalline rocks and metamorphic slates, overlain by Devonian deposits, a series of more recent formations—Upper and Lower Cretaceous and Miocene—crops out in the outer wall of the Kopet-dagh The mountains of Asia which stretch towards the north-west continued to be uplifted at a geologically recent epoch Quarternary deposits have an extensive development on its slopes, and its foothills are bordered by a girdle of loess

The loess terrace, called Atok ("mountain base"), 10 to 20 m in width, is very fertile, but it will produce nothing without irrigation, and the streams flowing from the Kopet-dagh are few and scanty The winds which impinge upon the northern slope of the mountains have been deprived of all their moisture in crossing the Kara-kum—the Black Sands of the Turkmen desert; and even such rain as falls on the Kopet-dagh (10½ in at Kyzyl-arvat) too often reaches the soil in the shape of light showers which do not penetrate it. Where the mountain streams run closer to one another, as at Geok-tepe, Ashkhabad, Lutfabad and Kaaka, the villages are more populous, and the houses are surrounded by gardens, nourished by irrigation

North of this narrow strip of irrigated land begins the desert—the Kara-kum—which extends from the mountains of Khorasan to Lake Aral and the plateau of Ust-Urt, and from the Caspian to the Amu-darya, interrupted only by the oases of Merv and Tejeñ. But the terrible shifting sands, blown into *barkhans*, or elongated hills, sometimes 50 and 60 ft in height, are accumulated chiefly in the west, where the country has more recently emerged from the sea Farther east the barkhans are more stable

The saksaul (*Anabasis ammodendron*) of the Kara-kum has been almost destroyed within the last hundred years, and occurs only sporadically, but the borders of the spaces covered with saline clay are brightened by forests of tamarisk, which are inhabited by great numbers of the desert warbler (*Atraphornis aralensis*)—a typical inhabitant of the sands—sparrows and ground-choughs (*Podoces*); the *Houbara macqueeni*, is characteristic of the region Hares and foxes, jackals and wolves, marmots, moles, hedgehogs and one species of marten live in the steppe.

The Uzboi.—A feature distinctive of the Turkmen desert is the very numerous *shors*, or elongated depressions, the lower portion of which are mostly occupied with moist sand. They are obviously the relics of brackish lakes, and, like the lakes of the Kirghiz steppes, they often follow one another in quick succession, thus closely resembling river-beds As the direction of the *shors* is generally from the higher terraces drained by the Amu-darya towards the lowlands of the Caspian, they led to the idea that the Amu-darya once flowed across the Turkmen desert towards what is now the Caspian sea. It was assumed, not only that that river (*see* OXUS) flowed into the Caspian, but that after having ceased to do so in the 7th century, its waters were again diverted to the Caspian about 1221. A chain of similar depressions was traced from Urgenj to the gap between the Great and the Little Balkans; this was marked on the maps as the Uzboi, or old bed of the Oxus The idea of again diverting the Amu into the Caspian was thus set afloat, but the investigations of Russian engineers, especially A E. Hedroitz, A. M. Konshin, I. V. Mushketov, P. M Lessar and Svintsov[1], went to show that the Uzboi is no river-bed at all, and that no river has ever discharged its waters in that direction. The existence of an extensive lacustrine depression, now represented by the small Sary-kamysh lakes, was proved, and it was evident that this depression, having a length of more than 130 m., a width of 70 m, and a depth of 280 ft. below the present level of Lake Aral, would have to be filled by the Amu before its waters could advance farther to the south-west.

The ancient texts (of Pliny, Strabo, Ptolemy) about the Jaxartes and Oxus only become intelligible when it is admitted that, since the epoch to which they relate, the outlines of the Caspian Sea and Lake Aral have undergone notable changes, commensurate with those which are supposed to have occurred in the courses of the Central Asian rivers. The desiccation of the Aral-Caspian basin proceeded with such rapidity that the shores of the Caspian cannot possibly have maintained for some twenty centuries the outlines which they exhibit at present. The general configuration of the Trans-Caspian region leaves no doubt that both the Jaxartes and the Oxus, with its former tributaries, the Murghab and the Tejeñ, once flowed towards the west, but the Caspian of that time was not the sea of our days; its gulfs penetrated the Turkmen steppe, and washed the base of the Ust-Urt plateau (*See* CASPIAN and ARAL.)

Climate, etc.—The region between the Heri-rud and the Murghab is a plateau, 2,000 ft. above the sea, with hills 500 and 600 ft high covered with sand, the spaces between being filled with loess. The Borkhut Mountains which connect the Kopet-dagh with the Sefid-kuh in Afghanistan reach 3,000 to 4,000 ft, and are cleft by the Heri-rud Thickets of poplar and willow accompany both the Murghab and the Heri-rud. Pistachio and mulberry trees grow in isolated clumps on the hills, but there are few places available for cultivation The climate is continental and the maximum temperature in the shade in summer varies between 43° C at Tejend and 46° C at Serakhs The average summer temperature varies between 29° C and 32° C and winter between 0 1° C at Merv and 3° C at Termez The rainfall is insignificant and falls in December, January and February, summer being rainless and sultry Thus cultivation depends entirely on irrigation

Agriculture, etc.—The years of civil war and disorder following 1917 resulted in a sharp drop in the amount of cultivated land; irrigation canals were not cleaned or repaired and famine was widespread. As a result the number of cattle, especially sheep, was disastrously diminished, partly through slaughter and partly because herdsmen migrated into Persia and Afghanistan with their flocks. After the restoration of somewhat more settled conditions a complete revolution in social system was enforced, the old tribal holding of water rights was abolished and a new system of government control and distribution of water supply and of fertile land introduced This involves much difficulty for the illiterate tribesmen and conditions are far from stable, though there has been a marked improvement during 1926–8, especially in cotton-growing, to which the Soviet government attaches much importance. The grain and wheat crop is insufficient for the needs of the people and 75,000 tons were imported in 1926–7. The Merv oasis (*q.v.*) is reviving and an electric plant and new irrigation works have been constructed Watermelons, fruits and vines are cultivated and silkworm breeding is an ancient occupation, especially round Merv and Ashkabad In former times the silk was worked entirely as a peasant industry, but in 1927–8 a factory was under construction for large scale silk manufacture.

Peasant industries include the making of homespun and felt for

[1]Their original papers are printed in the *Izvestia* of the Russian Geographical Society, 1883 to 1887, also in the *Journal* of the Russian ministry of roads and communications

local needs, the making of primitive agricultural implements and household goods, and the preparation of leather and silk goods Carpet weaving is an ancient peasant industry for export, and each tribe has its own design, guarded as a secret from other tribes The cutting off of income from carpet making during the civil war was a disaster Horses, camels, working cattle, sheep (especially karakul), goats, asses and mules are bred Their numbers are much below 1913 level, and sheep particularly have diminished

Minerals.—Salt, Glauber's salt, ozokerite and naphtha exist In pre-1914 times the output of salt was about 58,000 tons; during the civil war production ceased, but by 1926–7 it had risen to 31,600 tons. Ozokerite production in that year surpassed the previous level, reaching 700 tons as against 450 tons. The naphtha of the Ashkabad district is little exploited as yet, but that on Cheleken Island, which is obtained from natural fountains yields on an average 154,000 tons per annum Rock salt is exported to Transcaucasia, Persia and Afghanistan, while Glauber's salt from the Kara-bugaz Gulf is increasingly worked, and plans are under consideration for developing a superphosphate manure industry in the region. Vast resources of sulphur exist in the Kara-Kum desert north of Ashkabad, but their exploitation in a waterless desert seems impossible at present and Russia depends on imported sulphur. The chief town and administrative centre is Ashkabad, the population of which increased from 13,737 in 1897 to 47,155 in 1926, during which period the population of Krasnovodsk on the Caspian rose from 6,322 to 10,022 and of Merv from 8,533 to 19,099, the latter town has grown rapidly since the construction of the electric power plant

Industries.—Factory industries include cotton and wool cleaning, glass manufacture, flour-milling, brewing and distilling, the preparation of dried fruit is increasing Krasnovodsk on the Caspian is the port for the republic, its chief exports being cotton and dried fruits and its imports naphtha, timber, grain and sugar. During the civil war dredging operations ceased and the town has consequently suffered A fishing industry exists along the coast, especially near Chikishliar and Hassan-Kuli, but it is still considerably below the pre-war output of 10,000 tons The Transcaspian railway is the chief means of communication, and there is a branch from Merv to Kushka on the southern frontier The Amu-darya is difficult for steam navigation, and camel caravan is the chief trading link Caravan routes cross the desert to the oasis of Khiva, to the various stations on the railway, to the port of Krasnovodsk and to the towns of North Persia Much of the present income of the republic is going towards the provision of new irrigation canals and the sinking of wells Its financial prospects are good in view of its trade with Persia and Afghanistan and the development of its mineral resources The literacy rate is the lowest in the U S S R , averaging 4 2% among men and 0·2% among women

Population.—The population consists of Turkmens 70·2%, Uzbeks 11·7%, Russians, Ukranians and White Russians (chiefly in towns) 9 1%, Armenians 1%, Kirghiz 0·7%, with a few Persians and Bokhara Jews About half of the Turkmen tribes live in the republic, the rest being found in Persia and Afghanistan Turkmen tribes seem to have been settled in the steppe between the Oxus (Amu-darya) and the Caspian from time immemorial and are of the west-central Turkish group They are mentioned by Arab writers of the 10th century and were noted even at that time as much feared by their neighbours owing to their warlike disposition Up to the time of the defeat of the Tekke tribe at Geok-tepe in 1881 by the Russians, they preserved their nomadic predatory life, frequently holding Russian and Persian captives for ransom, and were perpetually engaged in tribal warfare. Since the Russian conquest many have taken to settled life, though much semi-nomadism and some pure nomadism still exists The Yamut tribe, which formerly wandered in the steppe to the south-east of the Caspian, is now mainly occupied at the naphtha works in Cheleken Island, while other Yamuts settled as agriculturalists in Khiva in the early 19th century. The Tekkes, who were the most important tribe at the time of the Russian occupation (1881) are much scattered; many have become settled cultivators. In early times they inhabited the Mangishlak peninsula, but were driven out by the Kalmucks in 1718 Later they occupied the Akkal and Merv oases The most ancient tribe was the Salors, who occupied the western corner of the Paropamisus range, and with whom the Arabs came in contact on their march towards the Oxus in the 7th century. Intertribal strife, and emigration to the oases and to Persia have much reduced their numbers The Ersaris, formerly a warlike tribe of the Mangyshlak peninsula were driven by the Uzbeks to the steppe south of the Ust-Urt plateau, and have lately settled as peaceful cultivators on the left bank of the Oxus The building of the Transcaspian railway further altered their habits, as did the introduction of naphtha and salt working Up to the October 1917 revolution they preserved their tribes and clans, and, though these will not disappear at once, the confiscation of water and property from the chieftains drove a sharp wedge into traditional custom and must lead to tribal disintegration. For the history of the oasis of Merv, which capitulated to the Russians in 1883 *see* MERV

See the researches of Andrusov, Bogdanovich, Konshin, Mushketov and Obruchev in the *Memoirs*, the *Bulletin* (*Izvestia*) and the *Annals* of the Russian Geographical Society (1890–1900), P. M Lessar, *L'Ancienne jonction de l'Oxus avec la mer Caspienne* (1889), Zarudnoi (zoology) in *Bulletin de la société des naturalistes de Moscou* (1889 *seq*); N. B Arkhipov, *Central Asiatic Republics*, 1927 (in Russian, with a bibliography).

TURKOMANS, a group of the Iranian Turks, found in Persia, Khiva, Bokhara, in the Caucasus, and in Transcaspia, and probably numbering about 1,000,000 They include the following clans, Chaudor, Yomut, Goklan, Akhal, Merv Tekkes, Sarik, Salor, and Ersari The clan divisions are endogamous, and owing to the scarcity of women a high bride price is paid, and many of the men are unmarried. A large number of the Turkomans are nomadic horse-breeders, although some have become agriculturists All of them are Muslims Some of the Turkomans of the steppes appear to preserve the old Proto-Nordic physical type, but in most places they have absorbed the physical type and much of the culture of the people amongst whom they live. (*See* TURKS, and CENTRAL ASIA: *Ethnology*) (L. H. D. B.)

TURKS. The term Turk is purely linguistic and refers to those peoples who speak Turkic languages having no racial sense The Turks may be divided into two groups: a western, which includes the Osmanli the Turks of what was formerly "Turkey in Europe and Turkey in Asia," the old Ottoman empire, and the eastern Turks, including many of the peoples of Turkistan and Central Asia, as far as the river Lena There are also Turks in the Crimea, in the Caucasus, and along the Volga The latter are culturally entirely associated with the eastern Europeans, as are the Osmanli with the south-eastern Europeans and western Asiatics, but linguistically they are associated with the western Turks (For racial history *see* ASIA: *Central*, and *South-western*) The eastern Turks include the Turks of Turkistan and the Caspian steppes, who have become largely absorbed culturally and physically in the Iranian peoples, and may be conveniently called Iranian Turks, and the Turanian Turks, many of whom are called Tatars (this rather than the more familiar "Tartar" is the more correct spelling), of the Steppes, of southern Siberia, Dzungaria and northern Mongolia The Iranian Turks include the Turkomans, the Sarts, the Taranchi or Ili Tatars, the Uzbegs, the Kaizak and the Kara Kalpak The Turanian Turks include the Khirghiz, a somewhat loose term, the Yakut and the Siberian Tatars.

The social organization of the Turks is based on a patriarchal system of sub-clans, all related by blood, and these sub-clans are gathered together in a loose confederacy of the clan (sok).

There is no definite mode of life which can be associated with the Turks as a whole; the western Turks and most of the Iranian Turks are sedentary agriculturalists, while those eastern Turks who have been most subject to migrations and live under steppe conditions have adopted the horse culture found in its most typical form among the Mongols (*q v*), while the Yakuts practise the reindeer culture of eastern Asia.

The western Turks are Muslims, but to the east, in spite of the superimposition of higher religions, including formerly Nestorian Christianity, which at one time was a serious rival of Islam, much

of the animistic old religions remain, and shamanism is a specially important feature among the eastern and northern tribes.

It is almost impossible to make any generalized statement about the Turks; their most potent bond is that of language; they have no uniform culture, no uniform religion or physique, and even the features of some of the ceremonies of the Kirghiz, considered by Czaplicka to be one of the purest of Turkic tribes, are almost exactly similar to those of the Mongols. Ethnologically, therefore, they must be referred to the regions in which they live.

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HISTORY

The discovery near the river Orkhon, to the south of Lake Baikal, of Turkish inscriptions dating from the 8th century A.D., and the publication of materials furnished by Chinese writers, has stimulated interest in the history of the Turkish movements in Asia.

Early Period.—From 1400 B.C. onwards, but especially about 200 B.C., Chinese history contains notices of warlike nomads called Hiung-nu or Hsiung-nu. Their political power broke up in the early centuries of this era before the advance of the Sien-pi and Tobas, who appear to have been Tunguses, and from whom arose the Wei dynasty of northern China. In A.D. 433 a Hiung-nu clan called Asena or A-shih-na, disliking the rule of the Wei, moved eastwards and sought the protection of a people called Jeu-Jen or Jwen-Jwen, who were also a kind of Hiung-nu. They are the Geougen of Gibbon and others, and their identity with the Avars has been affirmed and disputed with equal confidence. The Asena served the Jwen-Jwen as workers in iron and lived not far from the modern city of Shan-Tan in Kan-suh. In this neighbourhood was a hill called from its shape Túrkü, Durkü or T'u-chueh, meaning helmet, and this is said to be the origin of the national name which has become so celebrated. The name Tu-Kiue (Tou-Kiue) or Turk is first used by the Chinese in recording the events of A.D. 545, and the following years, when the Turks, or descendants of the Asena, revolted against the Jwen-Jwen. These latter were crushed and disappear from history, at least under that name. The victorious Turks advanced across their territory, came into collision with the Hephthalites or Ephthalites (*q.v.*), whom they defeated, and are heard of on the Oxus (*q.v.*), about A.D. 560. The period 546–582 marks the first brilliant epoch of early Turkish history. The tribes were not divided and made the most astonishing advance under Tumen (who took the title of Ili-Khan), his brother Itsämi or She-ti-mi (perhaps the Stembis of Greek writers), his son Mokan and Istämi's son Tardu or Ta-t'eu. Though fifty years before only a servile clan in China, they sent an embassy in 567 to the East Roman emperor Justin II., as related by Menander Protector (C. Muller: *Fragm. hist. graec.*, vol. iv). In 598 the khan Tardu wrote to the emperor Maurice, and in 620–28 the Turks assisted Heraclius in his campaigns against Persia. Meanwhile the Turks had themselves split into two divisions with separate princes. A tendency towards division, very natural in so loose and extended a community, had been visible for some time, and the rupture was precipitated in 582 by the jealousy of Ta-lo-pien or Dalobian, who was angry at not being chosen khan. For a century and a half or so we hear of two khanates: the northern Turks, living near Lake Baikal and the southern tributaries of the Yenisei, and the western Turks, who appear to have had two headquarters, one near Urumchi and one near Aulieata, north of Tashkent. But their conquests, or at least their successful raids, extended very much farther to the west and south. In 630 the Chinese pilgrim Yüan Chwang (Hsüan Tsang) was well received by their khan, T'ung-she-ho, who exercised some kind of authority from Turfan to Merv. The Chinese followed a consistent policy of spreading dissension among these dangerous tribes and of supporting the factions that were weak or distant against those that were strong or near. Accordingly they were friendly to the western Turks until they had conquered the northern Turks. This western branch lasted until about 750 as a political name. From about 550 till 650 they were independent, and, as mentioned, allies of the east Roman Empire against the Persians. But about 650 the politics of the Nearer East were transformed by the conquests of the Arabs following on the preaching of Mahomet. After subduing Persia in 639 they spread to Transoxiana. At the same time dissension prevailed among the western Turks themselves: the five tribes called Nu-she-pi, who lived west of Issyk-kul, quarrelled with the five tribes called Tu-lu living to the east of it. The Chinese fomented the quarrel, and in 659 were able to declare that they annexed the whole territory of the western Turks, including at least Dzungaria, Tashkent, Ferghana, Bokhara, Khulm, Badakshan, Ghazni, Bamian, Udyana, Wakhan and Karateghin. But it would seem that neither the Turkish occupation nor the Chinese annexation of most of these countries was effective From 650 to 750 the possession of them was disputed not only by the Turks and Chinese but by the Tibetans in the east and the Arabs in the west. In the west, the campaigns of Qotaiba b. Muslim or Kutaiba (705–14) completed the Mohammedan conquest of Transoxiana (*see* CALIPHATE, sect. B § 6).

For the history of the northern Turks our only authorities are the Orkhon inscriptions and Chinese writers. The half-century following on the division was prosperous for the northern as well as for the western Turks, and they menaced China; but in 630 the Chinese conquered them. This is the Chinese servitude mentioned in the inscriptions. In 682 Kutluk (also called Elteres, which seems to be a title) re-established a Turkish state on the Orkhon. He was succeeded by his brother Kapagan (or Me-Chuo), who subdued the Turgäsh, or perhaps merely drove them southwards, early in the 8th century, and was succeeded by Bilgä Kagan of the inscriptions

This northern khanate was destroyed by a coalition of the Karluk, Uighur and Basmal in 744. These peoples, like the Turgäsh, appear to have been Turkish A succession of these pressed forward from the east When first heard of, the Karluk inhabited the country on the Irtysh and the Urungu, and subsequently occupied Teles and Tokmak. The Uighurs belonged to the group of tribes known as Tolös or T'ie-le and established themselves at Balasaghun (also known by the forms Kara-Balghasun, Kara-Balgassun and Balagasun: *see* KARAKORUM) This brings us to the middle of the 8th century For the next two hundred years the Turkish element in Central Asia, though it must have been numerous, does not cut any figure in history, which is filled with the chronicles of Arab and Persian dynasties (*see* CALIPHATE, SAMANIDS), but in the 10th century we begin to hear of it again. Turkish adventurers founded the dynasty of Ghaznevids at Ghazni, and there was a Uighur kingdom in the east comprising Kashgar and Khotan Boghra Khan, the ruler of this kingdom, was converted to Islam at the end of the 10th century, and it continued under various branches of Uighurs until 1120 More important politically is the rise of the Seljuks They were the princely family of the Kabaks, who were a section of the group of tribes called Ghuzz (Oghuz, Οὔζοι), and are heard of in Transoxiana about 985. Their chieftains Toghrul and Chakir drove the Ghaznevids to India and established themselves as protectors of the Abbasid caliph, who formally ceded his temporal power to them (For the history of the dynasty *see* SELJUKS.) Alp Arslan, the son of Chakir, defeated the Byzantines at Manzikert (1071), and prepared the way for the Ottoman conquests. His son Malik Shah ruled over nearly all the modern Turkey in Asia, and as far as the frontiers of China. On his death in 1092 his empire broke up into several pieces Konia became the capital of the sultanate of Asia Minor and various Seljuk dynasties established themselves in Kerman, Irak and Syria. A new Turkish power was founded by the khans of Khiva, who are known as the Khwarizm-shahs. They were originally vassals of the Seljuks, with the title of tasdar or ewer-bearer, but became independent and conquered Khorasan and Irak. They had, however, to contend with yet another new arrival from the east, the Kara-Kitais. These also were probably Turks, and were pushed westwards from China by the Kins. They conquered Kashgar, Khotan, Yarkand and later Transoxiana, pushing the Ghuzz tribes before them into Persia and Afghanistan. Their prince bore the title of *gur-khan*, and the Khwarizm shahs did homage to him till

1208, when they unsuccessfully revolted. But all these squabbling principalities were swept away in 1219 by the extraordinary wave of invasion which surged across Asia to Europe under Jenghiz Khan (*q.v.*) After the death of Jenghiz his conquests were divided, and Transoxiana, Kashgar, Badakshan, Balkh and Ghazni were given to his second son Chagatai or Jagatai. Jenghiz and his family must have been Mongols, but the name Jagatai passed to the population and language of the countries about the Oxus. In 1321 the Jagatai khanate split into two khanates, Transoxiana and Dzungaria, and in 1370 collapsed before Timur. This great conqueror (1333–1404), who like Jenghiz had an extraordinary power of collecting and leading the hordes of Central Asia, was a native of the district of Samarkand and a Turk by descent. He conquered successively Dzungaria (1370), Persia and the Caucasus (1390), the Kipchaks on the Volga (1395), and Northern India (1398). He then invaded Syria and Asia Minor, where he defeated but did not annihilate the Osmanlis The house of Timur did not retain his more distant conquests, but they ruled at Samarkand until 1499 with the usual struggles between different branches of the family. Their possessions included, at least from time to time, the northern parts of Afghanistan and Persia, as well as Transoxiana and Turkestan. They were one of the most enlightened and cultivated of Turkish dynasties. They beautified the cities of Central Asia and were patrons of literature The literary languages were as a rule Arabic or Persian; Turkish was used more rarely and chiefly for poetry.

The Timurids were overthrown and succeeded by the Shaibani dynasty, a branch of the house of Juji, Jenghiz Khan's eldest son, to whom his father had assigned dominions in the region north of the kingdom of Jagatai About 1465 a number of this clan migrated into the Jagatai khanate. They were given territory on the Chu River and were known as Uzbegs. About 1500 their chief, Mahommed Shaibani or Shahi Beg, made himself master of Transoxiana and founded the Uzbeg power The chief opponent of the Uzbegs in their early days was Baber, who represented the house of Timur in the fifth generation, but he ultimately led his armies in another direction and invaded India (1526), where he founded the Mogul Empire, a far more important state than the principalities of the Oxus.

The Osmanlis, or house of Osman, the founders of the present Turkish Empire, appear to have been a clan similar to the early Seljuks or the present Turkomans of Transcaspia, who migrated into Asia Minor from Khorasan and made the neighbourhood of Brusa their headquarters Their conspicuous position in history is mainly due to the fact that they attained pre-eminence very late and in districts very near Europe. Except for the invasion of Timur they did not suffer from the attacks of other Turks and they were able to concentrate their strength on the conquest of the decrepit Byzantine Empire *See* TURKEY

TURKS AND CAICOS ISLANDS, a group in the British West Indies, belonging geographically to the Bahamas. They are of coral and sand formation· combined area 169 sq m. The Turks Islands, so named from the cactus resembling a turban, are nine in number; Grand Turk (10 sq m) and Salt Cay (5½ sq.m.) are the largest. The town of Grand Turk is the seat of government and a port of registry. Salt Cay has a good harbour The Caicos Islands lie north-west of Turks Islands and are seven in number. Cockburn Harbour on South Caicos, 22 m. from Grand Turk, is a port of entry. The climate is healthy. Drinking water is scarce, the rainfall being only 27½ in. The mean temperature is 82° F, but owing to the sea breezes the climate is not oppressive. Hurricanes are not infrequent. Salt raking is the staple industry. Sisal hemp is grown and some cotton. Sponges are plentiful and there are four curing factories. The exports, chiefly to the United States, include salt, sponges and sisal hemp. Grand Turk has a cable to Bermuda, Kingston and Jamaica, some 420 m. to the S.W The islands were uninhabited when, about 1678 the Bermudians began to visit them to rake salt. In 1710 the British were expelled by the Spaniards, but they returned and the salt trade (largely with America) continued despite attacks by Spaniards and French, and counter-claims by the British authorities at the Bahamas, who about 1765 made good their claim. In 1799 the islands were given representation in the Bahamas Assembly, but in 1848, on the petition of the inhabitants they were made a separate colony under Jamaica, to which island, in 1873, they were annexed. They are governed by a commissioner assisted by a nominated legislative board Population (est. 1925) 5,500; 200 white, the rest negro or mulatto, about 1,570 live in Grand Turk.

See the *Jamaica Handbook* (London, yearly) and Sir C. P Lucas, *Historical Geography of the British Colonies,* vol. ii (2nd ed, Oxford, 1905).

TURKU, formerly ABO, a seaport of Finland on the Gulf of Bothnia. Pop. (1925) 61,031. It is the second largest town in Finland, and has a shipbuilding and repairing industry. An ice-breaker keeps the port open throughout the winter. There are four entrances to the harbour, with lighthouses for each, and there are four patent slips capable of taking vessels up to 1,200 tons. The chief imports are salt, salt-fish, pig-iron, oils, coal, cotton, machinery and colonial goods and the exports timber, grain, butter, bar-iron, pork, beef and game. There is a considerable coasting trade. When the Estates of Finland seceded from Sweden and accepted the Emperor of Russia as their grand duke at the Diet of Borgå in 1809, Turku became the capital of the new state, but in 1819 the government was moved to Helsinki In June 1929 it celebrated its 700th anniversary.

TURKU-PORI (ÅBO-BJORNEBORG), a department in the south-west of the republic of Finland Area (in English square miles), 8,934. Pop. (1925), 512,013. It is a lowland region containing much boulder-clay soil and a consequent imperfect drainage. The department, together with most of Finland, has not yet recovered from the effects of severe glaciation. Finnish and Swedish are spoken by the inhabitants. The chief towns are Turku (Abo), pop. (1925), 61,031; and Pori (Björneborg), 17,456

TURMERIC, the tuberous rhizomes of *Curcuma longa,* an herbaceous perennial plant belonging to the family Zingiberaceae. It is a native of southern Asia, being cultivated on a large scale both on the mainland and in the islands of the Indian Ocean. Turmeric has been used from a remote period both as a condiment and as a dyestuff, and was once employed to a more limited extent as a medicine In Europe it is employed chiefly as a dye, also as an ingredient in curry powder and as a chemical test for alkalies The root (rhizome) is prepared by cleaning it and drying it in an oven. There are several varieties (Madras, Bengal, Gopalpur, Java, China and Cochin turmeric), differing chiefly in size and colour of the tubers and to a slight degree in flavour All are hard and tough, but break with a short resinous or waxy fracture; the exposed surface varies in tint from an orange brown to a deep reddish brown The colour is due to *curcumin,* $C_{21}H_{20}O_6$, of which the drug contains about 0·3%. When pure it forms yellow crystals having a vanilla odour and exhibiting a fine blue colour in reflected light. On oxidation with potassium permanganate it gives vanillin, the flavouring and odorous material of vanilla (*q v.*). It is soluble in alcohol, in chloroform, but only sparingly in water. Paper tinged with a tincture of turmeric exhibits on the addition of an alkali a reddish brown tint, which becomes violet on drying, a test for alkalinity discovered by H. A. Vogel in 1815.

TURNEBUS, ADRIANUS [ADRIEN TURNEBE] (1512–1565), French classical scholar, was born at Les Andelys in Normandy, and at the age of 12 was sent to Paris to study. After having held the post of professor of belles-lettres in the University of Toulouse, in 1547 he returned to Paris as professor (or royal reader) of Greek at the Collège Royal. In 1552 he was entrusted with the printing of the Greek books at the royal press, in which he was assisted by his friend, Guillaume Morel (*q v.*). He died of consumption on June 12, 1565 His works chiefly consist of philological dissertations, commentaries (on Aeschylus, Sophocles, Theophrastus, Philo and portions of Cicero), and translations of Greek authors into Latin and French. His son, Etienne, published his complete works, in three volumes (Strasbourg, 1600), and his son Adrien his *Adversaria,* containing explanations and emendations of numerous passages in classical authors

See *Oratio funebris* by Léger du Chesne (Leodegarius a Quercu) prefixed to the Strasbourg edition; L. Clément, *De Adriani Turnebi praefationibus et poematis* (1899); J. E. Sandys, *History of Classical Scholarship* (1908) iii.

TURNER, CHARLES (1774–1857), English engraver, was born at Woodstock on Aug. 31, 1774. He entered the schools of the Royal Academy in 1795; and, engraving in stipple in the manner of Bartolozzi, he was employed by Alderman Boydell. His finest plates, however, are in mezzotint, a method in which he engraved J. M W Turner's "Wreck" and 24 subjects of his *Liber studiorum*, Reynolds's "Marlborough Family," and many of Raeburn's best portraits, including those of Sir Walter Scott, Lord Newton, Dr Hamilton, Professors Dugald Stewart and John Robinson, and Dr Adam. He also worked after Lawrence, Shee and Owen. He was an admirable engraver, large, broad and masterly in touch He died on Aug 1, 1857.

TURNER, FREDERICK JACKSON (1861–), American historian, was born at Portage, Wis., on Nov 14, 1861, and educated at the University of Wisconsin (A B., 1884; A M, 1888) and Johns Hopkins (Ph.D., 1890). He was assistant professor, 1889–91 and professor, 1892–1910, of American history at the University of Wisconsin From 1910 to 1924 he was professor of history at Harvard, and afterwards professor emeritus. In 1927 he went to San Gabriel, Calif., to assume direction of research in the *Americana* of the large Henry E Huntington library His publications are few but they have been of great importance in their influence upon the interpretation and the writing of American history In his essay "The Significance of the Frontier in American History," first published in the *Report of the American Historical Association* for 1893, he set forth the thesis that the frontier was up to that date the most influential factor in American history and in the development of a distinctly national character Various other essays collected in *The Frontier in American History* (1921) amplify various phases of his thought and illustrate it by type studies His viewpoint was also illustrated in his excellent study *The Rise of the New West* (1906) in the American nation series Turner's students are numerous among American history teachers and writers of mid-west universities and historical societies, and through their agency, perhaps more than through his writings, his ideas have been made vital in American historiography.

TURNER, JOSEPH MALLORD WILLIAM (1775–1851), English painter, was born in London on April 23, 1775. His father, William Turner, a native of Devonshire, kept a barber's shop at 26 Maiden Lane, Covent Garden His mother died insane. The earliest known drawing by Turner, a view of Margate Church, dates from his ninth year. His father taught him to read, and this and a few months at a school at New Brentford and afterwards at Margate were all the schooling he ever had, he never mastered his native tongue Yet, one of his strongest characteristics was a taste for associating his works with personages and places of legendary and historical interest.

Early Training.—By the time Turner was thirteen he had chosen an artist's career. In 1788–89 he was receiving lessons from Palice, "a floral drawing master;" from T. Malton, a perspective draughtsman; and from Hardwick, an architect. He also attended Paul Sandby's drawing school in St Martin's Lane. Part of his time was employed in making drawings at home, which he exhibited for sale in his father's shop window, two or three shillings being the usual price. He coloured prints for engravers, washed in backgrounds for architects, went out sketching with Girtin, and made drawings in the evenings for Dr. Munro "for half a crown and his supper." In 1789 Turner became a student of the Royal Academy. He also worked for a short time in the house of Sir Joshua Reynolds. In 1790 he exhibited for the first time at the Royal Academy, a "View of the Archbishop's Palace, Lambeth." About 1792 he received a commission from Walker, the engraver, to make drawings for his *Copper-Plate Magazine*, and this topographical work took him to many interesting places. A year or two after he accepted a similar commission for the *Pocket Magazine*, and before his twentieth year he had travelled over many parts of England and Wales. None of these magazine drawings is remarkable for originality or for artistic feeling.

Until 1792 Turner's practice had been almost exclusively in water colour, and his early works show how much he was indebted to some of his contemporaries, such as J. R. Cozens. His first exhibited oil picture appeared in the Academy in 1793. In 1794–95 Canterbury Cathedral, Malvern Abbey, Tintern Abbey, Lincoln and Peterborough Cathedrals, Shrewsbury, and King's College Chapel, Cambridge, were among the subjects exhibited, and during the next four years he contributed no less than thirty-nine works to the Academy. In the catalogue of 1798 he first began to add poetic quotations to the titles of his pictures, showing that his mind was now occupied with something more than the merely topographical element of landscape, Milton's *Paradise Lost* and Thomson's *Seasons* being laid under frequent contribution for descriptions of sunrise, sunset, twilight or thunderstorm. Turner's first visit to Yorkshire took place in 1797. It seems to have braced his powers and possibly helped to change the student into the painter. Until then he was little more than a painstaking and tolerably accurate topographer; but even under these conditions he had begun to attract the notice of his brother artists and of the critics. The only formidable rivals Turner had to contend with were De Loutherbourg and Girtin, and after the death of the latter in 1802 he was left undisputed master of the field

(1799–1804).—In 1799 he was elected A R A. (age 24), and by 1800 had moved to Harley Street. He was elected R.A in 1802 He enjoyed the dignity of Academician for nearly half a century, and he took an active share in the direction of the Academy's affairs. His speeches are described as "confused, tedious, obscure, and extremely difficult to follow", but at council meetings he was ever anxious to allay anger. His opinions on art were always listened to with respect; but on matters of business it was often difficult to know what he meant His friend Chantrey used to say, "He has great thoughts, if only he could express them " When appointed professor of perspective to the Royal Academy in 1808, this painful lack of expression stood greatly in the way of his usefulness Ruskin says, "The zealous care with which Turner endeavoured to do his duty is proved by a series of large drawings, exquisitely tinted, of the most difficult perspective subjects, illustrating not only directions of line, but effects of light, with a care and completion which would put the work of any ordinary teacher to utter shame " With his election to the associateship of the Academy Turner's early struggles may be considered to have ended He abandoned topographical fidelity and began to paint his dreams, the visionary faculty—the true foundation of his art—asserting itself, nature being used to supply suggestions and materials His work is described by Ruskin as "stern in manner, reserved, quiet, grave in colour, forceful in hand."

Turner's visit to Yorkshire in 1797 was followed a year or two later by a second, when he made the acquaintance, which afterwards ripened into a long and staunch friendship, of Fawkes of Farnley Hall. From 1803 till 1820 Turner was a frequent visitor at Farnley The large number of his drawings still preserved there—English, Swiss, German and Italian, the studies of rooms, outhouses, porches, gateways, of birds shot while he was there, and of old places in the neighbourhood—prove the frequency of his visits and his affection for the place. Turner visited Scotland in 1800, and in 1801 or 1802 he made his first tour on the Continent. In the following year, of the seven pictures he exhibited, six were of foreign subjects, among them "Bonneville," "The Festival upon the Opening of the Vintage of Mâcon," and the well-known "Calais Pier" in the National Gallery. The last-named picture, although heavily painted and somewhat opaque in colour, is magnificently composed and full of energy. In 1802 he took his father, who still carried on the barber business in Maiden Lane, to live with him. Turner was never the same man after his father's death in 1830, when he lived a solitary life.

The Liber Studiorum.—In 1804 Turner made a second tour on the Continent, and in the following year painted the "Shipwreck" and "Fishing Boats in a Squall" (in the Ellesmere collection), seemingly in direct rivalry of Vandervelde, in 1806 the "Goddess of Discord in the Garden of the Hesperides" (in rivalry of Poussin), and in 1807 the "Sun rising through Vapour" (in

rivalry of Claude). The last two are notable works, especially the "Sun" In after years it was one of the works he left to the nation, on the special condition of its being hung beside the Claudes in the National Gallery. In this same year (1807) Turner commenced his most serious rivalry. Possibly it arose out of a desire to break down Claude worship—the then prevailing fashion—and to show the public that there was a living artist not unworthy of taking rank beside him. That the *Liber studiorum* was suggested by the *Liber veritatis* of Claude, and was intended as a direct challenge to that master, is beyond doubt. There is, however, a certain degree of unfairness to Claude in the way in which the challenge was given Claude made drawings in brown of his pictures as they left the easel, not for publication, but merely to serve as private memoranda. Turner's *Liber* drawings had no such purpose, but were intended as a direct appeal to the public to judge between the two artists The first of the *Liber* drawings was made in the autumn of 1806, the others at intervals till about 1815 They are of the same size as the plates and carefully finished in sepia He left over fifty of these to the National Gallery The issue of the *Liber* began in 1807 and continued at irregular intervals till 1819, when it stopped at the fourteenth number Turner had resolved to manage the publishing business himself, but in this he was not very successful He soon quarrelled with his engraver, F C. Lewis, on the ground that he had raised his charges from five guineas a plate to eight He then employed Charles Turner, who agreed to do fifty plates at the latter sum, but, after finishing twenty, he too wished to raise his price, and, as a matter of course, this led to another quarrel. Reynolds, Dunkarton, Lupton, Say, Dawe and other engravers were afterwards employed—Turner himself etching and mezzotinting some of the plates

Each part of the *Liber* contained five plates, the subjects, divided into "historical," "pastoral," "marine," etc, embracing the whole range of landscape art Seventy-one plates in all out of one hundred were published (including one as a gift of the artist to his subscribers); ten other plates—more or less completed—intended for the fifteenth and sixteenth numbers were never published, the work being stopped for want of encouragement. The merit of the plates is unequal; some—for example, "Solway Moss," "Inverary Pier," "Hind Head Hill," "Ben Arthur," "Rizpah," "Junction of the Severn and Wye" and "Peat Bog"—are of great beauty, while a few are comparatively tame and uninteresting. Among the unpublished plates "Stonehenge at Daybreak," "The Stork and Aqueduct," "The Via Mala," "Crowhurst," and "Moonlight off the Needles" take a high place The *Liber* shows strong traces of the influence of Cozens and Girtin, and, as a matter of course, of Claude. A good deal has been written about Turner's intention, and the 'lessons" of the *Liber studiorum*. Probably his only intention in the beginning was to show what he could do, to display his art, to rival Claude, perhaps to educate public taste, and at the same time make money Already in this work are seen strong indications of one of his most remarkable characteristics—a knowledge of the principles of structure in natural objects; mountains and rocks are drawn, not with topographical accuracy, but with what appears like an intuitive feeling for geological formation; and trees have also the same expression of life and growth in the drawing of stems and branches. This instinctive feeling in Turner for the principles of organic structure is described in the fourth volume of *Modern Painters*.

A curious example of the *reasonableness* accompanying his exercise of the imaginative faculty is to be found in his creations of creatures he had never seen, as, for example, the dragon in the "Garden of the Hesperides" and the python in the "Apollo," exhibited in 1811. Both these monsters are imagined with such vividness and reality, and the sense of power and movement is so completely expressed, that the spectator never once thinks of them as otherwise than representations of actual facts in natural history. He was further aided by a memory of the most retentive kind. A good illustration of this may be seen at Farnley Hall in a drawing of a "Man-of-War taking in Stores." Some one, who had never seen a first-rate, expressed a wish to know what it looked like. Turner took a blank sheet of paper, outlined the ship, and finished the drawing in three hours.

From 1813 till 1826, in addition to his Harley Street residence, Turner had a country house at Twickenham. He kept a boat on the river, also a pony and gig, in which he used to drive about the neighbouring country on sketching expeditions The pony, for which Turner had a great love, appears in his well-known "Frosty Morning" in the National Gallery. In 1813 Turner commenced the series of drawings, forty in number, for Cooke's *Southern Coast*. This work was not completed till 1826. The price he at first received for these drawings was £7, 10s. each, afterwards raised to £13, 2s 6d

"Crossing the Brook" appeared in the Academy of 1815. It marks the transition from his earlier style to that of his maturity. It represents a piece of Devonshire scenery, a view on the river Tamar. In design and execution this work is founded upon Claude. The colour scheme is limited to greys and quiet greens for the earth and pale blues for the sky. It is a sober but very admirable picture, full of diffused daylight "Dido Building Carthage" also belongs to this period It hangs beside the Claudes in the National Gallery. Towering masses of Claudesque architecture piled up on either side, porticoes, vestibules, and stone pines, with the sun in a yellow sky, show the Carthage imagined

Middle Period.—In 1818 Turner was in Scotland making drawings for the *Provincial Antiquities*, for which Sir Walter Scott supplied the letterpress, and in 1819 he visited Italy for the first time. From this time his works became remarkable for their colour Hitherto he had painted in browns, greys and blues, using red and yellow sparingly He had gradually been advancing from the sober grey colouring of Vandervelde and Ruysdael to the mellow and richer tones of Claude His works now begin to show a heightened scale of colour, gradually increasing in richness and splendour and reaching its culminating point in such works as "Ulysses," "Childe Harold's Pilgrimage," "The Golden Bough," and "The Fighting Téméraire" All these works belong to the middle period of Turner's art (1829–1839), when his powers were entirely developed. Much of his most beautiful work at this period is to be found in his water-colour drawings: those executed for Whitaker's *History of Richmondshire* (1819–1821), for Cooke's *Southern Coast* (1814–26), for *The Rivers of England* (1824), for *England and Wales* (1829–38), *Provincial Antiquities* (1826), Roger's *Italy* (1830), Scott's *Works* (1834), and *The Rivers of France* (1833–35) are in many instances of the greatest beauty.

One of the great services Turner rendered to the art of England was the education of a whole school of engravers. His best qualities as a teacher came from the union of strength and delicacy in his work, subtle and delicate tonality was almost a new element for the engraver to deal with, but with Turner's teaching and careful supervision his engravers by degrees mastered it more or less successfully, and something like a new development of the art of engraving was the result. No better proof can be found of the advance made than by comparing the work of the landscape engravers of the pre-Turnerian period with the work of Miller, Goodall, Willmore, Cooke, Wallis, Lupton, C. Turner, Brandard, Cousen, and others who worked under his guidance The art of steel engraving reached its highest development in England at this time Roger's *Italy* (1830) and his *Poems* (1834) contain perhaps the most beautiful and delicate of the many engravings executed after Turner's drawings They are vignettes, a form of art which Turner understood well "The Alps at Daybreak," "Columbus Discovering Land," and "Datur Hora Quieti" are superb.

In 1828 Turner paid a second visit to Italy, this time of considerable duration, on the way visiting Nîmes, Avignon, Marseilles, Genoa, Spezzia and Siena, and in the following year he exhibited the "Ulysses Deriding Polyphemus," now in the National Gallery. It marks the beginning of the central and best period of Turner's power The picture is of great power and splendour. The painting throughout is magnificent, especially in the sky. From this period till 1840 Turner was entirely absorbed in his art, and so isolated. Between 1829 and 1839 he sent fifty-five pictures to the Royal Academy, painted many others on private commission, made over four hundred drawings for engravers, besides thousands of studies and sketches from nature.

Later Work.—The first of Turner's Venetian pictures ("Bridge of Sighs, Ducal Palace and Custom House, Venice, Canaletto Painting") appeared in the Academy in 1833. Compared with the sober work of Canaletto, Turner's pictures of Venice appear like poetic dreams. Splendour of colour generally characterize them. Venice appeared to him "a city of rose and white, rising out of an emerald sea against a sky of sapphire blue." Many of these Venetian pictures belong to his later manner, and some of them, "The State Procession bearing Giovanni Bellini's Pictures to the Church of the Redeemer" (exhibited in the Royal Academy, 1841), "The Sun of Venice Going to Sea" (1843), "Approach to Venice" (1844), and "Venice, Evening, Going to the Ball" (1845), to his latest. As Turner grew older his love of brilliant colour and light became more and more a characteristic.

"The Fighting Téméraire Tugged to her Last Berth to be Broken Up" was exhibited in the Academy of 1839 Turner had all his life been half a sailor at heart many of his best pictures are sea pieces Hence the pathetic feeling he throws around the old three-decker, looking ghostly and wan in the evening light. "The Slave Ship," another important sea picture, was exhibited in the following year, and in 1842 "Peace. Burial at Sea," commemorative of Wilkie. His faculty for colour remained unimpaired almost to the end. He paid his last visit to the Continent in 1843, avoiding his own countrymen, an old and solitary man.

In 1850 he exhibited for the last time He had given up attending the meetings of the Academicians; none of his friends had seen him for months, and even his old housekeeper had no idea of his whereabouts Turner's mind had evidently given way, and with that love of secrecy which in later years had grown into a passion he had gone to hide himself in a corner of London. He had settled as a lodger in a small house in Chelsea, overlooking the river, kept by his old Margate landlady, Mrs Booth To the children in the neighbourhood he was known as "Admiral Booth" His short, sailor-like figure may account for the idea that he was an impoverished old naval officer. He had been ill for some weeks, and when his Queen Anne Street housekeeper at last discovered his hiding-place she found him sinking, and on the following day, Dec 19, 1851, he died. He was buried in St Paul's Cathedral, in deference to his wish. He left a large fortune (about £140,000) to found a charity for the "maintenance and support of male decayed artists, being born in England, and of English parents only, and of lawful issue" His pictures he bequeathed to the nation, on condition that they were exhibited in rooms of their own, and that these rooms were to be called "Turner's Gallery." The will and its codicils were so confused that after years of litigation, during which a large part of the money was wasted in legal expenses, it was found impossible to decide what Turner really wanted A compromise was effected, his next-of-kin inheriting the bulk of his property The Royal Academy got £20,000 and the nation got all the pictures and drawings (now housed in the National Gallery and in the Tate gallery in rooms erected by the generosity of Sir Joseph Duveen. Of the 282 pictures and studies, 199 are now framed and exhibited Of the collection of drawings numbering over 19,000 only a part are on exhibition).

In 1843 a champion, in the person of John Ruskin, arose to defend Turner against the unjust and ignorant attacks of the press, and what at first was intended as a "short pamphlet, reprobating the manner and style of these critics," grew into the five volumes of *Modern Painters* Ruskin employed all his eloquence and his great critical faculty to prove how immeasurably superior Turner was to all who had ever gone before, hardly restricting his supremacy to landscape art, and placing him among the "seven supreme colourists of the world"

Bibliography —*See* · Ruskin, *Modern Painters* (1843–60); *Harbours of England* and *Notes on the Turner Gallery at Marlborough House* (1856); Wornum, *The Turner Gallery* (1859); Burnet, Cunningham and Murray, *Turner and his Works* (1859); *Notes on his drawings by Turner* (1878); Thornbury, *Life* (1862 and 1877); P. G. Hamerton, *Life* (1879); C. Monkhouse, *Turner* (1879); F. Wedmore, *Turner and Ruskin* (1900); Sir W. Armstrong, *Turner* (1902) with list of works by E Dillon; W. L. Wyllie, *Turner* (1905); W. G. Rawlinson, *Turner's Liber Studiorum*, 2nd ed. (1906); *The Engraved Work of Turne* (1908); C. Mallord Turner, *The Family History of the late J. M Turner* (1902); *Catalogue of the Turner Collection* (Tate Galler 1920), *A complete inventory of the drawings of the Turner Beques* with which are included the 23 drawings bequeathed by M. H Vaughan, arranged chronologically by A. J. Finberg (1909); D. S MacColl, *Turner's Lectures at the Academy*, Burlington Magazin (1908). (G. Re.; X.)

TURNER, NAT (1800–1831), the negro leader of a slav insurrection in Virginia, known as the "Southampton insurrec tion," was born in Southampton county, Va., in 1800. From hi childhood he claimed to see visions and hear voices, and he becam a Baptist preacher of great influence among the negroes. In 182 he confided to a few companions that a voice from heaven ha announced that "the last shall be first," which was interpreted t mean that the slaves should control. An insurrection was planned and a solar eclipse in Feb., 1831, and peculiar atmospheric condi tions on Aug 13, were accepted as the signal for beginning th work. On the night of Aug 21, 1831, with seven companions, h entered the home of his master, Joseph Travis, and murdere the inmates. After securing guns, horses and liquor they visite other houses, sparing no one. Recruits were added, in some case by compulsion, until the band numbered about 60. About noon o the 22nd they were scattered by a small force of whites, hastil gathered Troops, marines and militia were hurried to the scene and the negroes were hunted down In all 13 men, 18 women an 24 children had been butchered. After hiding for several week Nat was captured on Oct 30, and was tried and hanged, havin made, meanwhile, a full confession Nineteen of his associate were hanged and 12 were sent out of the State. The insurrection which was attributed to the teachings of the abolitionists, led t the enactment of stricter slave codes

See S. B Weeks, "Slave Insurrections in Virginia," in *Magazin of American History*, vol xxxi. (1891), and W. S. Drewry, *Th Southampton Insurrection* (Washington, 1900)

TURNHOUT, town in the province of Antwerp, Belgium 26 m N E of that city Pop (1925), 25,207 It carries on a active industry in cloth, playing cards and other manufactures There is a breeding establishment for leeches. The hôtel de vill was formerly a palace of the dukes of Brabant Two miles wes of Turnhout is the curious penal or reformatory colony of Merx plas (pop. in 1904, 2,827) The system of this establishment i to allow certain approved prisoners to follow their usual occupa tions within a defined area

TURNIP (*Brassica Rapa*) a hardy biennial, which has bee cultivated from a remote period for its fleshy roots. The tende growing tops are also used in spring as a green vegetable Th so-called "root" is formed by the thickening of the primary roo of the seedling together with the base of the young stem (hypo cotyl) immediately above it. The great mass of the "root" con sists of soft "wood" developed internally by the cambium laye and composed mainly of thin-walled, unlignified, wood-paren chyma. The stem remains short during the first year, the leave forming a rosette-like bunch at the top of the "bulb"; they ar grass-green and bear rough hairs In the second season the bu in the centre of the rosette forms a strong erect branched sten bearing somewhat glaucous smooth leaves. The stem and branche end in corymbose racemes of small, bright yellow flowers, whic are succeeded by smooth, elongated, short-beaked pods

The turnip probably originated in Europe or western Asia an by cultivation has spread throughout the temperate zone

The varieties of turnip are classified according to their shap as (1) long varieties, with a root three or more times as long a broad; (2) tankard or spindle-shaped varieties, with a root abou twice as long as broad; (3) round or globe varieties with a almost spherical root; (4) flat varieties with a root broader tha long; there are also many intermediate forms. Turnips are als grouped according to the colour of the upper part of the roo which comes above ground, and according to the colour of th flesh, which is white or yellow. The yellow-fleshed varieties which are not hybrids between the turnip and swede, are mor robust, of slower growth and superior feeding value to the white fleshed turnips, and are less injured by frost.

The swede-turnips, *Brassica Napo-brassica* and *B. Rutabaga* differ from the turnip proper in having the first foliage-leaves glaucous, not grass-green, in colour, and the later leaves smooth and glaucous; the root bears a distinct neck with well-marked leaf-scars, the flesh is white or yellow, firmer and more nutritious, and the roots keep much better during winter. The white-fleshed forms (*B Napo-brassica*) have a rough, green skin, firm white flesh and are of irregular form. The flowers are of a bright canary colour The yellow-fleshed swede-turnips have a firm yellow flesh, a smooth skin of a green, purple or bronze colour. The flowers are buff yellow or pale orange.

CULTIVATION AND TRADE

Extensive British cultivation of turnips as a forage crop for sheep and cattle was first noticed in Suffolk about 1724; by the middle of the same century the crop had won an important position in the husbandry of Norfolk In 1733 Tull had demonstrated the advantages of drilling and hoeing, but the crop continued to be grown broadcast until after the modern system had established itself in Border farming about 1750.

The adoption of turnip husbandry revolutionized British farming It facilitated winter feeding of stock, the conversion of straw into yard manure for the improvement of the soil, and the reclamation of light and medium soils, which had previously been unproductive under a system that depended on bare fallowing as the means of restoring fertility and freedom from weeds The acreage of turnips increased with the gradual spread of rotation husbandry, the enclosure of commons and the division of open fields into compact holdings The increase continued during the third quarter of the 19th century, in the period of high farming and intensive corn and meat production; but after the commencement of the depression which followed, the acreage began an annual decline which has since been almost regular and continuous

Turnip husbandry is still extensively practised in light-land arable districts that are not well adapted for dairying or other form of pastoral farming Large areas of turnips are mainly associated with barley and sheep, but in some districts the crop is consumed wholly or partly by cattle.

Like mangolds, turnips are capable of producing very large quantities of digestible stock food per acre; and where the production of such nutriment is the principal object in cultivating the crop, as in certain systems of sheep farming and in dairying with little arable land, turnips may occasionally be grown twice in succession on the same field In most cases, however, turnips occupy a place in the rotation in which they serve as a fallow crop, affording opportunities for eradicating weeds that have appeared in preceding corn crops, and otherwise serving as a means of restoring the condition of the land for future corn cultivation

In the preparatory cultivations for turnips, the object of creating soil conditions favourable to the growth of the crop is generally more or less subservient to the processes of cleaning and manuring The two objects can best be combined when it is possible to clean the corn stubble in autumn and to apply the yard manure before the deep ploughing in early winter or before a second or cross ploughing in February. When autumn cleaning is impossible, it is customary to defer the application of the yard manure until spring, when it is applied in the ridges on which the roots are drilled, after the weeds have been extracted by appropriate operations. In some cases, particularly in districts of low rainfall, turnips grown on land that has been cleaned in spring are sown on the flat and receive artificial manures only. The artificials applied in the latter case are typically 1½ cwt. sulphate of ammonia, 5 cwt. superphosphate and 1 cwt muriate of potash per acre.

Swedes are drilled in May in districts north of the Trent and in June farther south, where earlier sowing predisposes the crop to attack of turnip flea beetle and mildew. Yellow turnips are sown about a month later than swedes, but are harvested—where not consumed on the land by sheep—about the same time, November. White turnips may be sown at different times in the summer: they are almost invariably fed without previous storage. White turnips are also frequently sown broadcast and not further cultivated or thinned Swedes and yellows, however, are usually drilled in rows about 24 in apart and afterwards thinned out to 10-in intervals, and horse- and hand-hoed two or three times during the summer

Swedes contain a higher percentage of dry matter, and also of digestible nutrients, than yellow turnips, which in their turn are richer than white turnips. Ton for ton, therefore, the order of feeding value is: swedes, yellow turnips, white turnips

There is no extensive trade in swedes, though there may occasionally be small farmer to farmer sales, and crops may be sold for feeding off on the field This applies equally to turnips. In some districts also swedes may be sold to green-grocers, much of the south Lancashire crop, for example, being consumed in the towns White turnips are of course specially grown in fairly considerable quantities for table use. (*See* VEGETABLE *Culture in the United States*) (J R B; H C L)

TURNSTONE (*Arenaria interpres*), a shore-bird found on the coasts of every part of the world, but breeding only in the high Arctic. About the size of a snipe, and allied to the plovers (*q v*), the turnstone has short legs and a heavy build The white face, striped with black, the black gorget and white band on the wings are characteristic features. The sexes are alike The bird feeds on small crustacea, worms, etc, which it seeks under stones The nest contains four olive-green eggs, closely blotched with brown. Both male and female incubate

TURNTABLE. A rotary platform which turns wagons carriages, and locomotives. The smallest sizes are less than three feet in diameter and are without rails, being used for light temporary work or with portable tracks In other cases rails are mounted, flush with the surface, for use inside factories or other places subject to foot or wheeled traffic. A circle of small rollers or a ring of balls supports these tables An automatic catch prevents the table from making more than a quarter of a revolution at a time, unless it is desired to move further

In the large tables for carriages and wagons most of the load is carried upon a centre pivot, and the two rollers at each end run on a circular rail or *race*, and function when the load is unbalanced The rollers are attached to steel joists bolted to the main girders and the rollers can be taken off for cleaning at any time. A hand lever enables the table to be readily pulled around, then locked with a wedge which also blocks up the end so taking the load off the wheels When there is insufficient depth available for the pit of an ordinary turntable, the "inverted girder" or "surface type" is installed, the girders being placed upside down in this type of construction. If locomotives cannot be well balanced, or rapid handling is important, power-driven turntables are chosen In the electric tractor system, a wheel resting on the circular race is driven by a motor so as to turn the table in about a minute. Rotating gear on the winch system comprises a barrel pulling on two steel wire ropes so that one pays out while the other winds in. These operate a wheel on the race. Some turntables, for locomotive manufacturing works, carry three tracks (*e g.*, 2 ft 6 in, 4 ft 8½ in, and 5 ft 6 in). The centre-pivot support is not applied in this case, but the uneven loads are sustained by a ring of cast-steel rollers running on the fifty-foot diameter race Some tables are about 85 ft in diameter and take engines up to 267 tons, 5 ft 6 in gauge. The electric tractor drive is fitted to these. Turntables are also used in motor garages and works

TURNU SEVERIN, the capital of the department of Mehedinti, Rumania, on the main Walachian railway, and on the left bank of the river Danube, below the Iron Gates cataracts. Pop (1928) 30,967. It is a modern commercial town, having a school of arts and crafts, several churches, and large government yards for the building of river steamers, lighters and tug-boats. There is a considerable trade in live stock, preserved meat, petroleum and cereals. The town, which was originally called Drobetae by the Romans, took its later name of Turris Severi, or the "Tower of Severus," from a tower built to commemorate a victory over the Quadi and Marcomanni, by the Roman emperor Severus (A.D. 222–235). Near Turnu Severin are the remains of the celebrated Trajan's bridge, the largest in the Roman Empire, built in

A.D. 103 by Apollodorus of Damascus The river is about 4,000 ft. broad at this spot. The bridge of twenty arches was supported by stone pillars, several of which are still visible at low water.

TURNVEREIN, a German institution founded in the early part of the 19th century by Friedrich Ludwig Jahn for the purpose of furthering physical education German settlers established branches in the United States and later their objectives were extended to include the discussion of intellectual, political, social and religious ideas. In 1925, there were in the United States 169 local societies, with a total membership of more than 30,000, not including 6,000 members of women's auxiliaries. Since 1866 they have maintained a normal college at Indianapolis, Ind, for the training of teachers of physical education.

TURPENTINE, the oleo-resins which exude from some conifers—such as *Pinus sylvestris*—and from the terebinth tree, *Pistachia terebinthus, L* It was to the product of the latter, now known as Chian turpentine, that the term was first applied. The tree is a native of the islands and shores of the Mediterranean, passing eastward into central Asia; but the resinous exudation found in commerce is collected in the island of Chios Chian turpentine is a tenacious semi-fluid transparent body, yellow to dull brown in colour, with an agreeable resinous odour and little taste. On exposure to air it becomes dry, hard and brittle Turpentines are semi-fluid bodies, consisting of resins dissolved in turpentine oil, the chief constituent of which is pinene. They are largely used in the arts, being separated by distillation into rosin or colophony (*see* ROSIN), and oil or spirit of turpentine.

Crude or *common turpentine* is the commercial name for the oleo-resin yielded by several coniferous trees, both European and American. The principal European product (Bordeaux turpentine) is obtained from the cluster pine, *Pinus Pinaster,* in the Landes department of France. Crude turpentine is further yielded by the Scotch fir, *P. sylvestris,* and by the Corsican pine, *P Laricio* In the United States the turpentine-yielding pines are the swamp pine, *P. australis,* and the loblolly, *P Taeda,* both inhabiting North and South Carolina, Georgia and Alabama. *Venice turpentine* is yielded by the larch, *Larix europaea; Strassburg turpentine* is obtained from the bark of the silver fir. Less known turpentines are obtained from the mountain pine, *P. Pumilio,* the stone pine, *P. Cembra,* the Aleppo pine, *P. halepensis,* etc The so-called *Canada balsam,* from *Abies balsamea,* is also a true turpentine.

"Turps."—*Oil of Turpentine,* or *Turps,* as a commercial product is obtained from all or any of these oleo-resins, but on a large scale only from crude turpentine The essential oil is rectified by redistillation with water and alkaline carbonates, and the water which the oil carries over with it is removed by a further distillation over calcium chloride Oil of turpentine is a colourless, oily liquid, with a strong odour and a hot disagreeable taste It begins to boil at about 155° C, and its specific gravity is between 0·860 and 0·880. It rotates the plane of polarized light both to right and left in varying degrees according to its sources, the American product being dextrorotatory and the French laevorotatory It is almost insoluble in water, is miscible with absolute alcohol and ether, and dissolves sulphur, phosphorus, resins and caoutchouc. On exposure to the air it dries to a solid resin, and absorbing oxygen gives off ozone. Agitated with successive quantities of sulphuric acid and distilled in a current of steam, it yields terebene, a mixture of dipentene and terpinene mainly, which is used in medicine. Chemically, oil of turpentine is a mixture of terpenes (*q.v.*) It is largely used in the preparation of varnishes and as a medium by painters in their "flat" colours

Pharmacology and Therapeutics.—Oil of turpentine (*Oleum terebinthinae*) is administered internally as an anthelmintic to kill tapeworm. Externally it acts as a rubefacient, an irritant and a counter-irritant. It is also an antiseptic and, in small quantities, a feeble anaesthetic. It is absorbed by the unbroken skin. The drug is largely employed as a counter-irritant, the pharmacopoeial liniments being useful in myalgia, bronchitis, "chronic rheumatism" and pleurisy.

In large doses oil of turpentine causes purging and may induce much haemorrhage from the bowel or kidneys It is readily absorbed unchanged and has a marked contractile action upon the blood vessels. It is a nervous depressant leading even to coma and total abolition of reflex action. The drug is excreted partly by the bronchi and partly in the urine Glycuronic acid also appears in the urine It may give rise to an erythematous rash It must not be given to the subjects of Bright's disease. At the present time its chief uses are as constituents of fomentations and enemata and as a local disinfectant in bronchiectasis (*q.v.*).

Old turpentine and French oil of turpentine are antidotes to phosphorus, forming turpentine-phosphoric acid, which is inert

TURPIN (d *c.* 800), archbishop of Reims, was for many years regarded as the author of the legendary *Historia de vita Caroli Magni et Rolandi,* and appears as one of the twelve peers in a number of the *chansons de geste* He is probably identical with Tilpin, archbishop of Reims in the 8th century, who is alluded to by Hincmar, his third successor in the see. According to Flodoard, Charles Martel drove Rigobert, archbishop of Reims, from his office and replaced him by a warrior clerk named Milo, afterwards bishop of Trier. The same writer represents Milo as discharging a mission among the Vascones, or Basques, the very people to whom authentic history has ascribed the great disaster which befell the army of Charlemagne at Roncesvalles

Flodoard says that Tilpin was originally a monk at St Denis, and Hincmar tells how after his appointment to Reims he occupied himself in securing the restoration of the rights and properties of his church, the revenues and prestige of which had been impaired under Milo's rule Tilpin was elected archbishop between 752 and 768, probably in 753, he died, if the evidence of a diploma alluded to by Mabillon may be trusted, in 794, although it has been stated that this event took place on Sept 2, 800 Hincmar, who composed his epitaph, makes him bishop for over forty years, and from this it is evident that he was elected about 753, and Flodoard says that he died in the forty-seventh year of his archbishopric Tilpin was present at the Council of Rome in 769, and at the request of Charlemagne Pope Adrian I sent him the pallium and confirmed the rights of his church.

The *Historia Caroli Magni* was declared authentic in 1122 by Pope Calixtus II It is, however, entirely legendary, being rather the crystallization of earlier Roland legends than the source of later ones, and its popularity seems to date from the latter part of the 12th century Gaston Paris, who made a special study of the *Historia,* considers that the first five chapters were written by a monk of Compostella in the 11th century and the remainder by a monk of Vienne between 1109 and 1119. There are at least five French translations of the *Historia* dating from the 13th century and one into Latin verse of about the same time. According to Potthast there are about fifty manuscripts of the story in existence The *Historia* was first printed in 1566 at Frankfort, perhaps the best edition is the one edited by F. Castets as *Turpini historia Karoli magni et Rotholandi* (Paris, 1880). It has been translated many times into French and also into German, Danish and English The English translation is by T Rodd and is in the *History of Charles the Great and Orlando, ascribed to Turpin* (London, 1812) *See* G Paris, *De pseudo-Turpino* (Paris, 1865), and *Histoire poétique de Charlemagne,* new ed by P. Meyer (1905); and V. Friedel, "Études compostellanes" in *Otia Merceiana* (Liverpool, 1899).

TURPIN, RICHARD [DICK] (1706–1739), English robber, was born in 1706 at Hempstead, near Saffron Walden, Essex, where his father kept an alehouse. He was apprenticed to a butcher, but, having been detected at cattle-stealing, joined a notorious gang of deer-stealers and smugglers in Essex. On the gang being broken up Turpin went into partnership with Tom King, a well-known highwayman. To avoid arrest he finally left Essex for Lincolnshire and Yorkshire, where he set up under an assumed name as a horse dealer. He was convicted at York assizes of horse-stealing and hanged on April 7, 1739. Harrison Ainsworth, in his romance *Rookwood,* gives a spirited account of a wonderful ride by Dick Turpin on his mare, Black Bess, from London to York. But as far as Turpin is concerned the incident is pure fiction. A somewhat similar story was told about a certain John Nevison, known as "Nicks," a well-known highwayman in the time of Charles II., who to establish an alibi rode from Gad's Hill to York (some 190 m.) in about 15 hours.

TURQUOISE, a mineral much used as an ornamental stone for the sake of its blue or bluish-green colour. It is generally held that the name indicates its source as a stone from Turkey,

the finest kinds having come from Persia by way of Turkey.

Turquoise is a crypto-crystalline mineral, occurring in small reniform nodules or as an incrustation, or in thin seams and disseminated grains. Its mode of occurrence suggests its formation by deposition from solution, and indeed it is sometimes found in stalactitic masses. The typical colour is a delicate sky-blue, but the blue passes by every transition into green In some cases the colour deteriorates as the stone becomes dry, and may be seriously affected by exposure to sunlight; whilst with age there is often a tendency to become green, as seen in examples of ancient turquoise. The mineral is always opaque in mass, but generally translucent in thin splinters Turquoise takes a fair polish, but the lustre is feeble, and inclines to be waxy, the hardness is nearly 6, the specific gravity between 2·6 and 2·8.

Much discussion has arisen as to the chemical composition of turquoise. It is commonly regarded as a hydrous aluminium phosphate having the composition $2Al_2O_3 \, P_2O_5 \, 5H_2O$ or rather $Al_2HPO_4(OH)_4$, coloured with a variable proportion of a copper phosphate, or perhaps partly with an iron phosphate. S L. Penfield (1900), however, was led by careful analysis of turquoise from Nevada to propose the general formula:

$$[Al(OH)_2,Fe(OH)_2,Cu(OH),H]_3PO_4$$

An analysis of minute crystals from Virginia gave the formula $CuO \, 3Al_2O_3 \, 2P_2O_5 \, 9H_2O$ An ingenious counterfeit of turquoise has been formed by compressing a precipitate of cupriferous aluminium phosphate

Turquoise is usually cut as an ornamental stone in circular or elliptical form, with a low convex surface In the East, where it is used not only for personal ornament but for the decoration of dagger-handles, horse-trappings, etc , the pieces are usually of irregular shape In Persia, where the finest turquoise is found, the mines have been worked for at least eight centuries The principal locality is near Nishapur, in the province of Khorasan Here the turquoise occurs in narrow seams in a brecciated trachyte-porphyry. It is found also in some other localities in Persia and in Turkestan In the Sinai Peninsula relics of extensive ancient mining operations for turquoise show that the rock was at one time worked with flint implements The mineral here occurs as nodules in a red sandstone and as an incrustation on the joint-faces

In ancient Mexico much use was made of turquoise as an inlay for mosaic work, with obsidian, malachite, shell and iron pyrites Relics of extensive workings are found in the mountains of Los Cerillos near Santa Fé in New Mexico, where mining for turquoise is now actively carried on One of the hills in which old workings occur has been called Mt Chalchihuitl, since it is believed that the turquoise was known by the name chalchihuitl, which in some places was applied also to jade The matrix at Los Cerillos is an altered augite-andesite, in which the turquoise occurs in thin veins and in small nodules in patches of kaolin

Turquoise is sometimes termed by mineralogists callaite, since it is believed to be the *callais* of Pliny. The name callainite was suggested by J. D Dana for a bright green mineral which was found in the form of beads, with stone hatchets, in ancient graves near Mané-er-H'roek (Rock of the Fairy), near Locmariaquer in Brittany, and which A Damour sought to identify with Pliny's *callais*. The mineral seems to be identical with variscite (*q v.*).

"Bone-turquoise" or odontolite, also known as "occidental turquoise," is merely fossil bone or ivory coloured by iron phosphate (vivianite) or perhaps stained in some cases by cupriferous solutions, and is readily distinguished from true turquoise by showing organic structure under the microscope.

TURRIFF, burgh of Aberdeenshire, Scotland. Pop (1921) 2,152, 38½ m. N.W. of Aberdeen Only the choir and belfry of the ancient church remain. On May 14, 1639, the national struggle for civil and religious liberty was inaugurated in the county with the skirmish known as the Trot of Turriff. Some 4 m. S. are the remains of the castle of Towie Barcley.

TURRIS LIBISONIS (modern Porto Torres, an ancient seaport at the N.W. extremity of Sardinia. It was probably of Roman origin, and in Pliny's time it was the only colony in the island. A Roman bridge of seven arches, the ruins of a temple (now known as Il Palazzo del Re Barbaro), which an inscription found there shows to have been restored (A D 247–249) by the *praefectus* of the province, together with the basilica, an aqueduct, various buildings and some rock tombs, still exist.

TURTLE, the name given to the marine and larger freshwater reptiles of the order Chelonia. (*See* TORTOISE)

TURTLE CREEK, a manufacturing and coal-mining borough of Allegheny county, Pennsylvania, U.S A , 10 m. S E. of Pittsburgh, near the Monongahela river. Pop (1920) 8,138 (84% native white) Electrical goods are the principal products

BY COURTESY OF THE WILD FLOWER PRESERVATION SOCIETY

THE COMMON TURTLE-HEAD, OR SNAKE-HEAD, (CHELONE GLABRA)

TURTLE-HEAD (*Chelone*), a genus of North American herbs of the family Scrophulariaceae (*q v.*), comprising four species, all smooth perennials which bear clusters of showy flowers, the corolla resembling a turtle's head The common turtle-head (*C glabra*), with white flowers, occurs from Newfoundland to Manitoba and southward *C Lyoni* and *C obliqua*, of the south-eastern States, and *C nemorosa*, found from California to Washington, have red or purple flowers

TURTON, urban district, Darwen parliamentary division, Lancashire, England, 4 m north of Bolton on L M S railway Pop (1921) 12,154 It manufactures cotton goods and there are large stone quarries in the vicinity Turton tower, containing some fine contemporary woodwork, dates from the 16th century

TUSCALOOSA, a city of western Alabama, U S A , the county seat of Tuscaloosa county, on the Warrior river and Federal highway 11, 55 m. S.W of Birmingham It has a municipal airport and is served by the Louisville and Nashville and the Mobile and Ohio railways and barges of the Inland Waterways Corporation (Mississippi-Warrior Service) Pop. (1920) 11,996 (38% negroes), estimated locally at 25,000 in 1928 The city lies at the edge of the great coal and mineral deposits of Alabama, in a rich agricultural region There are many fine old residences and gardens, dating from the time (1826–46) when Tuscaloosa was the capital of the State, and the older streets are lined with magnificent water oaks, planted in the years beginning with 1839 Tuscaloosa is the seat of the State home for mentally deficient children, the Bryce (State) hospital for the insane (1861), Stillman Institute (a Presbyterian theological seminary for negroes; 1876), and the University of Alabama, which occupies 300 ac. adjacent to the city limits The university was founded in 1820, on an endowment of 46,080 ac of land, donated by the U.S. Congress in 1819, and it was opened to students in 1831 On April 4, 1865, a body of Federal cavalry set fire to and completely destroyed all the buildings except the astronomical observatory and a little house where the records were kept, and instruction was necessarily suspended until 1869 By way of restitution, a second grant of 46,080 ac was made by Congress in 1884 The enrolment for the year 1926–27 was 6,151, including 2,395 in the extension division Tuscaloosa is the trade centre of a large cotton-growing, lumbering, farming and dairying region Ample hydro-electric power is available from the development on the Coosa river. There are 90 plants in or near the city (including foundries, blast furnaces, coke ovens and paper mills) with an output in 1927 of $106,432 000 The city valuation for 1928 was $16,232,872

Tusca-Lusa ("Black Warrior") was a Choctaw chief (commemorated by a granite monolith in Court House square), who, according to tradition, hanged himself, to escape capture, after a desperate battle with De Soto in 1540 somewhere in this region In 1816 Emanuel York and John Bartow came from Tennessee and settled on the plain where the city now stands. A town site was laid out and the city was chartered in 1819, and in 1825 it was chosen to be the seat of government of the State Industrial development began after the removal of the capital (1846).

TUSCANIA, a town of the province of Rome, Italy, 15 m. N.E. of Corneto by road, 545 ft. above sea-level. Pop. (1921), 4,561 (town), 5,454 (commune). The ancient town lay on the Via Clodia; its Etruscan tombs have yielded valuable antiquities, and remains of a large thermal establishment of the Roman period have also been found. The mediaeval walls with their towers are still preserved. On the ancient citadel hill is the Romanesque church of S. Pietro, belonging to four different periods—739, 1093 (the date of the reconstruction of the crypt), the middle of the 12th and the end of the 12th century. It has the shape of a Roman basilica, with a nave and two aisles and one apse. The elaborate façade with its rose window also belongs to the 12th century. S Maria in the valley below dates from 1050 to 1206, and has a similar façade and a massive square campanile. In the town are two other Romanesque churches. The town was called Toscanella until 1912, when it resumed the name which it bore in ancient Latin times.

TUSCANY (*Toscana*), a territorial division of Italy, consisting of the western part of the centre of the peninsula, bounded north-west by Liguria and Emilia, east by the Marches and Umbria, south-east by the district of Lazio and west by the Mediterranean. It consists of nine provinces, Arezzo, Firenze (Florence), Grosseto, Livorno (Leghorn), Lucca, Massa-Carrara, Pisa, Pistoia and Siena, and has an area of 8,997 sq. miles. Pop. (1921) 2,766,291 (showing a very low relative increase—only 200,000—since 1901) The chief railway centre is Florence.

Except towards the coast and around Lucca, Florence and Arezzo, where the beds of prehistoric lakes form plains, the country is hilly, being intersected with sub-Apennine spurs, some of which have extensive forests. The most fertile country in Tuscany is in the valley of the Arno. In the neighbourhood of Lucca the irrigation system dates from 1376, while at Coltano, near Pisa, it goes hand in hand with land reclamation In strong contrast with this is the coast plain known as the Maremma, 850 sq m in extent, where malaria has been prevalent since the depopulation of the country in the middle ages An elaborate system of drainage, begun in the 19th century, is still being completed. The greater part of the Maremma now affords pasture to large herds of horses and half-wild cattle, but the drier parts are cultivated The hill country just inland, especially near Volterra, has poor soil, largely clayey, and subject to landslips, but is rich in minerals, boric acid and mineral springs But for the Maremma, Tuscany is one of the most favoured regions of Italy. The climate is temperate, and the rainfall not excessive

The following is a list of the chief agricultural products in 1927 (the wine is largely produced in the district of Chianti, south-south-west of Florence):

	Area	Tons
	Acres	
Wheat	881,250	487,500
Rye	10,250	4,090
Barley	16,250	6,160
Oats	88,750	40,530
Maize	218,250	104,100
Broad beans	53,000	18,920
Runner beans	75,150	10,000
Sugar beets	13,250	59,690
Garden produce	17,000	69,630
Potatoes	50,150	180,700
Silk cocoons		1,386
Tobacco	7,800	3,397
Hay		1,704,600
Vines	1,436,750	690,800 (grapes)
		95,634,000 (wine, gal.)
Olives	780,000	109,170 (olives)
		4,023,800 (olive-oil, gal.)
Fruits (various)		27,690
Chestnuts	384,450	142,280

The mineral products of the Florence district (including the provinces of Siena, Grosseto and Livorno [Leghorn]) were (1926) in tons: Iron, 470,170; manganiferous iron, 17,730; copper, 6,674; mercury, 147,194 (from Monte Amiata); iron pyrites, 462,755; marble, 509,805 (337,083 of which from the Carrara district); lignite, 567,615 (province of Arezzo), 120,207 (province of Grosseto). There are cotton mills at Florence, Leghorn, Prato and Pisa; Prato (*q.v.*) is an important centre of the wool industry, which flourished more in Florence in the middle ages than at present. Hydro-electric power, mainly derived from the Serchio basin, is supplemented by the plants at Terni (*q.v*) in Umbria. Glass is made at Pisa. Porcelain and ceramic products are made, especially at Signa and Doccia, near Florence, where silk, straw hats, etc, are also manufactured; and much furniture is also produced. The Tuscans are, indeed, active, both in agriculture and industry. There are universities at Florence, Pisa and Siena. Viareggio and Leghorn are much frequented for sea-bathing, while the latter is a prosperous port.

The main art centres of Tuscany are Florence, Pisa and Siena, the headquarters of the chief schools of painting and sculpture from the 13th century onwards. While the first city, however, bore as prominent a part as any in Italy in the Renaissance, the art of Pisa ceased to advance at a comparatively early period, its importance being in ecclesiastial architecture in the 12th, and in sculpture in the 13th century. Siena, too, never accepted the Renaissance to the full, and art retained its individuality

The language of Tuscany is remarkable for its purity of idiom, and its adoption by Dante and Petrarch probably led to its becoming the literary language of Italy (*See* ITALIAN LANGUAGE)

See E Repetti, *Dizionario geografico fisico storico della Toscana* (6 vols Florence, 1834–46) On mediaeval and Renaissance architecture and art there are innumerable works Among those on architecture may be mentioned the great work of H von Geymüller and V C. von Stegmann, *Die Architektur der Renaissance in Toscana;* Raschdorff-Haupt, *Palastarchitektur von Oberitalien und Toscana von 15–17 Jahrhundert* (6 vols); B. Patzak, *Palast und villa in Toscana* (2 vols, 1912–13). (T. A)

HISTORY

Etruria (*q.v.*) was finally annexed to Rome in 351 B.C. and was later known as Tuscia, but was a larger area than the present Tuscany, comprising the northern part of Latium. Under Charlemagne the name of Tuscia or Toscana became restricted to the area north of Viterbo and Bolsena One of the earliest of the Frankish marquises in the 9th century was Boniface, who about 828 fought with success against the Saracens in Africa. The male line of marquises ended with Boniface II. (or III.), who was murdered in 1052 His widow, Beatrice, in 1055 governed the country till her death in 1076, when she was succeeded by Matilda (*q.v.*), her only child by her first husband. Matilda died in 1114 without issue, bequeathing all her extensive possessions to the Church. The consequent struggle over her inheritance between the popes and the emperors enabled the principal cities of Tuscany gradually to assert their independence, so that Tuscany as a whole was no longer a state.

The Return of the Medici.—After the surrender of Florence to the Imperialists in Aug. 1530 the Medici power was re-established, and Alessandro de' Medici was made duke of Florence, the dignity to be hereditary in the family. In the reign of Cosimo III. Siena was annexed (1559); the title of grand duke of Tuscany was conferred on that ruler in 1567 by Pope Pius V. and recognized in the person of Francis I. by the emperor Maximilian II. in 1576. Under his descendants Tuscany played but a small part in European history; a wave of degeneracy set in, affecting both the people and the new and shoddy nobility, and art and letters declined. Giovan Gastone, the last Medicean grand duke, being childless, it was agreed by the treaty of Vienna that at his death Tuscany should be given to Francis, duke of Lorraine, husband of the archduchess Maria Theresa, afterwards empress. In 1737 Giovan Gastone died, and Tuscany was governed for Francis II., who resided in Austria, by a series of foreign regents. (The history of Tuscany from 1530 to 1737 is given in greater detail under MEDICI.)

Reforms of Leopold I.—Francis, who had been elected emperor in 1745, died in 1765 and was succeeded on the throne of the grand duchy by his younger son, Leopold I. Leopold resided in Tuscany and proved one of the most capable and remarkable of the reforming princes of the 18th century. He sub-

stituted Tuscans for foreigners in government offices, introduced a system of free trade in foodstuffs (at the suggestion of the Sienese Sallustio Bandini), and promoted agriculture. He re-organized taxation on a basis of equality for all citizens, reformed the administration of justice and local government, and suppressed torture and capital punishment. His reforms in Church matters made a great stir at the time, for he curbed the power of the clergy, suppressed some religious houses, reduced the mortmain, and rejected papal interference. With the aid of Scipione de' Ricci, bishop of Pistoia, he even attempted to reform Church discipline, but Ricci's action was condemned by Rome and he was forced to resign. (*See* PISTOIA, SYNOD OF.) At the death of his brother, Joseph II., in 1790, Leopold became emperor and removed to Vienna. After a brief regency he appointed his second son, Ferdinand III., grand duke.

The French Occupation.—During the French revolutionary wars a French force entered Florence in 1799 and was welcomed by a small number of republicans. The grand duke was forced to fly, and a provisional government on French lines was established. But the great mass of the people were horrified at the irreligious character of the new régime, and a counter-revolution broke out at Arezzo. Bands of armed peasants marched through the country to the cry of "Viva Maria!" and expelled the French, not without committing many atrocities. With the assistance of the Austrians Florence was occupied and a government established in the name of Ferdinand. But after Bonaparte's victory at Marengo the French returned in great force, dispersed the bands, and re-entered Florence (Oct. 1800). They, too, committed atrocities and sacked the churches, but they were more warmly welcomed than before by the people, after the experience of Austro-Aretine rule. Joachim Murat set up a provisional government, and by the peace of Lunéville Tuscany was made a part of the Spanish dominions and erected into the kingdom of Etruria under Louis, duke of Parma (1801). The new king died in 1803, leaving an infant son, Charles Louis, under the regency of his widow, Marie Louise of Spain. Marie Louise ruled until 1807, when the emperor Napoleon obliged Charles IV. of Spain to cede Tuscany to him, compensating Charles Louis in Portugal.

From 1807 to 1809, when Napoleon's sister, Elisa Baciocchi, was made grand duchess, Tuscany became a French department. French ideas had gained some adherents among the Tuscans, but to the majority the new institutions, although they produced much progress, were distasteful as subversive of cherished traditions. After Napoleon's defeats in 1814, Ferdinand III. returned, warmly welcomed by nearly everybody, for French rule had proved oppressive, especially on account of the heavy taxes and the drain of conscription. At the Congress of Vienna he was formally reinstated with certain additions of territory and the reversion of Lucca (incorporated in 1847).

The Restoration.—The restoration in Tuscany was unaccompanied by the excesses which characterized it elsewhere, and much of the French legislation was retained. Ferdinand was succeeded in 1824 by his son, Leopold II., who continued his father's policy of benevolent but enervating despotism. When the political excitement consequent on the election of Pius IX. spread to Tuscany, Leopold, in Feb. 1848, granted a constitution A Tuscan contingent took part in the Piedmontese campaign against Austria, but the increase of revolutionary agitation in Tuscany, culminating in the proclamation of the republic (Feb. 9, 1849), led to Leopold's departure for Gaeta to confer with the pope and king of Naples. Disorder continuing, he was invited to return, and he did so, but accepted the protection of an Austrian army, by which act he forfeited his popularity (July 1849). In 1852 he formally abrogated the constitution, and three years later the Austrians departed. When in 1859 a second war between Piedmont and Austria became imminent, the revolutionary agitation broke out once more. There was a division of opinion between the moderates, who favoured a constitutional Tuscany under Leopold, but forming part of an Italian federation, and the popular party, who aimed at the unity of Italy under Victor Emmanuel. At last a compromise was arrived at and the grand duke was requested to abdicate in favour of his son, grant a constitution, and take part in the war against Austria. Leopold having rejected these demands, the Florentines rose as one man and obliged him to quit Tuscany (April 27, 1859).

Union with the Italian Kingdom.—A provisional government, led by Ubaldino Peruzzi and afterwards by Bettino Ricasoli, was established It declared war against Austria and then handed over its authority to Boncompagni, the Sardinian royal commissioner (May 9). A few weeks later a French force under Prince Napoleon landed in Tuscany to threaten Austria's flank, but in the meanwhile the emperor Napoleon made peace with Austria and agreed to the restoration of Leopold and other Italian princes. Victor Emmanuel was obliged to recall the royal commissioners, but together with Cavour he secretly encouraged the provisional governments, and the constituent assembly of Tuscany voted for annexation to Sardinia. The king accepted the annexation and appointed his kinsman, Prince Carignano, viceroy of Central Italy, with Ricasoli as governor-general (March 22, 1860). On Feb. 18, 1861, the kingdom of Italy, comprising Tuscany, was proclaimed.

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TUSCARORA, an Indian tribe of Iroquoian family, originally numbering 5,000, in North Carolina Encroachments by the whites, including kidnapping of their children as slaves, led to a war with the settlers (1711–13), at the end of which the Tuscarora fled or drifted northward and were admitted into the League of the Iroquois as a sixth nation. About 700 survive in Canada and New York.

TUSCULUM, an ancient city of Latium, in a commanding position on the north edge of the outer crater ring of the Alban volcano, 1½ m N E of the modern Frascati The highest point is 2,198 ft. above sea-level It has a very extensive view of the Campagna, with Rome lying 15 m. distant to the north-west Rome was approached by the Via Latina (from which a branch road ascended to Tusculum, while the main road passed through the valley to the south of it), or by the Via Tusculana.

According to tradition, the city was founded by Telegonus, the son of Ulysses and Circe When Tarquinius Superbus was expelled from Rome his cause was espoused by the chief of Tusculum, Octavius Mamilius, who took a leading part in the formation of the Latin League, composed of the thirty principal cities of Latium, banded together against Rome Mamilius commanded the Latin army at the battle of Lake Regillus (497 B C), but was killed, and the predominance of Rome among the Latin cities was practically established In 381 B C., the people of Tusculum received the Roman franchise. Several of the chief Roman families were of Tusculan origin, *e g*, the gentes Mamilia, Fulvia, Fonteia, Juventia and Porcia (to which the Catos belonged) By the end of the Republic, and still more during the imperial period, the territory of Tusculum was one of the favourite places of residence of the wealthy Romans. The number and extent of the remains is very great. Even in the time of Cicero we hear of eighteen owners of villas there. Much of the territory (including Cicero's villa), but not the town itself, which lies far too high, was supplied with water by the Aqua Crabra On the hill of Tusculum itself are remains of a small theatre (excavated in 1839), with a reservoir behind it, and an amphitheatre. Both belong probably to the imperial period, while a temple (the substructures of which are preserved), often called the villa of Cicero, or of Tiberius, near the latter, is probably earlier. Between the amphitheatre and the theatre lay the Forum The citadel—which stood on the highest point, an abrupt rock—was approached only on the side, towards the city. Upon it remains of the mediaeval castle, which stood here until 1191, are visible.

It was here that Cicero composed his *Tusculan Disputations* and other philosophical works. His villa must have been at or near Grotta Ferrata and what is now known as Poggio Tulliano a little to the east (where remains of a villa exist) may well have been its site. After the transference of the seat of empire to

Constantinople, Tusculum became a very important stronghold, and in the 10th–12th centuries its counts occupied a leading position in Rome and were specially influential in the selection of the popes. During the 12th century there were constant struggles between Rome and Tusculum, and in 1191 the Romans, supported by the German emperor, gained the upper hand, and the whole city was destroyed.

See L. Canina, *Descr. dell' antico Tusculo* (Rome, 1841); A. Nibby, *Dintorni di Roma*, iii. 293 (2nd ed, Rome, 1841); H. Dessau in *Corp. inscript. lat.* pp. 252 *sqq.* (Berlin, 1887); F. Grossi-Gondi, *Il Tuscolano nell' età classica* (Rome, 1907); T. Ashby in *Papers of the British School at Rome*, iv., v. (London, 1907, 1909). (T. A.)

TUSKEGEE (tŭs-kē′gē), a city of Alabama, U.S.A. Pop. (1920), 2,475. It is the seat of U S. Veterans Bureau hospital 91 (for negroes) and of Tuskegee Normal and Industrial institute (for negroes), founded in 1880 by Booker T Washington (*q v*), who was its principal until his death in 1915, and endowed by Congress in 1889 with 25,000 ac. of land. The institute provides practical training for many trades and agricultural occupations, and for nursing, teaching, home-keeping and commercial positions. In the year 1927–28 it gave systematic instruction to 3,323 persons from 31 States and 9 foreign countries Its "movable school" (a motor truck carrying tools and equipment, two demonstrators and a nurse) travels through the remote rural districts of the Black Belt, teaching the negroes how to improve their working methods, health and living conditions. A two-day conference, representative of the South, is held in December.

TUSSAUD, MARIE (1760–1850), founder of "Madame Tussaud's Exhibition" of wax figures in London, was born in Berne in 1760, the daughter of Joseph Grosholtz (d. 1760), an army officer. She began to model figures for her uncle, Dr. J C Curtius, in Paris It was from Curtius's exhibition that the mob obtained the busts of Necker and the duke of Orleans that were carried by the procession when on July 12, 1789 the first blood of the French Revolution was shed. Marie Grosholtz modelled the heads of many of the prominent leaders and victims of the Revolution, and was herself for three months a prisoner In 1794 she married a Frenchman named Tussaud, from whom she was separated in 1800. She then removed to London, taking with her the nucleus of her collection from the *cabinet de cire* in the Palais Royal, and the idea of her "Chamber of Horrors" from Curtius's *Caverne des Grands Voleurs,* in the Boulevard du Temple. Her wax figures were first shown in the Strand, and through the provinces, and finally the exhibition was established in permanent London quarters in Baker Street in 1833 Here Mme. Tussaud died on April 16, 1850 The exhibition was moved in 1884 to a large building in Marylebone Road It was destroyed by fire in 1925 and after reconstruction reopened in 1928

See J. T. Tussaud, *The Romance of Madame Tussaud* (1920)

TUSSER, THOMAS (*c.* 1524–1580), English poet, son of William and Isabella Tusser, was born at Rivenhall, Essex, about 1524. He was a chorister at Wallingford castle, and then at St Paul's cathedral, and from there went to Eton college. He has left a quaint account of his privations at Wallingford, and of the severities of Nicholas Udal at Eton. He was elected to King's college, Cambridge, in 1543, moved to Trinity Hall, and on leaving Cambridge went to court in the service of William, 1st Baron Paget of Beaudesart, as a musician. After ten years of life at court, he married and settled as a farmer at Cattiwade, Suffolk, near the river Stour, where he wrote his *Hundreth Good Pointes of Husbandrie* (1557, 1561, 1562, etc.). He never remained long in one place. For his wife's health he removed to Ipswich. After her death he married again, and farmed at West Dereham. He then became a singing man in Norwich cathedral. After farming at Fairsted, Essex, he removed to London, whence he was driven by the plague of 1572–73 to find refuge at Trinity Hall, being matriculated as a servant of the college in 1573 At death he had a small estate at Chesterton, Cambridgeshire. Thomas Fuller says he "spread his bread with all sorts of butter, yet none would stick thereon." He died on May 3, 1580.

The *Hundreth Good Pointes* was enlarged to *A Hundreth good pointes of husbandry, lately maried unto a hundreth good poyntes of huswifery* . . . the first extant edition of which, "newly corrected and amplified," is dated 1570. In 1573 appeared *Five hundreth pointes of good husbandry* . . . (reprinted 1577, 1580, 1585, 1586, 1590, etc.). The numerous editions of this book, which contained a metrical autobiography, prove that the homely and practical wisdom of Tusser's verse was appreciated. He gives directions of what is to be done in the farm in every month of the year, and minute instructions for the regulation of domestic affairs in general. The later editions include *A dialogue of wyvynge and thryvynge* (1562). Modern editions are by William Mavor (1812), by H M W. (1848), and by W. Payne and Sidney J. Herrtage for the English Dialect Society (1878).

TUTANKHAMUN: *see* Ikhnaton.

TUTBURY, town, Burton parliamentary division Staffordshire, England, 4½ m. N.W. of Burton-upon-Trent, picturesquely situated on the river Dove. Pop. (1921) 2,062. It is on the L.N.E. and L.M.S. railways, but the railway station is in Derbyshire. The fine church of St. Mary has a nave of rich Norman work with a remarkable western doorway. There are ruins of a large castle standing high above the valley; these include a gateway of 14th century work, strengthened in Caroline times, a wall enclosing the broad "Tilt Yard," and portions of dwelling rooms. Glass is the staple manufacture. Alabaster is found in the neighbourhood.

Tutbury (*Toteberie, Stutesbury, Tuttebiri, Tudbury*) is said to have been a seat of the Mercian kings. After the Conquest it was granted to Hugh d'Avranches, who appears to have built the first castle there. At the time of the Domesday Survey the castle was held by Henry de Ferrers. Tutbury was the centre of an honour in Norman times, the castle and town continuing in the hands of the Ferrers until 1266, when they were forfeited to the Crown and granted to Edmund Crouchback, earl of Lancaster. They are still part of the duchy of Lancaster. Tutbury castle was partially rebuilt by John of Gaunt. Later it was, for a time, the prison of Mary Queen of Scots. During the Civil War it was held for the king but surrendered to the parliamentary forces (1646), and was reduced to ruins by order of parliament (1647).

TUTICORIN, a seaport of British India in the Tinnevelly district of Madras Pop (1921) 44,522. It is the southern terminus of the South Indian railway, 443 m. S W. of Madras city In connection with this railway a steamer runs to Colombo, 149 m distant by sea Tuticorin is an old town, long in possession of the Dutch, and has a large Roman Catholic population. It used to be famous for its pearl fisheries and pearl fishing was again engaged in successfully in 1926 There are industrial and training schools, and a mission centre of the Society of the Propagation of the Gospel Salt is manufactured, cotton woven, and there are cotton ginning and pressing factories. Tuticorin is the 2nd port of Madras, though it has only an open roadstead, where vessels must anchor 5 to 7 miles from the shore A deepwater harbour was in process of construction in 1927, and considerable sums have recently been spent on a dry dock and port equipment.

TUTTLINGEN, a town of Germany, in the republic of Württemberg, on the left bank of the Danube, 37 m. by rail N E. of Schaffhausen, and at the junction of lines to Stuttgart and Ulm. Pop. (1925) 16,281. Tuttlingen, a very ancient place, has belonged to Wurttemberg since 1404 Its chief manufactures are shoes, cutlery, surgical instruments and woollen goods.

TUXEDO, a town of Orange county, New York, U.S.A., 40 m. N.N.W. of New York city; served by the Erie railroad. Pop. (1925) 2,969 (State census). About 1½ m. from the station is Tuxedo lake, in a tract of 13,000 ac. which was taken for debt by the elder Pierre Lorillard in 1814. He built a shooting box here, and his grandson Pierre Lorillard (1833–1901) formed the Tuxedo Park Association for the development of the estate, which resulted in the formation of the Tuxedo club and the opening (June 1, 1886) of Tuxedo park.

TUY, a city of north-western Spain, in the province of Pontevedra, on the right bank of the river Miño (Portuguese *Minho*), opposite Valença do Minho, which stands on the left bank in Portuguese territory. Pop. (1920), 12,529 During part of the 7th century Tuy was the Visigothic capital. It was taken from the Moors by Alphonso VII. in the 12th century.

Tuy is the southern terminus of the railways to Santiago de Compostela and Corunna; Valença do Minho is the northern terminus of the Portuguese railway to Oporto. To the east of

Tuy is the river Louro, a right-hand tributary of the Miño abounding in fishes; and beyond the Louro, on the railway to Corunna, are the hot mineral springs of San Martin de Caldelas. The cathedral, founded in the 12th century, but largely restored between the 15th and 19th, is of a fortress-like architecture.

TUZLA or **DONJI SOLI,** a town of Bosnia, Yugoslavia, beautifully situated on the Jala or Julla. Pop. (1921) 13,354, almost all, including a permanent colony of gipsies, being Muslims. Tuzla is the seat of a district court and an Orthodox bishop, with several churches, many mosques, a hospital, gymnasium and commercial school. Besides a large ammonia soda factory, and the generating of electric power, it has a vigorous trade in grain, live stock, plums, bricks, timber and coal from the surrounding hills, where there is a colony of Hungarian miners, while the salt springs, owned by the State, are unrivalled in the Balkan peninsula. It was here that the sugar beet was first cultivated in Bosnia. The town was known by the Romans as Ad Salinas; in mediaeval documents it appears as Sou Sow or Soli.

TVER, a province of the Russian S F S.R, surrounded by those of Smolensk, Pskov, Novgorod, Cherepovetz, Yaroslavl and Moscow, and not coinciding with the pre-1917 province of that name. Area 61,095 sq.km. Pop. (1926) 2,239,177, mainly Great Russians, with Karelians in the north. The Volga, Southern Dvina and Msta rise in marshes and lakes on the Valdai plateau (800–1,000 ft) in the west of the province.

The plateau is built up chiefly of Carboniferous limestones, lower and upper, lying on Devonian and Silurian deposits, which crop out only in the denudations of the lower valleys The whole is covered by a thick sheet of boulder clay, the bottom-moraine of the Scandinavo-Russian ice-sheet, and by subsequent lacustrine deposits Lakes are numerous, Lake Seliger near the sources of the Volga and Lake Mzstino being the largest.

The climate is continental with severe winter frosts of five months' duration and an average July temperature of 67° F. Average rainfall 18–20 in per annum. Coniferous forests, especially firs, cover 32·2% of the province, and 12% is marsh land In the remaining area meadow and grassland prevail, ploughed land occupying only 25% There has been a marked diminution of grain production since 1887 and dairying, with an export trade in butter and cheese, is developing, as is the cultivation of potatoes, flax and grass. Rye, oats and barley are the chief grain crops Sheep, working and milch cattle, pigs and a few goats are bred Coal beds exist, but are little worked.

Hunting and fishing supplement the income of the peasants, and there are koustar (peasant) industries of leather and fur preparation, textiles and wooden wares, with the preparation of pitch and tar Factory industries include saw-milling, flour-milling, the making of leather goods, textiles, bricks, glass, machinery, oil-pressing, starch preparation, distilling and brewing Vyshniy-Volochok and Rhzev have populations of over 30,000 and Tver has over 100.000.

The province is well drained by the upper Volga and its tributaries, especially the Tvertsa and Mòloga; 17% of the rivers are available for steam navigation, and boats and rafts can be floated on many of the others. The Vyshniy-Volochok system of canals connects the Volga with the Baltic and the Tikhvin system connects the Mologa with Lake Ladoga. Railways are comparatively good and the province is thus well situated for trade, especially as it lies on the direct route between Moscow and Leningrad.

TVER, the chief town of the above province, situated on both banks of the Volga, at its confluence with the Tvertsa in 56° 52′ N., 35° 48′ E. The low right bank is protected from inundations by a dam. The town is growing rapidly; its population in 1900 was 45,644 and in 1926 it had reached 106,021. Its situation on the Moscow-Leningrad railway and on the navigable Volga has given it great trading importance, as a collecting centre for a productive region and a distributing centre via the upper Volga of goods from Leningrad and Moscow. Its chief manufactures are machinery, textiles and leather goods.

A fort was erected in 1180 at the mouth of the Tvertsa to protect the Suzdal principality against Novgorod. In the 13th century it became the capital of an independent principality, and remained so until the end of the 15th century. Michael, prince of Tver, was killed (1318) fighting against the Tatars, as also was Alexander his son. It long remained an open question whether Moscow or Tver would ultimately gain the supremacy in Great Russia, and it was only with the help of the Tatars that the princes of the former eventually succeeded in breaking down the independence of Tver. In 1486, when the city was almost entirely burned down by the Muscovites, the son of Ivan III. became prince of Tver; the final annexation to Moscow followed four years later. In 1570 Tver had to endure, for some reason now difficult to understand, the vengeance of Ivan the Terrible, who ordered the massacre of 90,000 inhabitants of the principality. In 1609–12 the city was plundered both by the followers of the second false Demetrius and by the Poles.

TWAIN, MARK, the pen-name of SAMUEL LANGHORNE CLEMENS (1835–1910), American novelist and humorist, was born at Florida (Mo.), Nov. 30, 1835. His father, a happy-go-lucky storekeeper and lawyer from Tennessee, popularly known as "Judge" Clemens, moved when the boy was four years old to Hannibal (Mo), dying eight years later and leaving the family all but destitute Little Sam had virtually no formal education, but his imagination was early stored with the lore of the Mississippi river and the negroes who peopled the neighbourhood. As his brother's assistant on the Hannibal *Journal* he learned type-setting and became a journeyman printer, travelling as far eastward as New York and Philadelphia before he was 19. Drawn back to the Mississippi by the "permanent ambition" of his boyhood to become a pilot, he set to work "learning the river," getting "personally and familiarly acquainted," as he says in *Life on the Mississippi*, "with all the different types of human nature that are to be found in fiction, biography or history." At the beginning of the Civil War in 1861, the river trade came to an end, and young Clemens soon set out for the West with his brother Orion, who had just been appointed lieutenant governor of Nevada. There, in the neighbourhood of Carson City, he had a most hilarious but equally unlucrative experience as a gold miner, the record of which he has left in *Roughing It,* the classic account of the post-'49 pioneering epoch in the West. Soon he turned to journalism on the Virginia City *Enterprise,* adopting the *nom de plume* "Mark Twain," a call used by Mississippi pilots in taking soundings on the river. Moving to San Francisco, he became a member of the witty group that gathered about the *Golden Era* and included Artemus Ward, Charles Warren Stoddard, Bret Harte and Orpheus C. Ker, and with the publication of *The Celebrated Jumping Frog of Calaveras County* found himself famous overnight On the wave of this notoriety he went to New York, where he delivered his "serio-humorous" lecture on the Sandwich Islands at Cooper Institute. In June, 1867, on a commission to contribute letters to the San Francisco *Alta California,* he joined the party embarking on the steamship "Quaker City" for the tour of the Mediterranean described in *The Innocents Abroad.* With the publication of these letters, which had a prodigious sale, Mark Twain immediately became the most widely read author in America In 1870, he married Olivia L. Langdon and moved to Hartford, which became his home for the next 30 years

He settled down at once to the trade of authorship, publishing *Roughing It* in 1872, collaborating in 1874 with Charles Dudley Warner in *The Gilded Age,* his sole novel of contemporary manners which contained the famous character portrait, Colonel Sellers, and writing *The Adventures of Tom Sawyer* (1875). In 1880 he visited Europe a second time, recording his experiences humorously in *A Tramp Abroad.* In 1882 he published his romance for children, *The Prince and the Pauper,* which was followed in successive years by *Life on the Mississippi* and his masterpiece, *The Adventures of Huckleberry Finn,* a sequel to *Tom Sawyer.* Meanwhile his energy, which had found insufficient vent in his literary work, had turned him towards various forms of speculative investment. He had had better success for a time as the principal partner of the publishing house of Charles L. Webster and Company which reaped immense profits from the *Memoirs of General Grant*, the *Life of Pope Leo XIII.*, and other works of great popular interest, although this firm also failed and left him with heavy debts Meanwhile he had published *A Con-*

necticut Yankee at King Arthur's Court (1889) and *The American Claimant* (1892), which were followed in 1894 by *The Tragedy of Pudd'nhead Wilson,* a story set in the Mississippi valley and containing much of the cynical philosophy that had become characteristic of its author.

In 1891 Clemens went abroad again, and, after spending a winter in Berlin, settled in Florence, where he wrote his *Personal Recollections of Joan of Arc,* a book for which, as he later declared, he had spent 14 years in preparation, and which he published anonymously, observing to his wife that it meant more to him than anything he had ever undertaken, and that it would never be accepted seriously over his own signature. After spending two years at home, he set out, with the purpose of earning money to pay off his debts, on the journey round the world recorded in *Following the Equator,* lecturing on the way in Australia and India. Returning home in 1900, he settled in New York, and during this year a collected edition of his works in 22 volumes was issued by the American Publishing Company of Hartford. He had published in 1897 a volume of miscellaneous essays entitled *How to Tell a Story;* and his further works included *The Man that Corrupted Hadleyburg* (1900), *The Double-Barrelled Detective Story* (1902), *Adam's Diary* (1904), *What is Man?* (privately printed, 1906), *Christian Science* (1907), *Captain Stormfield's Visit to Heaven* (1907) and *Is Shakespeare Dead?* (1909).

By the beginning of the last decade of his life Mark Twain had become a world celebrity and undoubtedly the most conspicuous and picturesque figure in America. In the year 1902 he made his spectacular return to the home of his childhood in Missouri, and in 1907, after having received honorary degrees from Yale and the university of his native state, he went to England to receive the degree of Doctor of Literature at Oxford. In 1906 he had built a country-house, "Stormfield," at Redding (Conn.), which became his home during the remaining years of his life, and there, shortly before he died, his daughter Clara, the only one of his four daughters who survived him, was married to the pianist Ossip Gabrilowitsch. His posthumous works comprise *The Mysterious Stranger* (1916), *What is Man? and Other Essays* (1917), *Mark Twain's Speeches* (1923), and two volumes of *Autobiography* (1924).

Mark Twain will always undoubtedly be regarded as the most characteristic American writer of his epoch. The first to represent the transition of the literary hegemony of the country from New England to the West, he was typical of the new democracy in his contempt for authority and for the sublimities as well as the commonplaces of 19th-century culture. He was most widely popular in his own day as a humorist, but he will survive rather as the master folk-writer of the pioneering epoch who has left in *Roughing It* and *Life on the Mississippi* unrivalled pictures of the character and manners of the Middle and Far West in Civil War days, and in *Tom Sawyer* and *Huckleberry Finn* a veritable epic of that primitive civilization, poetic in feeling, strictly veracious in detail, abounding in colour, and, in the latter book especially, with a grasp of life that can only be described as classical.

The standard biography of Mark Twain is by Albert Bigelow Paine (in three volumes, 1912). (V. W. B.)

TWAY-BLADE (*Listera*), a genus of small plants of the orchid family (Orchidaceae). The flower is green, with a downwardly directed, forked labellum. Two species, the common tway-blade (*L. ovata*) and the heart-leaved tway-blade (*L. cordata*), are found in the British Isles, the last named occurring also in North America, where three other tway-blades are also native,—the broad-lipped (*L. convallarioides*), the southern (*L. australis*) and the western (*L. caurina*). For fertilization mechanism *see* C. Darwin, *Fertilization of Orchids*.

TWEED, WILLIAM MARCY ("Boss"), American politician and leader of the "Tweed Ring," was born in New York City Apr. 3, 1823. In 1852 he was elected an alderman of the New York City council. From 1854 to 1856 he served as U.S. Representative in Washington. His real power in municipal politics began in 1857 with his election to the board of supervisors, which he came to dominate. By working the downfall of Fernando Wood, a notoriously corrupt mayor, Tweed came into power under a cloak of respectability. He fortified himself through his political appointments. From 1858 to 1871, while holding successively the positions of school commissioner, deputy street commissioner, State Senator and deputy commissioner of public works, Tweed, except for brief intervals, controlled the city administration. In 1868 he also controlled the State Democratic Assembly at Albany, and in 1869, though he lost the Assembly, he secured the election of his nominee as governor. The "Tweed Ring" of history, composed of Tweed, Mayor A. Oakey Hall, Peter B. Sweeny and Richard B. Connolly, began its operations in Jan. 1869 and lasted until Tweed's downfall in 1871. Conservative estimates place the amount stolen directly from the city during this period at $45,000,000, though including taxes lost through arbitrary reductions by the "ring" for money or favor and the issuance of bonds at extravagant rates of interest some authorities have estimated as high as $200,000,000. Exposure came through a book-keeper who placed evidence in the hands of the New York *Times* where it was printed. Tweed was tried, found guilty and sentenced to 12 years in the penitentiary. In 1875 he escaped from the Ludlow Street gaol where he was confined, fled to Cuba and thence to Spain, where he was arrested by the Spanish Government and returned to the United States. He was again imprisoned in Ludlow Street gaol where he died Apr. 12, 1878.

See D. Lynch, *"Boss" Tweed* (1927).

TWEED, a river in the south of Scotland. It rises in the south-west corner of Peeblesshire, in the hill country in which the Clyde and Annan also rise. The stream flowing from Tweed's Well, about 1,500 ft. above the sea, is generally regarded as its source. For the first 36 m. of its course the stream intersects the shire of Peebles in a north-easterly direction, and then, bending towards the south-east, passes Innerleithen, where it receives the Leithen (left) and the Quair (right). It then crosses Selkirkshire and, having received the Ettrick on the right, flows northward past Abbotsford, forming for about 2 m the boundary between the counties of Selkirk and Roxburgh After receiving the Gala on the left, the Tweed crosses the north-western corner of Roxburghshire past Melrose and, after being joined by the Leader on the left, winds past Dryburgh abbey round the south-western corner of Berwickshire. The remainder of its course is in a north-easterly direction through Roxburghshire past Kelso, where it receives the Teviot on the right, and then between the counties of Berwick and Northumberland, past Coldstream, to the town of Berwick, where it enters the North sea. The last 2 m of its course before reaching Berwick are in England.

The Tweed is 97 m. long and drains an area of 1870 square miles Its bed is pebbly and sandy, and notwithstanding discolorations from manufactures, the stream, owing to its clear and sparkling appearance, still merits the epithet of the "silver Tweed."

TWEED, a term of very general application in the woollen and worsted trades. It is employed as a trade description for a very large variety of woollen and worsted fabrics that embody the same general textural features, but which differ in the minor details of their manufacture, construction and finish They are described as "Scottish," "Harris," "Cheviot," "Irish," "Yorkshire," "Saxony" and "West of England" tweeds, according to the particular locality of their origin, the yarn used in their construction, their character of structure, texture, finish and other details.

The description of this particular variety of worsted fabrics as "Tweeds" is commonly, but erroneously, associated with the Scottish river of that name. The origin of the word "tweed" however, has no reference to the river Tweed, but is said to be due to an error on the part of a London clerk who, in the year 1826, when writing out an invoice for these goods, inadvertently wrote the word "tweeds" instead of "tweels," the Scottish for "twills." Orders were placed for more "Scottish tweeds"—a novel description which immediately won the popular favour and became firmly established in the clothing trade as a brand of quality.

The chief characteristic feature of the true type of "tweed" fabrics in general is, as the name suggests, their construction on a twill weave basis, although they are not restricted entirely to the simple regular twill weave structures, as many tweed fabrics are

based on the numerous modifications of those weaves. Tweed fabrics are produced from Scottish, Cheviot, Saxony and many other types of worsted and woollen yarns of various counts and quality, and woven in solid colours, mingled "heather" tones, and coloured stripes and checks in endless variety of pattern and colour, and in every variety of texture suitable both for men's and women's clothing for outer wear, and for every season of the year.

"Herring-bone" twills, "diamonds," "chevrons," "cross-twills" and "basket" weaves are popular styles for tweed designs, which are now more of a broken character than formerly, while more intricate patterns are introduced in textures of superior quality. A new vogue of quite recent origin consists of printed tweed effects with the pattern printed on both sides of the fabric to give the impression of woven designs. These printed tweeds are executed with such realistic effect that it is in some cases very difficult without close inspection to distinguish the printed imitation tweed effect from the genuine woven tweed patterns. (H N.)

TWEEDDALE, JOHN HAY, 2ND EARL and 1ST MARQUESS OF (1626–1697), was son of John, 8th Lord Hay of Yester (*c.* 1599–1654), created earl of Tweeddale in 1646. Before succeeding to the peerage in 1654 the second earl fought for Charles I. during the Civil War, but he was in the Scottish ranks at Marston Moor. Changing sides again, he was with the royalists at Preston; but he was a member of Cromwell's parliament in 1656, and was imprisoned just after the restoration of Charles II. He was soon, however, in the king's favour, and in 1663 was appointed president of the Scottish council, and in 1664 an extraordinary lord of session In Scotland he sought to mitigate the harshness shown by the English Government to the Covenanters, and for this attitude he was dismissed from his offices in 1674; but he regained an official position in 1680 and held it during the reign of James II. A supporter of William of Orange, he was made lord high chancellor of Scotland in 1692, and two years later was created marquess of Tweeddale and earl of Gifford. He favoured the scheme for the expedition to Darien, and as lord high commissioner during William's absence he formally assented to the act establishing the trading company in 1695; for this action he was dismissed from office when the king returned to England in 1696. He died on Aug. 11, 1697

TWEED RIVER: *see* RICHMOND RIVER AND BASIN.

TWELVE TABLES, the tables of wood on which was engraved or painted the earliest codification of the Roman law Originally ten in number, two others were afterwards added, containing supplemental matter, and the whole code was termed the *Lex XII. Tabularum* (Law of the Twelve Tables). (*See* ROMAN LAW and ROME.)

TWENTY-FOUR PARGANAS, THE, a district of British India, in the presidency division of Bengal, with an area of 4,856 square miles. Pop. (1921), 2,628,205. It occupies part of the Gangetic delta, east of the Hugli, surrounding (but not including) the city of Calcutta. It also includes the greater part of the almost uninhabited Sundarbans (*q.v.*), so that within its confines are found virgin forest, settled tilth and the busy life of the suburb of a great city. The administrative headquarters are at Alipur, a southern suburb of Calcutta. The country consists for the most part of an alluvial plain with a population devoted to agriculture and almost entirely rural, but a chain of industrial towns stretches along the bank of the Hugli from Garden Reach northwards. Rice is the staple crop, followed by jute, pulses and sugar-cane. The riparian strip is crowded with towns, factories and mills; Bhatpara has 65,609 and Titagarh 52,451 inhabitants. Other industrial towns are Baranagar, Budge-Budge, Naihati, Kamarhati, South Dum-Dum and Kanchrapara, in the last of which are the works of the broad gauge system of the Eastern Bengal State railway. In other towns various manufactures are to be found, principally jute mills and jute presses, and also, at Dum-Dum, Government factories for rifles.

TWICKENHAM, an urban district in the Twickenham parliamentary division of Middlesex, England, 12 m. west-southwest of St. Paul's Cathedral, London, on the river Thames. Pop. (1921) 34,790. Its situation is pleasant, and it has grown into an extensive residential district The body of the church of St. Mary was rebuilt in brick after its collapse in 1713, but the Perpendicular tower remains. Among men of eminence buried here are Alexander Pope and Sir Godfrey Kneller. The Thames in this neighbourhood forms a long deep reach in favour with fishermen, and Eel Pie Island is a resort of boating parties. There are many fine houses in the vicinity, more than one possessing historical associations. Strawberry Hill, the residence of Horace Walpole, was built to his taste in a medley of Gothic styles. Marble Hill was erected by George II. for the countess of Suffolk, and Pope, Swift and Gay took part in its equipment.

Orleans House was the residence in 1800 of Louis Philippe, then duke of Orleans, and this family again acquired it in 1852, when it was occupied by the duke of Aumale. Several eminent French refugees resided at this period in the neighbourhood. York House was given to Lord Clarendon by Charles II, was probably the occasional residence of James II when duke of York, and in 1864 was occupied by the comte de Paris

Twickenham at the Domesday survey was included in Isleworth. Anciently it was called Twittenham or Twicanham, and the first form, or a variation of it, is used by both Pope and Walpole. The manor was given in 941 by King Edmund to the monks of Christ Church, Canterbury, from whom it had been previously taken, but it was again alienated, for it was restored to the same monks by Edred in 948. In the reign of Henry VIII. it came into the possession of the Crown, and by Charles I. was assigned to Henrietta Maria as part of her jointure. In 1670 it was settled for life on Catherine of Braganza, queen of Charles II. It remains in possession of the Crown, but since the death of Catherine has been let on leases. The old manor house, now demolished, was Catherine's residence; and had been, according to tradition, the place of the retirement of Catherine of Aragon after her divorce from Henry VIII.

TWILIGHT, the interval during which the atmosphere is illuminated after sunset; formerly known as *crepusculum,* Lat for dusky or obscure. The analogous early morning phenomenon is known as the *dawn* (*q v.*). These phenomena are caused by the intervention of the atmosphere between the sun and the earth's surface. An entire absence of atmosphere would cause darkness to set in sharply at sunset as on the moon; but under present conditions even when the sun is some distance below the horizon the upper layers of air are illuminated and are reflecting light. Even as early as the 11th century the duration of twilight was determined as ending when the sun had "travelled" 18° below the horizon and subsequent observations have not materially modified the figure.

This quantity, 18°, has been made the measure for the interval between sunset or sunrise and "complete" darkness, and is termed *astronomical twilight;* but during a large part of this interval the light is insufficient for ordinary employments, consequently a shorter period, *civil twilight,* is also recognized for which the quantity is about 6°, but it is conditioned by the amount of light still available The duration in each case is dependent on the latitude of the observer and the season of the year. The intensity of illumination depends to a considerable extent on the amount of atmospheric cloud and dust. Twilight after the sunsets of 1883–85 was frequently intense on account of the reflection from the extra dust in the higher layers of the atmosphere as a result of the eruption of Krakatoa.

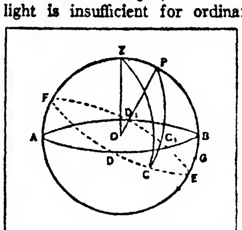

FIG. 1

The duration and possibility of *astronomical twilight* may be geometrically exhibited as follows: let O be the position of the observer; Z the zenith; P the pole of the heavens; ADB, the plane of the horizon; FDE, the path of the sun Let the circles ADB and FDE intersect in the points D and D_1 which thus correspond to sunrise and sunset. Astronomical twilight prevails during the period between the sun's position on the horizon and when it is 18° below the horizon; the arcs ZC and ZC_1 equal

108°, and terminate on the circle FDE at C and C_1. then the arcs DC and D_1C_1 represent the distance to be traversed by the sun during twilight and the arc C_1EC represents the sun path during "complete" darkness, and DFD_1 its path during the "day." To calculate CD, join CP by an arc of a great circle, then in the triangle ZPC, ZP = the colatitude of O; PC = the sun's polar distance and ZC = 108°. The angle ZPC, the sun's hour angle, then gives the time before or after noon when the sun passes C or C_1. The times of sunrise and sunset being known, the duration of dawn and twilight is a matter of simple subtraction. This represents the problem when the sun does attain a depression of 18°, but this depression may not be attained. Take ZG equal to 108°. Now if G lies beyond B and E (the maximum depression of the sun), E being also below B, then the sun will rise and set, but never descend so low as to occasion "complete" darkness and the entire interval between sunset and sunrise will be twilight.

If E be not below B but above it, the sun will never descend below the horizon, *i.e.*, will neither rise nor set, and so will give the phenomenon known as the *midnight sun*. Since the new PE = 90° − sun's declination, and PG = latitude of observer + 18°, then for there to be "complete" darkness the latitude of the observer together with the declination of the sun must exceed 72°. The maximum declination of the sun is about 23° 30′, and hence in latitude 72° − 23° 30′ = 48° 30′ there will be one day without a true night; in higher latitudes there will be an increasing number of such days; and in lower latitudes none. In mid-England there is no real night from about May 22 to July 22. To calculate the duration of *civil twilight* ZC and ZC_1 are made equal to 96° and the argument then proceeds as above.

TWILIGHT SLEEP: *see* SCOPOLAMINE.

TWILL, a woven cloth in which the passage of the weft is arranged, not in regular succession as in plain weaving, but over one thread and under two or more according to the kind of twill. This gives a succession of diagonal lines to the cloth, and though in the normal type of twill this diagonal traverses from selvage to selvage at an angle of 45°, considerable variations may be made.

TWIN FALLS, a city of southern Idaho, U.S.A., on the Snake river plateau, 40 m from the Nevada State line, the county seat of Twin Falls county It is on Federal highways 30 and 93 and the Oregon Short Line of the Union Pacific railway system. Pop. (1920) was 8,324—93% native white, 1928 estimate. 10,400. It is a trading and shipping point for a fertile irrigated region (706,000 ac. within 50 m.), producing chiefly live stock, dairy and agricultural products. The city has large wholesale and commission houses, bonded warehouses, several farmers' co-operative associations, flour mills, creameries, a fruit dehydrating plant and other manufacturing industries, converting farm products into less bulky form. There are many points of interest in the immediate vicinity. The black lava canyon of the Snake river is spanned 2½ m. N. of the city, by a bridge 476 ft above the water and 1,400 ft. long (completed in 1927). The falls from which the city and county take their name are divided into two parts by a huge mass of black lava in the middle of the river bed.

TWINS AND TWINNING. That human twins are of two kinds is now well established. Most mammals regularly or occasionally bear several young at a litter, and these are taken to arise from as many eggs matured together and ready for fertilization at one heat. Human twins of this kind are derived from two distinct eggs. In the nine-banded armadillo (*Dasypus novemcinctatus texanus*) and related species, on the other hand, a totally different cause of multiple births has been found. A single embryo is found at a certain early stage to divide and subdivide into four parts, which develop severally into four distinct offspring. In addition to producing two-egg twins the human race produces also a considerable proportion of twins derived from a single egg in a manner probably analogous to the armadillo. Man is the only mammal known to produce both kinds.

In most civilized countries account is taken of multiple births in official birth registration. These official records show approximately one in 100 twin births, one in 10,000 triplets and one in 1,000,000 quadruplets. The exact proportions vary from place to place and from period to period, but owing to the higher proportion of premature and still-births, and to variability in the rates of survival and in the completeness of registration, it is not possible safely to make international comparisons of frequency, or to discover whether the frequency is increasing or decreasing. The mortality at and soon after birth increases rapidly with increasing number born. A recent British enquiry shows that of triplet children, about half the girls and three-eighths of the boys survive; the chance of life of quadruplets is much lower. Five and even six at birth have been authentically recorded.

Sex Distribution.—Twins are more frequently of like than of unlike sex. Extensive counts extending over more than 100,000 cases show that twins are of unlike sex in nearly three cases out of eight. From such counts an estimate may be made of the frequency of one-egg twins, for these should never be of unlike sex, while of the two-egg twins half may be expected to be so. Since in fact three-eighths are of unlike sex, it may be inferred that three-quarters must be two-egg twins.

Very exceptionally twins are joined at birth; such junctions are said to be effected always between like parts, with respect to which the twins are placed symmetrically. Superficial unions are easily severed at birth More deeply united pairs seldom survive, though a few such have become celebrated for their peculiarity. Joined twins usually exhibit an abnormal disposition of the blood-vessels, known as *situs inversus,* in which the normal differences between the right and left sides of the body are in one twin at least partially reversed. This condition is not found in separate one-egg twins Joined twins are always of the same sex, and evidence points to their being always one-egg twins in which fission has remained incomplete That separate one-egg twins show symmetry reversal of palm and finger pattern has not been established.

At birth an expert can distinguish one-egg from two-egg twins by an examination of the foetal membranes in the afterbirth. In the first type the *chorion* is believed always to be single, in the second double. Although earlier accounts of the proportion of the two conditions showed serious discrepancies, the data from more modern examinations agree well with the proportion judged to be single-egg twins from the sex distribution

Degree of Resemblance.—In characters wholly determined by heredity one-egg twins should be exactly alike, whereas two-egg twins should show a degree of resemblance no greater than that between brothers and sisters by different births. When it became realized that the differences between the physical measurements of ordinary brothers and sisters were principally due to heritable differences, and that the degree of resemblance between these or other pairs of relatives could be measured statistically, attempts were made to collect measurements of twins. The importance of such attempts was great, both in putting to a decisive test the theory of human twinning, and in exploiting the direct light which one-egg twins should throw on the heritability of different characters. The discrepancies of the earlier collections emphasize the fact that severe statistical precautions are necessary to obtain sufficiently reliable data. (1) The accuracy of the individual measurements should be controlled by independent duplicate measurements. (2) The selection of cases for measurement must rigorously exclude any preference for pairs showing striking resemblance or difference. (3) Incorrect allowance for growth with age will disturb the accuracy of the results, and a sufficiently correct allowance is difficult to ascertain; this is best overcome by measurements at a fixed age.

Though often puny at birth, twins and triplets measured at ages of six years and upwards show no appreciable retardation of growth; even triplets are not infrequently well-grown at birth, and the same is occasionally true of quadruplets (fig. 1). Modern collections of measurements, in which the precautions set out above have been increasingly observed, demonstrate (1) that twins and triplets of unlike sex show resemblance in physical measurements equal to that observed between brothers and sisters by distinct births (correlation about 0·5), (2) that pairs of like sex are on the average much more closely alike (correlation about 0·73), (3) that pairs of like sex are heterogeneous in their resemblance and can be interpreted as a mixture of two groups, one with cor-

BY COURTESY OF (1, 2, 3, 4) GUNNAR DAHLBERG FROM "TWIN BIRTHS AND TWINS FROM AN HEREDITARY POINT OF VIEW," (5) THE AMERICAN GENETIC SOCIETY; PHOTOGRAPH, (6) COPR. F. M. KEYES

FULL FACE AND PROFILE VIEWS OF TWINS

Twins are characterized as uniovular or biovular. Generally speaking, uniovular twins are usually of the same sex and nearly identical, but if biovular, they merely resemble one another as brothers and sisters do, and often are of opposite sex

1, 3. Full face and profile views believed to be biovular

2, 4. Full face and profile views of twins believed to be uniovular. Likeness closer than in figs. 1, 3

5. Triplets believed to be uniovular

6. Quadruplet daughters. In this case the father was one of 12 children, among whom was one pair of twins. There was no record of twins on the mother's side. If the explanation for the appearance of the quadruplets be sought in heredity, it is attributable most probably to the father rather than to the mother

relation about 0·5, who may be regarded as two-egg twins, and the other with correlation 0·93, presumably one-egg twins; the latter from between 50 and 60% of both the twin and triplet data measured. The exceedingly high correlation indicates that the physical dimensions of the head, trunk and limbs in man are in normal conditions only influenced to about 7% of the total variation by other than heritable causes

Heredity of Twinning.—That the relatives of twins have twins somewhat more frequently than the general population has been observed by many writers; satisfactory records are, however, rare. Comparison cannot safely be made between the frequency in a selected group as recorded in reply to enquiries, and that obtained from official birth registrations. It is possible, however, to demonstrate inheritance by comparing the twin frequency of two groups of parents, one more and the other less closely related to the original twin parents. It is of the greatest importance in the collection of statistical data of this kind that the method of collection should not admit in undue proportion those striking cases of apparent inheritance often brought to the notice of the investigator. It is best to attempt to enumerate every case in a circumscribed district, or group of families, in a chosen interval of time. When these precautions are taken it is found that an excess of twins certainly occurs, both on the father's and on the mother's side of the family, the influence on the father's side being, in the material collected by the writer, apparently confined to the production of one-egg twinning The production of two-egg twins seems thus to be influenced only by the mother, and depends greatly upon her age The frequency increases at least three-fold from the age of 18 to that of 38, and is also probably influenced by inherited qualities. The frequency of one-egg twinning depends on the inheritance of the father, and probably also on that of the mother, but it is not known to be influenced by age or environmental factors

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TWO-NAME PAPER: *see* Double-name Paper.

TWO-STEP, a modern round dance in which the partners perform a series of sliding steps in $\frac{2}{4}$ time. The first step of each measure, or the slide, is longer than the second. (*See* also Dance)

TWYSDEN, SIR ROGER (1597–1672), English antiquary and royalist pamphleteer, was educated at St. Paul's school, London, and then at Emmanuel college, Cambridge. He entered Gray's Inn on Feb. 2, 1623. He succeeded to the baronetcy on his father's death in 1629. For some years he remained on his estate at Roydon, East Peckham, largely engaged in building and planting, but also in studying antiquities and the law of the Constitution. He took the most prominent part in preparing the Kentish petition of March 1642 and in subsequent demonstrations on behalf of Charles He incurred the wrath of the parliament, was arrested on April 1, 1642, but was soon let out on bail, and on his promise to keep quiet. But his respect for legality would not let him rest, and he was repeatedly in trouble with the parliament until 1650, when he compounded and went home. He lived quietly there till the Restoration, when he resumed his position as magistrate. He died on June 27, 1672. He published *The Commons' Liberty* (1648), demonstrating that finings and imprisonings by parliament were illegal; *Historiae anglicanae scriptores decem* (1652), a work encouraged by Cromwell; and *Historical Vindication of the Church of England* (1657).

TYBURN, a left-bank tributary of the Thames, England, now having its course entirely within London and below ground. The name, which also occurs as Aye-bourne, is of obscure derivation, though sometimes stated to signify Twy-burn, *i.e.* (the junction of) two burns or streams. The Tyburn rose on the southern slope of the Hampstead heights in two streams, the more westerly of which rose in the spring known as the Shepherd's Well. It ran south, crossing Regent's Park, its course being marked by Regent's Park Water, and further south by the windings of Marylebone Lane and the dip in Piccadilly near the junction of Half Moon street. It then crossed the Green Park and entered the flood plain of the Thames near where Buckingham palace now stands The exact point at which it entered the Thames is doubtful but its water is now drained off by sewer. After 1238 it supplied the city with water for a long time by means of nine conduits. The name is more famous in its application to the Middlesex gallows also called Tyburn Tree and Deadly Never Green, and also at an early period, the Elms, through confusion with the place of execution of that name at Smithfield

The Tyburn gallows stood not far from the modern Marble arch. Connaught square is said by several authorities to have been the exact site, but it appears that so long as the gallows was a permanent structure it stood at the junction of the present Edgware and Bayswater roads. The site, however, may have varied, for Tyburn was a place of execution as early as the end of the 12th century. In 1759, moreover, a movable gallows superseded the permanent erection. On some occasions its two uprights and cross-beam are said to have actually spanned Edgware road Round the gibbet were erected open galleries, the seats in which were let at high prices Among those executed here were Perkin Warbeck (1449), the Holy Maid of Kent and confederates (1535), Haughton, last prior to the Charterhouse (1535), John Felton, murderer of Villiers, duke of Buckingham (1628), Jack Sheppard (1724), Earl Ferrers (1760)

In 1661 the skeletons of Cromwell, Ireton and other regicides were hung upon the gallows The last execution took place in 1783, the scene being thereafter transferred to Newgate. The Tyburn Ticket was a certificate given to a prosecutor of a felon on conviction, the first assignee of which was exempted by a statute of William III. from all parish and ward duties

See A Marks, *Tyburn Tree, its History and Annals* (London, 1908)

TYDEUS, in Greek legend, son of Oeneus, king of Calydon and Periboea. Having slain his uncle (or other relatives) he fled for refuge to Argos, where Adrastus purified him and married him to his daughter Deipyle, who became the mother of Diomedes (*q v.*). In the expedition of the Seven (*cf* Oedipus), Tydeus who had fought valiantly, was mortally wounded by Melanippus Having killed Melanippus, he proceeded to devour his head; this so disgusted Athena, who had meant to make him immortal, that she left him to die.

See Roscher's *Lexikon*, art "Tydeus."

TYLDESLEY with SHAKERLEY, an urban district of Lancashire, England, 10 m. W.N.W. from Manchester Pop (1921) 15,650. The town, of modern growth, depends on cotton mills and collieries

TYLER, JOHN (1790–1862), tenth President of the United States, was born at Greenway, Charles City county, Virginia, on March 29, 1790. He was the second son of John Tyler (1747–1813), of English descent, governor of Virginia in 1808–11 and U.S district judge in 1812–13 John Tyler the younger entered the grammar school of the College of William and Mary, at Williamsburg, in 1802, and graduated at the college in 1807 Two years later he was admitted to the bar. His public life began in 1811, when he was elected a member of the Virginia house of delegates. Here he served for five years, being chosen also in 1815 a member of the council of State. In 1813 he raised a company for the defence of Richmond against the British, but his command was not called into action and his military service was concluded after a month. From Dec. 1816 to March 1821 he was a member of the National House of Representatives. Believing firmly in the republican principles of Jeffersonian democracy, he opposed the demand for internal improvements and increased tariff duties He declined to follow Henry Clay in the proposed recognition of the independence of the Spanish colonies in South America and in the Missouri Compromise legislation, and he condemned Jackson for his execution of Arbuthnot and Ambrister in Florida. He declined re-election to the House in 1821 because of ill-health. In 1823–25 he was again a member of the Virginia house of delegates and in 1825–27 was governor of the State. In 1827 he was sen

to the U.S. Senate to succeed John Randolph, after having been unanimously re-elected governor. In 1829–30 he also served as a member of the Virginia Constitutional Convention. His career as senator was marked by great independence of party, for his political ideas continued to be those of a thoroughgoing "strict-constructionist." Believing protective tariff duties to be unconstitutional, he voted against the "tariff of abominations" in 1828, and also against the tariff of 1832; but the compromise tariff of 1833, made necessary by the hostile attitude of South Carolina, owed its inception largely to him. His hostility to a high tariff policy, however, did not prevent his condemning the South Carolina ordinance of nullification; and in the presidential election of 1832 he supported Andrew Jackson, to whose political principles and methods he was invincibly opposed, as the "least objectionable" of the various candidates. His opinions never changed, though he aligned himself with parties as they developed. In this way he became a Whig (1833), but agreed with the Democrats on State's rights and differed from them on nationalism He sought to incorporate in a new code for the District of Columbia, in 1832, a prohibition of the slave trade in the district, at the same time opposing the abolition of slavery there without the consent of Maryland and Virginia, which had originally ceded the district to the United States. In the controversy over the removal of the Government deposits from the Bank of the United States he sided with the bank In 1833 he was again elected to the Senate, notwithstanding the criticism of his independent attitude and the wide approval of Jackson's policy in regard to the bank. In the election of 1836 he was supported as a candidate for the vice presidency by the friends of H L. White of Tennessee, the Democratic candidate opposed to M Van Buren, and received 47 votes, none of them from Virginia When the legislature of Virginia instructed its senators to support Benton's expunging resolution, Tyler, admitting the right of instruction, could not conscientiously obey, and on Feb 29, 1836, he resigned his seat In 1838 he became once more a member of the Virginia house of delegates, and was chosen president of the Virginia colonization society, of which he had long been a vice-president In 1839 he made an unsuccessful contest for the U S senatorship In December of that year the Whigs nominated W H Harrison for President and Tyler for vice-president without issuing a platform. Tyler was nominated with the expectation that he would carry the South, and in the belief that his senatorial record was a declaration of principle. Harrison and Tyler each received 234 electoral votes and were elected On April 4, 1841, one month after the inauguration, Harrison died, and Tyler became President The detailed discussion of the events of his administration, 1841–45, belongs to the history of the United States (*see* UNITED STATES: *History*).

He kept Harrison's cabinet until his veto of the bill for a "fiscal corporation," as being opposed to State's rights, led to the resignation of all the members except D. Webster, who was bringing to a close the negotiations with Lord Ashburton for the settlement of the north-eastern boundary dispute. Tyler opposed the recognition of the spoils system and kept at their posts some of the ablest of the ministers abroad. He stood, however, between the two great parties, without the support of either; Van Buren refused to recognize him as a Democrat, and the Whigs repudiated him, while, with Clay leading the majority in Congress, harmony between that body and the executive was from the first impossible The annexation of Texas, achieved just before the close of his administration, seemed to commend him for a second term, and in May 1844 he was renominated by a convention of Democrats, irregularly chosen, at Baltimore. The majority of the annexationists, however, would not support him, and he had further to meet the opposition of Van Buren, who had failed to secure the nomination in the regular Democratic Convention, and of J K. Polk, the regular Democratic nominee. Tyler accepted the Baltimore nomination, but on Aug. 20 withdrew from the contest. From this time until the eve of the Civil War he held no public office, but his opinions on political questions continued to be sought, and he was much in demand as a speaker on public occasions. In Dec. 1860 when South Carolina adopted its ordinance of secession, Tyler, though sympathizing with the State, took firm ground against disunion and exerted himself on behalf of peace. The legislature of Virginia appointed him a commissioner to confer with President Buchanan and arrange, if possible, for the maintenance of the *status quo* in the matter of Ft. Sumter, in Charleston harbour; but his efforts were unavailing. He was largely responsible for, and presided over, the Peace Congress which assembled at Washington on Feb. 4, 1861, pursuant to a resolution of the Virginia legislature. The constitutional amendment proposed by the conference did not meet with his approbation, and his action in signing and transmitting the resolution to Congress was merely formal. On Feb. 13, while in Washington on this mission, he was elected to the Virginia Convention at Richmond, and took his seat on March 1. In the convention he advocated immediate secession as the only proper course under the circumstances He continued to serve as a member of the convention until it adjourned in December, in the meantime acting as one of the commissioners to negotiate a temporary union between Virginia and the Confederate States of America. He was a member of the provisional Confederate congress in May 1861, when the capital of the Confederacy was removed from Montgomery, Ala., to Richmond, and was elected a member of the House of Representatives of the permanent Congress, but died on Jan. 18, 1862, in Richmond, before that body assembled

His son, LYON GARDINER TYLER (b. 1853), graduated at the University of Virginia in 1875 and practised law at Richmond, Va., from 1882 to 1888, when he became president of the College of William and Mary. Among his publications, besides *Letters and Times of the Tylers*, are *Parties and Patronage in the United States* (1890); *Cradle of the Republic* (1900); *England in America* (1906), in the "American Nation" series, and *Williamsburg, the Old Colonial Capital* (1908)

The principal authority is Lyon G. Tyler, *Letters and Times of the Tylers*, Richmond, Va. (1884–96). A good sketch of Tyler is in *Virginia Portraits* (1924), by Armistead Gordon

TYLER, MOSES COIT (1835–1900), American historian, was born in Griswold (Conn), on Aug 2, 1835, but his boyhood was spent in Michigan. From his graduation at Yale in 1857 until his death in Ithaca (N Y.), on Dec. 28, 1900, he alternated between a desire for a life of service in the ministry and a life of study Although he attended the Yale and Andover theological schools, held pastorates at Owego and Poughkeepsie (1859–62), and indulged in a couple of journalistic interludes, his reputation was won through his professorships at Michigan and Cornell universities and his publications, notably his *History of American Literature during the Colonial Time, 1607–1765* (1878, rev. 1897); *Literary History of the American Revolution, 1763–1783* (1897); *Three Men of Letters* (1895); and *Patrick Henry* (1887), a sound and critical biography.

See tributes by W. P. Trent in the *Forum* (Aug. 1901) and by J. W. Jenks in the *Michigan Alumnus* (March 1901). *Moses Coit Tyler: Selections from His Letters and Diaries* (1911), by Jessica T. Austen, illuminates his personality and work.

TYLER, WAT (or WALTER) (d. 1381), English rebel, was a native either of Kent or of Essex. Nothing definite is known of him previous to the outbreak of the peasant revolt in 1381, but Froissart says he had served as a soldier in the French War. The name Tyler, or Teghler, is a trade designation and not a surname. The discontent of the rural labourers and of the poorer class of craftsmen in the towns, caused by the economic distress that followed the Black Death and the enactment of the Statute of Labourers in 1351, was brought to a head by the imposition of a poll tax in 1379 and again in 1381, and at the end of May in the latter year riots broke out at Brentwood in Essex on June 4, and at Dartford; on June 6 a mob several thousand strong seized the castle of Rochester and marched up the Medway to Maidstone. Here they chose Wat Tyler to be their leader, and the rising spread over Kent. On the 10th Tyler seized Canterbury, sacked the palace of Archbishop Sudbury, the chancellor, and beheaded three citizens as "traitors." Next day he led his followers, strengthened by many Kentish recruits, on the road to London, being joined at Maidstone by John Ball

(*q.v.*), whom the mob had liberated from the archbishop's prison. Reaching Blackheath on the 12th, the insurgents burnt the prisons in Southwark and pillaged the archbishop's palace at Lambeth, while another body of rebels from Essex encamped at Mile End. King Richard II. was at the Tower, but neither the king's councillors nor the municipal authorities had taken any measures to cope with the rising. The drawbridge of London Bridge having been lowered by treachery, Tyler and his followers crossed the Thames; and being joined by thousands of London apprentices, artisans and criminals, they sacked and burnt John of Gaunt's splendid palace of the Savoy, the official residence of the treasurer, Sir Robert Hales, and the prisons of Newgate and the Fleet. On the 14th Richard II., a boy of fourteen, rode out to confer with the rebels beyond the city wall. At Mile End the king met Wat Tyler; Tyler demanded the immediate abolition of serfdom and all feudal services, and the removal of all restrictions on freedom of labour and trade, as well as a general amnesty for the insurgents. Charters were immediately drawn up to give effect to these demands Meanwhile Tyler with a small band of followers returned to the Tower, and dragged forth Archbishop Sudbury and Sir Robert Hales from the chapel and murdered them on Tower Hill. During the following night and day London was given over to plunder and slaughter. Meantime the people of property began to organize themselves for the restoration of order. On June 15 Richard rode to Smithfield for a further conference with the rebels Wat Tyler advanced from the ranks of the insurgents and shook the king's hand, bidding him be of good cheer. Tyler then formulated a number of fresh demands, including the confiscation of ecclesiastical estates and the institution of social equality. Richard replied that the popular desire should be satisfied "saving the regalities of the Crown." Tyler thereupon grew insolent, and in the altercation that ensued was killed by the mayor, Sir William Walworth (*q.v*), and John Standwick, one of the king's squires The enfranchisement of villeins granted by Richard at the Mile End conference was revoked by parliament in 1382, and no permanent results were obtained for the peasants by Wat Tyler's revolt

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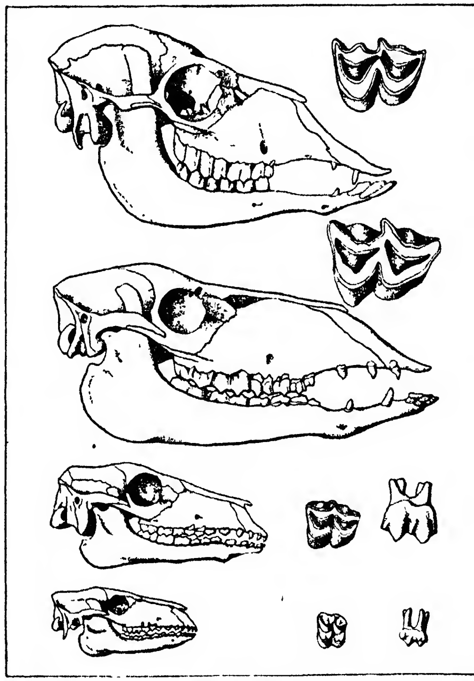
TYLER, a city of N.E. Texas, county seat of Smith county Pop. (1920) 12,085 (23% negroes), estimated locally at 20,000 in 1928. The city lies 558 ft above sea-level, between the Sabine and Neches rivers, surrounded by farmlands, five lakes and masses of forest. Pecans, fruits, berries, vegetables and cotton are the leading crops. Large nurseries specialize in pecan trees and rose plants Since 1925 the city has had an ample supply of natural gas, and oil was discovered 30 m. S. in March, 1927 The public school system includes a junior college. Tyler Commercial College (1899) trains over 4,000 students in a year. The industries had an output in 1925 of \$2,197,539. Since 1916 the city has operated under a commission-manager form of government. The East Texas Fair is held here in September. Tyler was laid out for the county seat in 1846, and was named after President Tyler. It was incorporated as a town in 1870; grew rapidly when the first railway reached it in 1871; and was chartered as a city in 1907

TYLOPODA, a section of ruminant cloven-hoofed mammals (*see* ARTIODACTYLA) including the single family Camelidae, of which the Old World camels (*see* CAMEL) and the South American llamas (*see* LLAMA) are the only living representatives The outstanding distinctions of the Tylopoda are: (1) the retention of the lateral incisors, canines and usually the first premolars as small recurved laniary tusks; (2) reduction of the remaining premolars and narrowness of the molars; (3) the peculiar form of tympanic bulla, folded in upon itself and filled with cancellous tissue; (4) elongate cervical vertebrae and peculiar course of the vertebral artery, perforating the inner side of the pedicle of the arch instead of the transverse process as in all other mammals (except *Macrauchenia*, *q.v.*); (5) carpal and tarsal bones remain separate, the trapezoid and magnum never co-ossified, nor the cuboid and navicular, while the trapezium is reduced to a small nodule in Miocene and disappears in later genera, only the ecto- and mesocuneiform are consolidated; (6) fore and hind feet completely didactyl, the lateral pair of digits absent except for small vestigial splints or nodules in the early forms, the median pair long, slender, appressed in early stages, consolidated into a cannon-bone in all later Tertiary and modern Tylopoda; (7) the distal ends of metapodials remain separate and slightly divergent, the keels of their distal facets confined to the palmar surface and not extending over the dorsal surface as in the pecora; (8) phalanges flattened and widened in varying degree and the hoof correspondingly reduced and limited to the upper surface of the terminal phalanx, conformant with the development of a heavy cutaneous pad on the palmar surface, and a digitigrade rather than unguligrade gait No horns or antlers are developed The femur and humerus are relatively elongate and the thigh and upper fore-limb are more free from the flank than in other ruminants Many features of the soft anatomy are peculiar to the



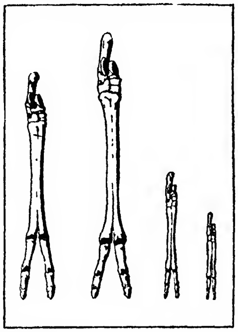
FROM SCOTT, "LAND MAMMALS OF THE WESTERN HEMISPHERE"
THE DEVELOPMENT OF THE SKULL AND MOLAR TEETH IN THE CAMEL

group; the absence of a distinct psalterium and presence of pockets for storage of liquid in the stomach, the diffuse placenta and the oval blood corpuscles are the most remarkable.

The modern camels and llamas are the remnants of a group which played an important part among the Tertiary mammals of North America, and in the Pliocene and Pleistocene found its way to South America, Asia, eastern Europe and northern Africa Fossil camels have been found in the Pleistocene of Alaska, in the Pliocene and Pleistocene of China, Siberia and Russia, the Pleistocene of Rumania and of Algeria, all of them related to the modern camels, but the Pliocene species from China and Russia are in a more primitive generic stage (*Paracamelus*). In South America the fossil Camelidae are related to the llama

group, the older forms of late Pliocene and early Pleistocene more primitive in dentition (*Palaeolama*).

The ancestry of the camels is shown in North America by a very complete fossil record from Oligocene to Pleistocene, with more doubtful predecessors in the Eocene. The earliest stage is *Protylopus* of the Upper Eocene, about the size of a jack-rabbit. It has none of the characteristics of the Tylopoda well developed but is said to show them in a rudimentary stage. *Xiphodon* and other genera from the Upper Eocene of Europe have some claim to be associated with the Tylopoda.



FROM SCOTT, "LAND MAMMALS OF THE WESTERN HEMISPHERE"

RIGHT FOOT OF THE CAMEL

Poebrotherium of the American Oligocene is the first of the undoubted ancestral line of the camels. It is about as large as a sheep and the long neck and limbs, peculiar course of the vertebral artery, the characteristic form of the tympanic bulla and the structure of teeth and feet are unmistakably camelid. The dentition is complete, the anterior teeth are all incisiform in some species, in others the canines are small, recurved, spaced tusks. The feet are two-toed, the lateral digits reduced to nodules, the median pair elongate and appressed but not co-ossified into a cannon-bone, the distal facets like those of modern Camelidae, the phalanges, however, are not flattened and probably there were no heavy pads on the feet.

Oxydactylus of the Lower Miocene has the anterior teeth small recurved tusks, the vestiges of the lateral digits have disappeared or co-ossified, the median pair is more closely appressed and the size has increased to that of a llama or larger

In *Protolabis* of the Middle Miocene the first and second upper incisors are reduced in size, the molar crowns are higher, and the metapodials are co-ossified to a varying degree in different species and at different ages. In *Procamelus* of the Upper Miocene the first and second upper incisors have disappeared, and the co-ossification of the metapodials is complete Another side branch, *Alticamelus,* in the later Miocene and Pliocene differs from *Procamelus* in the long limbs and neck and relatively small head

In the Pliocene follow a number of diverse genera incorrectly grouped under the name of *Pliauchenia,* and characterized by the loss of the second premolar in upper and lower jaw; but while they agree in this particular they differ widely in size, proportions, retention or loss of other teeth, height of molar crowns, etc. The best known is *Megatylopus,* probably identical with *Paracamelus* of the Chinese Pliocene, larger and more robust than the modern camel, with foot-pads less developed, but in most respects approximately ancestral A group of smaller species, to which the name *Pliauchenia* may be found applicable, shows a similar approach to the llamas; a third group appears to be derived from *Alticamelus,* and a fourth parallels the Virginia deer in proportions (although not related).

In the Pleistocene the genus *Camelops* has lost the third lower premolar as well as p$\frac{2}{3}$, and p^{3} is much reduced; p$\frac{1}{1}$ is present or absent in different species. It is of about the size and proportions of the modern camels, but lacks the broadly flattened toes and probably had not much padding on the foot. Another genus, akin to the llamas but with longer cannon-bones, relatively smaller head and sometimes retaining $p_{\overline{1}}$, occurs in the Pleistocene of the southern and south-western United States.

It has been generally believed that the camels became extinct in North America in the older Pleistocene, but recent evidence shows that some at least survived in Nevada until almost recent times, and probably elsewhere in the south and south-west until late Pleistocene. The splitting up of the family into the camels proper and the llama group is clearly foreshadowed in the geographical distribution of the Pliocene and Pleistocene species, many of the south-western species showing more affinities to the llamas, while those of the north-west are nearer to the camels. The Alaskan species and the Chinese *Paracamelus* make a still closer approach to the camel, and the Siwalik species is a typical *Camelus.* The Rumanian *"Camelus" alutensis* is, however, a side branch with low-crowned molars, slender jaw and retaining $p_{\overline{1}}$, related to one of the North American Pliocene groups. In South America *Palaeolama* of the early Pleistocene, while retaining the second and third premolars like *Procamelus,* is quite llama-like in details of molar construction, in characters and proportions of skull and skeleton.

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(W. D. M.)

TYLOR, SIR EDWARD BURNETT (1832–1917), English anthropologist, was born at Camberwell, London, on Oct. 2, 1832, the son of Joseph Tylor, a brassfounder. Alfred Tylor, the geologist, was an elder brother. His parents were members of the Society of Friends, at one of whose schools, at Grove House, Tottenham, he was educated. During 1855–1856 he travelled in the United States to recruit his health. Proceeding in 1856 to Cuba, he met Henry Christy the ethnologist, with whom he visited Mexico While on a visit to Cannes he wrote a record of his observations, entitled *Anahuac; or, Mexico and the Mexicans, Ancient and Modern,* which was published in 1861. In 1865 appeared *Researches into the Early History of Mankind,* which made Tylor's reputation. It showed great research, original insight and much constructive power in the formation of systematic views. The chapters on early myths and their geographical distribution are especially valuable In 1871 he published *Primitive Culture: Researches into the Development of Mythology, Philosophy, Religion, Language, Art and Custom,* which at once became the standard general treatise on anthropology. Tylor first determined the limits of animism, intending it to include "the general doctrine of souls, and other spiritual beings" In 1881 Tylor published a smaller and more popular handbook on *Anthropology.* In 1871 he was elected F.R S, and in 1883 he became keeper of the University museum at Oxford, and reader in anthropology in 1884. In 1888 he was appointed first Gifford lecturer at Aberdeen university, and delivered a two years' course on "Natural Religion." In 1896 he became first professor of anthropology at Oxford. Knighted in 1912, he died on Jan. 2, 1917.

See *Anthropological Essays,* a volume dedicated and presented to Tylor, which includes a bibliography of his publications by Miss Freire-Marreco, and an appreciation of Tylor by Andrew Lang.

TYMPANON or **TYMPANUM,** a name applied by the Romans to both kettledrum and tambourine. Pliny described half pearls having one side round and the other flat as *tympania.* In architecture the tympanum is the triangular space enclosed between any horizontal feature and any form of gable above it Though sometimes left plain, in the most celebrated Greek temples it was filled with sculpture of the highest standard ever attained

TYNAN, KATHERINE (Hinkson) (1863–), English novelist and poet, was born in Ireland where she lived until her marriage in 1893 to H. A. Hinkson, author and barrister. She published her first volume of verse, *Louise de la Vallière,* in 1885. She is a prolific and versatile novelist and the author of many admirable children's books; she has written miracle plays, and edited several anthologies. Her best work is in poetry, where she expresses religious feeling and love of Ireland with tenderness and charm.

Her publications include: *The Land of Mist and Mountain* (1895); *Miracle Plays* (1896); *The Handsome Brandons* (1896); *A Book of Memory* (1906); *Irish Poems* (1913); *The Middle Years* (1917); *Wives* (1924); *The Infatuation of Peter* (1926).

TYNDALE (or TINDALE), **WILLIAM** (*c.* 1492–1536), translator of the New Testament and Pentateuch (*see* BIBLE, ENGLISH), was born on the Welsh border, probably in Gloucestershire, some time between 1490 and 1495. In Easter term 1510 he went to Oxford, where Foxe says he was entered at Magdalen

Hall. He took his M.A. degree in 1515 and removed to Cambridge, where Erasmus had helped to establish a reputation for Greek and theology. Ordained to the priesthood, probably towards the close of 1521, he entered the household of Sir John Walsh, Old Sodbury, Gloucestershire, as chaplain and domestic tutor. Here he lived for two years, using his leisure in preaching in the villages and at Bristol, conduct which brought him into collision with the backward clergy of the district, and led to his being summoned before the chancellor of Worcester (William of Malvern) as a suspected heretic; but he was allowed to depart without receiving censure or being given any undertaking.

Translation of the Bible.—But the persecution of the clergy led him to seek an antidote for what he regarded as the corruption of the Church, and he resolved to translate the New Testament into the vernacular. In this he hoped to get help from Cuthbert Tunstall, bishop of London, and so "with the good will of his master" he left Gloucester in the summer of 1523. Tunstall disappointed him, so he got employment as a preacher at St. Dunstan's-in-the-West, and worked at his translation, living as chaplain in the house of Humphrey Monmouth, an alderman, and forming a firm friendship with John Frith, but finding publication impossible in England, he sailed for Hamburg in May 1524 After visiting Luther at Wittenberg, he settled with his amanuensis William Roy in Cologne, where he had made some progress in printing a 4to edition of his New Testament, when the work was discovered by John Cochlaeus, dean at Frankfurt, who not only got the senate of Cologne to interdict further printing, but warned Henry VIII and Wolsey to watch the English ports. Tyndale and Roy escaped with their sheets to Worms, where the 8vo edition was completed in 1526 Copies were smuggled into England but were suppressed by the bishops, and William Warham, archbishop of Canterbury, even bought up copies on the Continent to destroy them. Attempts were made to seize Tyndale at Worms but he found refuge at Marburg with Philip, landgrave of Hesse.

Other Works.—About this time he changed his views on the Eucharist and swung clean over from transubstantiation to the advanced Zwinglian position His *Parable of the Wicked Mammon* (1528), *Obedience of a Christen Man* (1528), in which the two great principles of the English Reformation are set out, viz. the authority of Scripture in the Church and the supremacy of the king in the state, and *Practyse of Prelates* (1530), a strong indictment of the Roman Church and also of Henry VIII.'s divorce proceedings, were all printed at Marburg In 1529 on his way to Hamburg he was wrecked on the Dutch coast, and lost his newly completed translation of Deuteronomy Later in the year he went to Antwerp where he conducted his share of the classic controversy with Sir Thomas More.

After Henry VIII 's change of attitude towards Rome, Stephen Vaughan, the English envoy to the Netherlands, suggested Tyndale's return, but the reformer feared ecclesiastical hostility and declined Henry then demanded his surrender from the emperor as one who was spreading sedition in England, and Tyndale left Antwerp for two years, returning in 1533 and busying himself with revising his translations. In May 1535 he was betrayed by Henry Phillips, to whom he had shown much kindness, as a professing student of the new faith. The imperial officers imprisoned him at Vilvorde Castle, the state prison, 6 m. from Brussels, where in spite of the great efforts of the English merchants and the appeal of Thomas Cromwell to Archbishop Carandolet, president of the council, and to the governor of the castle, he was tried for heresy and condemned. On Oct. 6, 1536 he was strangled at the stake and his body afterwards burnt.

Though long an exile from his native land, Tyndale was one of the greatest forces of the English Reformation. His writings show sound scholarship and high literary power, while they helped to shape the thought of the Puritan party in England. His translation of the Bible was so sure and happy that it formed the basis of subsequent renderings, especially that of the authorized version of 1611. Besides the New Testament, the Pentateuch and Jonah, it is believed that he finished in prison the section of the Old Testament extending from Joshua to Chronicles.

Beside the works already named Tyndale wrote *A Prologue on the Epistle to the Romans* (1526), *An Exposition of the 1st Epistle of John* (1531), *An Exposition of Matthew v.-vii.* (1532), a treatise on the sacraments (1533), and possibly another (no longer extant) on matrimony (1529)

The works of Tyndale were first published along with those of John Frith (*q.v.*) and Robert Barnes, "three worthy martyrs and principal teachers of the Church of England," by John Day, in 1573 (folio). A new edition of the works of Tyndale and Frith, by T Russell, was published at London (1828–1831). *His Doctrinal Treatises and Introductions to Different Portions of the Holy Scripture* were published by the Parker Society in 1848. For biography, *see* Foxe's *Acts and Monuments;* R. Demaus, *William Tyndale* (1871), also the Introduction to Mombert's critical reprint of Tyndale's Pentateuch (1884), where a bibliography is given.

TYNDALL, JOHN (1820–1893), British natural philosopher, was born in Co. Carlow, Ireland, on Aug. 2, 1820. Tyndall was to a large extent a self-made man; he was stimulated to earnest study by the writings of Carlyle He passed from a national school in Co Carlow to a minor post (1839) in the Irish ordnance survey, thence (1842) to the English survey, attending mechanics' institute lectures at Preston in Lancashire He then became for a time (1844) a railway engineer, and in 1847 a teacher at Queenwood College, Hants Thence with much spirit, and in face of many difficulties, he betook himself, with his colleague Edward Frankland, to the university of Marburg (1848–1851), where, by intense application, he obtained his doctorate in two years. His dissertation was an essay on screw-surfaces

Tyndall's contributions to science are due more to his personality and his gift for making difficult things clear rather than to his original researches He became known through some early magnetic investigations and was elected F R S. in 1852 In May 1854 he was chosen professor of natural philosophy at the Royal Institution, a post which exactly suited his striking gifts and made him a colleague of Faraday, whom in 1866 he succeeded as scientific adviser to the Trinity House and Board of Trade, and in 1867 as superintendent of the Royal Institution. His reverent attachment to Faraday is beautifully manifested in his memorial volume called *Faraday as a Discoverer* (1868).

With his friend Huxley he went to Switzerland to study the motion of glaciers; his views brought him into conflict with Forbes and James Thomson

Tyndall's investigations of the transparency and opacity of gases and vapours for radiant heat, which occupied him during many years (1859–1871), are frequently considered his chief scientific work (*See* HEAT) But his activities were essentially many-sided He definitely established the absorptive power of clear aqueous vapour—a point of great meteorological significance He made brilliant experiments elucidating the blue of the sky, and discovered the precipitation of organic vapours by means of light. He called attention to curious phenomena occurring in the track of a luminous beam He examined the opacity of the air for sound in connection with lighthouse and siren work, and he finally verified what had been already substantially demonstrated, viz., that germ-free air did not initiate putrefaction

Tyndall's devotion to science for its own sake may be seen in his treatment of the money which came to him in connection with his successful lecturing tour in America (1872–1873) He placed the money amounting to several thousand pounds in the hands of trustees for the benefit of American science—an act of lavishness which bespeaks a noble nature He took some part in the controversy over theological problems which was going on at the time. He died at Hindhead on Dec 4, 1893.

For the substantial publication of his researches reference must be made to the *Transactions of the Royal Society;* but an account of many of them was incorporated in his best-known books, namely, the famous *Heat as a Mode of Motion* (1863, and later editions to 1880), the first popular exposition of the mechanical theory of heat, which in 1862 had not reached the text-books; *The Forms of Water*, etc (1872); *Lectures on Light* (1873); *Floating Matter in the Air* (1881); *On Sound* (1867; revised 1875, 1883, 1893). The original memoirs themselves on radiant heat and on magnetism were collected and issued as two large volumes under the following titles: *Diamagnetism and Magne-crystallic Action* (1870); *Contributions to Molecular Physics in the Domain of Radiant Heat* (1872).

TYNDARIS, an ancient city on the northern coast of Sicily, 5 m. east of Patti. It was founded (almost the last Greek city

in Sicily) by Dionysius the Elder in 395 B.C. It was one of the earliest allies of Timoleon. In the first Punic War it was dependent on Carthage, but expelled the Carthaginian garrison in 254 B.C. and joined the Romans. It was one of the points occupied by Sextus Pompeius, but was later used by Agrippa as a base. Pliny mentions that half of it (the north and north-east portion) was swallowed up by the sea (*Hist. nat.* ii 206). The site is fine, an isolated hill (920 ft.) with spurs, rising abruptly seaward, and connected by a narrow isthmus with the lower ground inland. It has a magnificent view, including even the summit of Etna.

Remains of the city walls, built of rectangular blocks of stone, with several towers may be seen, and the main gate, on the land side, is traceable. Within are remains of a building incorrectly called the gymnasium, constructed of ashlar masonry, with three narrow halls, each about 90 ft. long; of a building with mosaic pavements, and a small theatre, the internal diameter of which is 212 ft., and the length of the stage 80 ft.

See R. V. Scaffidi, *Tyndaris* (Palermo, 1895). (T. A.)

TYNE, river in England, flowing into the North sea. The North Tyne rises, 80 m. from the mouth, at the south-west end of the Cheviot Hills, and has a wooded valley. At Bellingham it receives the Rede, whose valley, Redesdale, is the site of the battle of Otterburn (1388). The South Tyne rises below Cross Fell and flows north past Alston as far as Haltwhistle, where it turns east. The valley receives from the south the picturesque Allendale. The two branches join near Warden, above Hexham (30 m. from the sea) and the united stream continues past Corbridge, where a Roman road crossed it. In its last 15 m. the Tyne, here the boundary between Northumberland and Durham, is an important waterway, navigable up to Blaydon. Collieries and large towns line the banks—Newburn, Newcastle-upon-Tyne, Wallsend and North Shields on the north side; Gateshead, Jarrow and South Shields on the Durham side, with many lesser centres, forming continuous lines of factories and shipbuilding yards, necessitating the dredging of the river. At high-water spring tides there is 40 ft. of water at Shields Harbour at the river's mouth, and 29 ft. at Newcastle, 8 m. up the river.

TYNEMOUTH, municipal, county and parliamentary borough, Northumberland, England, including the townships of Chirton, Cullercoats, North Shields, Preston and Tynemouth. Pop. (1921) 63,770. North Shields, Tynemouth and Cullercoats are successive stations on a branch of the L.N.E.R. Tynemouth lies on the north bank of the Tyne, 8½ m. E. of Newcastle. Tynemouth is the principal watering-place and residential district on this part of the coast. On the point of the promontory on which it stands is a small battery called the Spanish battery. Within the grounds, to which the gateway of the old castle gives entrance, are the ruins of the ancient priory of St. Mary and St. Oswin—the principal remains being those of the church, which was a magnificent example of Early English work engrafted upon Norman. The municipal buildings are in North Shields, which is also an important seaport. (*See* North Shields.)

Although Roman remains have been discovered, the early history centres round the priory, founded (617–633) by Edwin, king of Northumbria. In 651, Oswin, king of Deira, was buried here. After the conquest Malcolm, king of Scotland, and Edward his son, were also buried here. Earl Waltheof gave Tynemouth to the monks of Jarrow, and it became a cell to the church of Durham, but later, to the abbey of St. Albans in Hertfordshire. The priory was probably fortified in Saxon times, and was strengthened by Robert de Mowbray. After the Dissolution the fortifications were repaired by Henry VIII. In 1642 it was garrisoned for the king by the earl of Newcastle, but surrendered to parliament in 1644. It became barracks at the end of the 18th century.

Tynemouth and North Shields did not become important until the 19th century; the establishing of a port here and holding of fairs being prevented by the people of Newcastle. Before that time charters were granted in 1203 and 1204 to the prior and convent, and include freedom from toll, etc. In 1292 there were disputes between the citizens of Newcastle and the prior, who had built a quay at North Shields, but was obliged by act of parliament to destroy it. Edward IV. in 1463 confirmed the previous charters of the monks, and at the same time gave them and their tenants licence to buy necessaries from ships in the "port and river of Tyne," and to load ships with coal and salt. After the Napoleonic wars the trade of North Shields rapidly increased. The borough was incorporated in 1849, and has returned one member to parliament since 1832.

TYPE, PRINTING: *see* Printing Type.

TYPE-CASTING MACHINES: *see* Printing Type; Printing.

TYPE METAL. An alloy containing antimony as the essential constituent; the other ingredient being lead, often with addition of tin and less frequently of copper. Metallic type containing antimony was used in the 17th century (Basil Valentine).

Antimony increases the fusibility and hardness of metals with which it is alloyed and imparts to these alloys its characteristic property of expansion on solidification Typical alloys for printing type have the following proportions:—

	Lead	Antimony	Tin	Copper
Type metal	60	30	10	
"	70	18	10	2
"	77·5	16	6·5	..
"	82	15	3	..
Stereotype Metal	85 7	14·3		
" "	82 5	13	4 5	.
Linotype Metal	84 5	13 5	2	..
" "	82	13	5	
Cheap Linotype Metal	85 5	11	3 5	

The proportions given for linotype metals approximate fairly closely to the most fusible (eutectic) alloy of lead (85%), antimony (13%), with an addition of tin (2%). This alloy has the comparatively low melting point of 246°C, a degree of fusibility which renders it useful in the production of this form of type.

Type metal, being easily cast, is used for statuettes, metallic candlesticks and other decorative objects. A lead-antimony alloy (lead two parts to one of antimony) is used for the metallic keys of certain reed musical instruments.

So-called *hard lead* or *antimonial lead* containing antimony (15%) and lead (85%) is used for chemical stopcocks, *e g.*, in the sulphuric acid industry. (G. T. M.)

TYPE SETTING: *see* Printing and Typography.

TYPEWRITER, a machine which prints characters in sequence, performing the work of writing at a speed far greater than is possible with the pen. Formerly the term "typewriter" was also applied to the operator, but more recently the operator has become known as a "typist."

Early Machines.—The first recorded attempt to invent a typewriter is found in the records of the British Patent Office. These show that on Jan. 7, 1714, a patent was granted by Queen Anne to Henry Mill, an English engineer, for "an Artificial Machine or Method for the Impressing or Transcribing of Letters Singly or Progressively one after another, as in Writing, whereby all Writing whatever may be Engrossed in Paper or Parchment so Neat and Exact as not to be distinguished from Print." Mill's machine was never manufactured. Only one other attempt was recorded in the 18th century. This was a machine invented in 1784 for embossing characters for the blind. The first American patent on a typewriter was granted in 1829 to William Austin Burt of Detroit. The only model of this machine was destroyed by fire at the Washington Patent Office in 1836.

In 1833, a French patent was granted to Xavier Progin (or Projean), of Marseilles, for a device which he described as a "Ktypographic" machine or pen. It consisted of an assembly of bars with type, each type striking downward upon a common centre. The Progin device was the prototype of all our present type-bar machines. The next important step was taken by Charles Thurber of Worcester, Mass., to whom an American patent was granted in 1843. In this machine the letter spacing was effected by the longitudinal movement of a cylinder or platen, a principle which is a feature of all present-day standard writing machines. A different model, brought out by Thurber in the year 1845, was designed to perform the motions of the hand in writing, and was intended for the blind. In the previous year a machine,

PHOTOGRAPH, (5) THE ROYAL TYPEWRITER COMPANY, INC., (7) THE REMINGTON RAND BUSINESS SERVICE, (8) THE UNDERWOOD TYPEWRITER COMPANY, (9) L. C. [illegible] TYPEWRITERS, INC.

EVOLUTION OF THE TYPEWRITER

1. Thurber's Machine, 1843
2. Francis' Machine, 1857
3. Sholes, Glidden and Soule Machine, 1868
4. The first shift-key typewriter, 1878
5. Royal Standard Typewriter, 1914
6. The first practical typewriter, 1874
7. Remington Noiseless Typewriter, 1925
8. Bookkeeping Machine, 1928
9. Portable typewriter, 1924

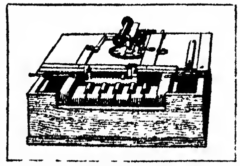
also intended for the blind, was shown by Littledale at the York meeting of the British Association Pierre Foucault, a teacher in the Paris Institute for the Blind, patented a machine in 1849 that was shown at the great exhibition in London in 1851, and is said to have embossed characters for the blind admirably.

From 1850 the attempts became more numerous. Among those who took out patents in America during this period were Oliver T. Eddy of Baltimore, in 1850, J. B Fairbanks, 1850, J. M. Jones of Clyde, N.Y., 1852, R. S. Thomas of Wilmington, N.C., 1854, Alfred Ely Beach of New York, 1856, J H. Cooper of Philadelphia, 1856, Dr. Samuel W. Francis of New York, 1857, Henry Harger, 1858, F. A. de May of New York, 1863, Benjamin Livermore of Hartland, Vt., 1863, Abner Peeler of Webster City, Ia., 1866, Thomas Hall, 1867, and John Pratt of Centre, Ala., who in 1866, while a resident in London, produced a device called the "Pterotype" (winged type), which operated on the type-wheel principle. Contemporary efforts by European inventors were those of Sir Charles Wheatstone in England, who constructed several experimental models between 1855–60; the Ravissa machine in Italy belongs to that period, and the models built by Peter Mitterhofer of the Tyrol, in 1864 and 1866. Among the most promising of these efforts were those of Beach and Francis. Beach's machine operated in much the same manner as a modern typewriter, but it wrote only on a narrow ribbon of paper. This machine, like so many others of this period, was designed for the blind, and printed raised letters which could be read by touch The machine invented by Dr. Francis was a bulky affair, with keys like those of a piano. Type-bars were arranged in a circle, printing at a common centre.

First Practical Typewriter.—The invention of three residents of Milwaukee, Wis., Christopher Latham Sholes, Carlos Glidden and Samuel W. Soulé, in 1867, resulted in the first practical machine. Soulé soon retired from the undertaking, but Sholes, within five years, made nearly 30 experimental models. The first of these, showing the working principles only, was covered in patent of June 23, 1868. The second one, patent of July 14, 1868, was the first efficient typewriter model, in that it would write well, at a speed far exceeding the pen It was still, however, a very crude machine, lacking the now familiar typewriter carriage, with its paper cylinder, and the keyboard in its present form. Many improvements followed and finally, on Mar. 1, 1873, a contract was made with E. Remington and Sons, gunmakers, of Ilion, N.Y., for the development and manufacture of the Sholes and Glidden machine. The first completed typewriters were placed on the market early in 1874 and the machine was soon re-named the Remington. Among its original features which remain standard in 1928 machines are the paper cylinder, with its line-spacing and carriage-return mechanism, the escapement which causes the letter spacing, the arrangement of the type-bars so as to strike the paper at a common centre, the actuation of the type-bars by means of key levers and connecting wires, printing through an inked ribbon, and the positions of the different characters on the keyboard, which conform almost exactly to the arrangement now known as "universal."

The first typewriter had no shift-key mechanism—it wrote capital letters only. The problem of printing both capitals and small letters without increasing the number of keys was solved by placing two types, a capital and small face of the same letter, on each bar, in combination with a cylinder-shifting mechanism. The first shift-key typewriter appeared on the market in 1878. Soon there appeared another solution of the same problem in the so called single key- or double keyboard machines, which contained twice the number of keys—one for every character, whether capital or small letter. For many years the single-key and the shift-key machines competed for popular favour, but the advent of the "touch method" of typing, for which the compact keyboard of the shift-key machines was far better suited, decided this issue. Touch typing was slow in its early progress and before the '90s was practised only by operators of exceptional skill. In the latter decade, however, it rapidly gained acceptance and since 1900 it has been practically the universal method of instruction.

Another early issue in the field of the typewriter concerned the relative merits of the type-bar and the type-wheel principles. The latter construction traces its descent through the Burt machine of 1829 and the Pratt machine of 1866. In modern machines of this variety the types are mounted on a circle or segment, the operation of the keys brings each type to correct printing position, and the imprint of type on paper is produced by a trigger action. The type-wheel machines offer an advantage in the ease with which the type segments may be changed, thus extending the range and versatility of the machine. However, machines of this construction have never been very serious competitors of the type-bar machines in the general commercial field. On nearly all typewriters the printing is done through an inked ribbon, which is fitted on spools, travels with the operation of the machine, and reverses automatically when one spool becomes completely unwound, the latter improvement dating from the year 1896.



BY COURTESY OF THE REMINGTON TYPEWRITER CO

SHOLES' FIRST MODEL OF THE TYPEWRITER

Following the first shift-key typewriter of 1878, the next great advance was the advent of visible writing. On all of the early type-bar machines the bars were arranged in a circular "basket," located underneath the carriage, and the type printed at a common point on the under side of the cylinder. This construction compelled the operator to raise the carriage in order to see the writing line. The first visible writing machine appeared in 1883. The earlier visible machines employed the down-stroke principle, the type striking on top of the cylinder Later the front-stroke machines took the lead in the general business field, the first machine of this type to attain prominence dating from 1897. In front-stroke machines the type-bars are placed in a segment in front of the carriage, the type printing on the front of the cylinder. This solved the problem of visible writing and all writing machines of the leading standard makes are of this type

Recent Developments.—Since the advent of visible writing there have been two other major developments in the general typewriter field, the development of the portable and the noiseless machine. The former—small, light, compact and easily carried—is especially designed for the owner's personal use. The earliest of these was a small machine of the type-wheel variety. The first type-bar portable to attain a considerable market appeared in 1912. Type-bar portable machines of all the leading makes are on the market, and their sale is extending the use of the typewriter to every kind of personal writing. The noiseless machine is a front-stroke machine of the type-bar variety, equipped with the usual standard keyboard. It differs, however, from other type-bar machines in that the printing is done not by percussion but by pressure, thus reverting to the principle of the printing press. This is accomplished by means of a little weight on the back of the type-bar. As the type-bar starts, this weight gathers momentum and presses the type against the paper, swiftly and noiselessly. It is too early as yet to predict the future of the noiseless typewriter, but it is obviously growing in popularity.

Form and Tabular Work.—The extension of the uses of the typewriter to form and tabular work of every kind constitutes a distinct and separate development During the first 25 years of its history, the time-saving service of the typewriter was confined almost entirely to straight, line-by-line writing, such as letter and manuscript writing, and the like. This limitation was due to the lack of any mechanism for the instantaneous setting of the carriage at any desired writing point. This need, however, was supplied by the decimal tabulator, which appeared in 1898. This device permitted the writing of columns of figures, anywhere on the page and as many as the page would hold, with the same speed as ordinary work. From this improvement the advance to the machine which would add the columns as written was a natural transition. The first *adding typewriters* added in vertical columns only, but from these in turn have been evolved the complete book-keeping or accounting machines, which write and add (or subtract)

simultaneously, both vertically and across the page, in any combination that the work requires In this field the standard typebar machines, with tabulating and computing mechanisms, have a competitor in the so-called flat-platen machine, which is similar in its combined writing and adding performance, but prints on a flat bed instead of a travelling and revolving cylinder. (*See* TABULATING MACHINES)

The service rendered by the accounting or book-keeping machine is broadly that of the ordinary typewriter, intensified. The combination in one operation of two tasks, writing and adding, eliminates the separate adding cost A further advantage is the error proofing of every task, the machine furnishing its own accounting controls. The application of electricity to the operation of the machine has made its greatest advance in the accounting machine field At least one operation, the return of the carriage, is usually performed by electric drive In the general typewriting field, more than one manufacturer has already brought out a machine which is electrically operated

The typewriter has been one of the great transforming factors of modern business One problem which confronted the writing machine in its early days was the securing of competent operators. Out of this need arose the modern commercial school, now a prominent feature in the educational system of every country. Socially the changes wrought by the typewriter have been even more noteworthy. Everywhere except in oriental countries the majority of stenographers and typists are women, and it is historically established that in all western countries, beginning with America, it was the typewriter that first opened to women the doors of business life (A. C Re)

TYPHOID FEVER. Typhoid is a specific infectious fever caused by B. typhosus (*see* BACTERIA AND DISEASE) and characterized mainly by its insidious onset, peculiar course of the temperature, specific lesion of the bowels and eruption upon the skin. The disease has received various names, such as enteric fever (*q v*), gastric fever, abdominal typhus, infantile remittent fever, slow fever, nervous fever, "pythogenic fever," etc. Here, typhoid fever according to its modern interpretation is considered, but much that is said on dissemination, prevalence, etc, is also true for the paratyphoid fevers.

Though typhoid fever is a general infection producing respiratory (bronchitis), cutaneous ("rose spots") and occasionally periosteal lesions the most noticeable effects occur in the lower part of the small intestine (ileum), particularly about the ileocaecal valve and concern the "solitary glands" and "Peyer's patches." These glands, comparatively indistinct in health, become inflamed, large and prominent during the first 8–10 days of the fever. During the second week these enlarged glands necrose and are cast off in mass or in fragments into the lumen of the gut, leaving ulcers in its walls. These ulcers may be few or many in number, and are usually oblong, with their long axis in that of the bowel, and have thin and ragged edges They may extend through the thickness of the intestine to the peritoneal coat and in their progress erode blood-vessels or perforate the bowel. This stage of ulceration exists from the second week onwards during the remaining period of the fever, and even into the stage of convalescence. In favourable cases the ulcers heal by cicatrization without contraction of the calibre of the bowel. The intestinal lesions do not appear synchronously so that all the above stages may be found at the autopsy of a fatal case. The mesenteric glands and the spleen become enlarged during the progress of the fever, but usually subside after recovery.

Symptoms.—The onset of typhoid fever is very much less marked than that of most other fevers Early symptoms are headache, lassitude and discomfort, together with sleeplessness and feverishness, particularly at night. The peculiar course of the temperature is also one of the most important diagnostic evidences of this fever. During the first week it rises by steps. Thus the morning temperatures on the first four days might be 99°, 100°, 101°, 102° F, the corresponding evening temperatures being 101°, 102°, 103°, 104° F About the eighth day, in an average case the highest point is attained. During the second and third weeks temperature remains high with but slight morning remission. In a favourable case during the fourth week gradual return to normal begins to take place. Although the patient may, during the earlier days of the fever, be able to move about, he feels languid and uneasy; and usually before the first week is over he has to take to bed. He is restless, hot and uncomfortable, particularly as the day advances, and his cheeks show a red flush, especially in the evening or after taking food. From an early period in the disease the abdomen is somewhat distended and pain accompanies light pressure about the lower part of the right side close to the groin—the region corresponding to that portion of the intestine in which the morbid changes already referred to are progressing. Diarrhoea is a frequent but by no means constant symptom. When present it may be slight or extremely profuse, and it corresponds, as a rule, to the severity of the intestinal ulceration. The discharges are light yellow and resemble pea soup Should intestinal haemorrhage occur, they may be dark brown, tarry or composed entirely of blood About the beginning, or during the course of the second week of the fever, an eruption frequently makes its appearance on the skin It consists of isolated oval or round spots, of a pale pink or rose colour, and of about one to one and a half lines in diameter As a rule they are few in number and are seen chiefly upon the abdomen, chest and back, and come out in crops, which continue for four or five days and then fade away When present crops continue to come out till nearly the end of the fever, and they may reappear should a relapse subsequently occur The symptoms persist throughout the third week, usually, however, increasing in intensity By the end of the third week the patient is prostrate and emaciated, the tongue is dry and brown, the pulse quickened and feeble, and the abdominal symptoms marked, while nervous disturbance is exhibited in delirium in tremors and jerkings of the muscles Convalescence proceeds slowly and is apt to be interrupted by relapses

Death in typhoid fever usually takes place from one of the following causes (1) Exhaustion in the second or third weeks, or later. Sometimes sinking is sudden, from heart failure (2) Haemorrhage from the intestines The evidence of this is exhibited not only in the evacuations, but in the sudden fall of temperature and rise in pulse-rate, together with great pallor, faintness and rapid sinking Sometimes haemorrhage, to a dangerous and even fatal extent, takes place from the nose (3) Perforation of an intestinal ulcer. This gives rise, as a rule, to sudden and intense abdominal pain, together with vomiting and signs of collapse, viz, a rapid flickering pulse, cold clammy skin, and the marked fall of temperature Symptoms of peritonitis quickly supervene and death usually takes place within 24 hours. (4) Occasionally, but rarely, hyperpyrexia (excessive fever) (5) Complications, such as pulmonary or cerebral inflammation.

Certain sequelae are sometimes observed, the most important being phlebitis (*q v*), periostitis affecting long bones, general ill-health and anaemia, with digestive difficulties, often lasting for a long time, and sometimes issuing in pulmonary tuberculosis Occasionally, after severe cases, mental weakness is noticed, but it is usually of comparatively short duration The prognosis of typhoid varies widely and is greatly influenced by the quality of the nursing. Nevertheless it is distinctly worse in tropical than in temperate climates and is one of the most feared diseases among Europeans in India

The susceptibility of individuals to the typhoid bacillus varies greatly. Some persons appear to be quite immune The most susceptible age is adolescence and early adult life; the greatest incidence, both among males and females, is between the ages of 15 and 35 The aged rarely contract it Men suffer considerably more than women, and they carry the period of marked susceptibility to a later age.

Dissemination.—The sick, from whose persons the germs of the disease are discharged, are always an immediate source of danger to those about them. There is evidence that this is the case with armies in the field, *e.g.*, the conclusions of the commission appointed to inquire into the origin and spread of enteric fever in the military encampments of the United States in the Cuban campaign of 1898. Out of 1,608 cases most thoroughly investigated, more than half were found to be due to direct and

indirect infection in and from the tents (Childs: Sanitary Congress, Manchester, 1902). A similar but perhaps less direct mode of infection was shown to account for a large number of cases under more ordinary conditions of life in the remarkable outbreak at Maidstone in 1897 (*see* below), which was also subjected to very thorough investigation. It was undoubtedly caused in the first instance by contaminated water, but 280 of the later cases were attributed to secondary infection, either direct or indirect, from the sick. A good deal of evidence to the same effect by medical officers of health in England has been collected by Dr. Goodall, who has also pointed out that the attendants on typhoid patients in hospital are much more frequently attacked than is commonly supposed (*Trans. Epidem. Soc.* vol xix).

Discoveries as to the part played in the dissemination of typhoid fever by "typhoid carriers" (*see* CARRIERS) have thrown light upon the subject of personal infection. The subject was first investigated by German hygienists in 1907, and it was found that a considerable number of persons who have recovered from typhoid fever continue to excrete typhoid bacilli in their faeces and urine (typhoid bacilluria). The liability of a patient to continue this excretion bears a direct relation to the severity of his illness, and it is probable that the bacilli multiply in the gall bladder, from which they are discharged into the intestine with the bile. The condition in a small number of persons may persist indefinitely In 101 cases investigated, Kayser found three still excreting bacilli two years after the illness, and George Deane has recorded a case in which bacilli continued to be excreted 29 years afterwards

Many outbreaks have in recent times been traced to typhoid carriers, one of the first being the Strassburg outbreak The owner of a bakehouse had had typhoid fever ten years previously, and it was noticed that every fresh employé entering her service developed the disease She prepared the meals of the men. On her exclusion from the kitchen the cases ceased In Brentry reformatory, near Bristol, an outbreak numbering 28 cases was traced to a woman employed as cook and dairymaid who had had typhoid fever six years previously Before entering the reformatory she had been cook to an institution for boarded-out girls, and during her year's residence there 25 cases had occurred Numerous cases of contamination of milk supplies by a "carrier" have been investigated, and in outbreaks traced to dairies it is wise to submit the blood of all employés to the agglutination test

The other means of dissemination are polluted soil, food and drink, particularly milk and water The mode in which polluted soil acts is by contamination of water-supply Exhalation is not regarded as a channel of communication The researches of Majors Firth and Horrocks prove that dust, flies and clothing may convey the germs Another way in which food becomes the medium of conveyance is by the contamination of oysters and other shellfish with sewage containing typhoid bacilli This has been abundantly proved by investigations in Great Britain, America and France. Uncooked vegetables, such as lettuce and celery, may convey the disease in a similar way. The most familiar and important medium, however, is water It may operate directly as drinking water or indirectly by contaminating vessels used for holding other liquids, such as milk cans. Outbreaks have been traced to ginger-beer and ice-creams. Water sources become contaminated directly by the inflow of drains or the deposit of excretal matter; indirectly, and more frequently, by the leakage of sewage into wells or by heavy rains which wash sewage matter and night-soil from ditches and the surface of the land into springs and watercourses. Water may further be contaminated in the mains by leakage, in domestic cisterns and in pipes by suction.

Prevalence.—Typhoid fever is more or less endemic and liable to epidemic outbreaks all over the world It has undergone marked and progressive diminution in many countries coincidently with improved sanitation, particularly in regard to drainage and water-supply. The case of Munich is so instructive that it deserves special mention. For many years typhoid was excessively prevalent in that city. The prevalence was continuous, but aggravated by large epidemic waves, extending over several years. These gradually decreased in magnitude, and ceased towards the end of 1880. Subsequently the prevalence still further diminished, the average annual mortality per million falling from 2,024 in 1851–1860, 1,478 in 1861–1870 and 1,167 in 1871–1880 to 160 in 1881–1890 and 52 in 1891-1900.

An examination of the relative incidence of typhoid in the counties of England and Wales (Bulstrode) goes to show that its prevalence, broadly regarded, is not capricious The areas of maximum and minimum incidence remained practically the same throughout the twenty years 1871–1890, though there was everywhere a large diminution. This fact suggests that standing conditions may be as important as those accidental occurrences which attract public attention by causing sudden and explosive outbreaks When these are on a small scale they may be due to milk; on a large scale they are always water-borne and caused by sudden contamination of a public supply. The classical example is Maidstone That outbreak began towards the end of August 1897, and within six weeks some 1.500 persons were attacked The total number of cases was 1,847, with 132 deaths, in a population of about 34 000. With the exception of 280 cases of secondary infection, which lingered on till the following January, they all occurred before the 18th of October, and the disease subsided almost as rapidly as it arose A mass of evidence of different kinds left no possibility of doubt that accidental contamination of a water-supply was the cause Perhaps the most striking point is that Maidstone was supplied with water from three different sources, known as Cossington, Boarley and Farleigh, and out of 1,681 cases the respective incidence in these areas was—Cossington 29, Boarley 69, Farleigh 1,583. Another great example of water-borne typhoid was furnished by Philadelphia where 14,082 cases occurred in 1898–1899

Treatment.—Improved knowledge of the nature and causation of typhoid fever has not led to the successful introduction of a specific treatment, nor have means been found to cut short the illness, though its fatality has been reduced It still goes through the classical stages, which broadly coincide with first, second and third weeks. Attempts have been made to deal directly with the toxins produced by the bacilli, on the hypothesis that they are formed in the intestinal canal, by the use of internal disinfectants, such as mercury, iodine, carbolic acid, salol, etc , and these agents are sometimes beneficial,[1] but the treatment remains essentially symptomatic, and follows the principles that were recognized before the discovery of the *bacillus typhosus*. One of the most important improvements is the regular use of sponging or bathing for the reduction of temperature It has even been developed into a continuous bath, in which the patient is kept in water throughout the illness Since the development of serum-therapy various anti-typhoid sera have been tried in the treatment of the disease but on the whole with indifferent success

Prevention.—If house drainage were always perfectly carried out, sewage satisfactorily disposed of, water-supply efficiently protected or treated, patients segregated, and the typhoid material excreted by them and typhoid "carriers" effectually annihilated—if, in short, scientific cleanliness were completely attained, the disease would disappear, or be at least excessively rare. In some communities much has been done in the directions indicated, but in many others the lessons of experience are ignored, and even the best practice lags behind theory. The most important difficulty is undoubtedly water-supply. The substitution of public water-supplies for shallow wells and small streams liable to pollution is one of the greatest factors in the diminution of typhoid and other water-borne diseases; but it may give rise to danger on a far larger scale, for a whole community may be poisoned at one blow when such a supply becomes contaminated. Unfortunately, it is extremely difficult to prevent contamination with certainty in a populous country. Theoretically, water may be pure at its source, and may be distributed in that condition Such is water derived from deep wells and springs, or gathered from uncultivated and uninhabited uplands. In the one case it has undergone natural filtration in the ground; in the other, it escapes all risk of pollution. These waters are generally pure, but the condition cannot be relied on. A tramp or a shepherd may pollute the most remote gathering-ground unless it be fenced in, deep wells may be similarly fouled by workmen, and sewage may find its way into them

from the surface or through fissures. To secure purity, therefore, and prevent liability to outbreaks of typhoid and other intestinal diseases, all gathering-grounds should be fenced in, and water, even from deep wells, should be regularly examined, both chemically and bacterioscopically, in order that any change in composition may be detected. In the water-supplies of great populations such examination should be made daily. Further, all supplies which are not above suspicion should be filtered through sand or sterilized by boiling. The latter can be carried out by simple means in the case of individual domestic water, and attempts have been made to apply it by means of mechanical apparatus to supplies on a larger scale. It is not, however, applicable to the water-supply of large towns. Sand filtration is at present the best mode of dealing with these supplies. There is no purer water than that which has been properly treated by subsidence and sand filtration, even when it is taken from an impure source So far as the prevention of typhoid and other water-borne disease is concerned, it is certainly safer than the unfiltered water which is taken from so-called pure sources. It cannot be a mere coincidence that London, Hamburg, Berlin and other towns using well-filtered but originally impure river water should be generally freer from water-borne disease than many large towns drawing their supply from purer sources but neglecting to filter it The table below, prepared by Mr Caink, while engineer to the city of Worcester, illustrates this fact, which has also been noted by Professor Saltet of Amsterdam as holding good of the Netherlands

Various Factors.—The amount of typhoid is dependent on other factors besides the water-supply, but the close connection between the two and the influence of filtration are well attested by the experience of Worcester, where the great reduction recorded after 1894 coincided with new and improved filtration. The weak point about sand filtration is that it is apt to be imperfectly performed when the filters are frozen or newly cleaned, or when the process is too rapid Filtration through porcelain is an efficient purifier, but it is not applicable to supplies on a large scale, and almost invariably breaks down through clogging of the filters Other portable filters are useless or worse The best emergency treatment for suspected drinking water is boiling, and the next best is chlorination.

Occurrences of Typhoid in England According to Sources of Water-supply

Source of water	Town	Annual typhoid case-rate per 100,000								
		1892	1893	1894	1895	1896	1897	1898	1899	1900
Deep wells in Red Sandstone	Wolverhampton	109	184	10)	146	159	117	124	224	237
	Birkenhead	157	207	185	165	138	126	211	230	145
Deep wells in Chalk	Southampton	145	159	109	83	78	64	153	171	109
Upland surface water	Liverpool	152	275	267	190	168	160	129	149	115
	Manchester	120	120	90	96	92	90	118	78	78
	Plymouth	126	63	47	32	31	49	41	40	120
Rivers (filtered)	London	65	84	77	81	71	70	66	98	95
	Reading	30	35	28	53	30	67	32	48	41
	Worcester	155	145	110	36	43	45	31	50	26
Average of 219 towns		88	142	103	115	102	100	115	127	116

Next to water-supply, and hardly less important, is drainage. The drying and cleansing of the soil by good household drainage and sewerage is essential to the prevention of typhoid. Cess-pits, leaking drains and privies, especially when there is only one to several houses, as in many industrial towns, are powerful allies of this disease The drainage of all old houses is defective and dangerous. The ground about them is commonly honeycombed with cess-pits and saturated with sewage. The only way to discover and remedy such defects is to lay them bare with the pickaxe and shovel. Soil-pipes should always be trapped and ventilated. In short, no disease requires for its prevention more careful attention to house sanitation. The paving of yards and other spaces is also desirable in towns, on account of the liability of the unprotected soil to harbour moisture and filth

Other modes by which the disease is spread—such as shellfish, milk and uncooked vegetables—suggest their own remedy. The dissemination by dust and flies is less easily prevented. All that can be done is to segregate the sick and promptly destroy all dangerous matters proceeding from them. It should be remembered that the urine may be an even greater source of danger than the faeces. The same observation applies to the prevention of infection from person to person. There is no doubt that sufficient care is often wanting, even in some hospitals, in handling patients' soiled linen and clothes, and in dealing promptly and effectually with their excreta For the effectual segregation and treatment of persons suffering from typhoid prompt recognition is necessary; and this, unfortunately, is a matter of much difficulty on account of variation in the type and severity of the illness Bacteriological science has here come to the assistance of the clinical physician with blood cultures and the Widal reaction, which are of great diagnostic value when carefully performed But obviously these remedies can only be applied to persons in the position of patients; it is of no use in the case of those who do not proclaim themselves ill, but go about their business when suffering from the disease Such "ambulatory" cases have long been recognized as an important factor in spreading the disease.

Typhoid Among Armies.—Before the introduction of anti-typhoid vaccination the prevention of typhoid among armies in the field was a problem of special difficulty, not in principle but because of the conditions During the South African War of 1899–1902, 31,000 men were invalided home to England on account of typhoid fever. Extraordinary results were obtained by the Japanese army medical department in the Russo-Japanese War of 1904–05 in the prevention of typhoid fever, which up to that period was responsible for the largest mortality of any disease affecting armies in the field Handbooks on the avoidance of cholera, plague and typhoid fever were issued to the troops Boiled water in quantities was provided for the soldiers, each battalion having its boiling outfit. Even foreign attachés and correspondents were requested to observe the regulations on this point With this there was a systematic advance testing of wells, the wells being labelled "fit for drinking" or "for washing purposes only" It being impossible to suppress the presence of flies on food, care was taken to cover all latrines and cover and disinfect excreta, so that infection from flies was reduced to a minimum Food was transferred from sterilized caldrons into sterilized lacquer boxes and served on sterilized plates. A crematory was attached to base hospitals, where all nightsoil, garbage and waste was burnt daily Owing to these precautions the incidence of infectious disease, notably typhoid fever, was reduced to a figure unparalleled in any previous war, only 3·51% of the total sickness being due to infectious disease. Taking the number of men at the front in April 1905 to have been 599,617, the entire deaths from infectious and contagious diseases amounted to 1·24% of the entire army in the field. In the World War care in disposal of sewage, chlorination of water and anti-typhoid vaccination of the troops reduced the typhoid incidence and case mortality to a still lower point notably in the British armies in France (*see* THERAPEUTICS).

Anti-typhoid Inoculation.—This consists in a hypodermic injection of the dead organism of the disease into the person who is to be protected Protection is acquired in about 10 days and lasts 18 months to 2 years. The method was initiated by Sir Almroth Wright in 1896, who first used broth cultures sterilized at 60° C. The method now in use is to grow the organisms on a solid medium and to suspend them in a saline. Sterilization is

carried out at a temperature of 53° C and 0·4% Lysol is added afterwards. The vaccine is standardised to contain 1,000 million typhoid organisms and 750 million of each of the two paratyphoid bacilli per cubic centimetre. Table I. shows the details in connection with the disease in various wars during modern times, and of these the European war was the only one in which antityphoid inoculation was extensively used

TABLE I.

War		Mean strength of force	Total number of enteric cases	Annual incidence per 1000
Franco-German War (Germans)		1,140,000	72,393	63·0
Spanish American War (Americans)		211,000	20,738	98 0
2nd Boer War (British)		208,226	57,684	105·0
World War				
British Troops		2,000,000	20,149	2 5
Figures on four fronts	France	1,568,500	6,800	1 1
	E. Africa	17,650	218	6 1
	Salonika	152,000	1,709	3 8
	Egypt	187,333	3,856	6·9

The opponents of antityphoid inoculation attribute the enormous reduction of enteric fever in the last war to improved sanitary measures These have undoubtedly played their part, but that prophylactic inoculation must have had a large share in this reduction is supported by the lower incidence of the disease amongst inoculated as compared with uninoculated persons when both were living under the same conditions. Table II contains a few comparisons between these two sets of persons in different parts of the world

TABLE II

	Incidence per 1000 men	
	Inoculated	Uninoculated
British Army in India, 1911	1·7	5 9
British Army in India, 1912	1 2	5·6
Malta Epidemic, 1910	2 7	31·0
British Army in France, 1915	0 9	10 3
German Army, War with the Herreros	51 0	99 0
American Army, 1910	0 5	6·0
French Army in Tunis, 1912	0·1	12·1
French Army, West Morocco, 1912	0 2	168·4
French Army, Avignon Epidemic, 1911	0 0	225·6

There is besides abundant proof that though an inoculated man may contract the disease it is less likely to prove fatal than in the case of an uninoculated man. Good reports have been received from the Continent of oral administration of the typhoid vaccine, but this method must be considered to have only reached the experimental stage at present. (N T. W)

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TYPHON, in Greek mythology, youngest son of Gē and Tartarus; or of Hera without father (*Homeric Hymns*, iii. 349 *et seq.*). He is described as a grisly monster, with 100 dragons' heads, who was conquered and cast into Tartarus by Zeus In other accounts, he was confined in the land of the Arimi in Cilicia (*Iliad*, ii. 783) or under Etna (Aeschylus, *P.V.* 370), or in other volcanic regions, where he was the cause of eruptions. He was probably a personification of volcanic forces. Amongst his offspring by Echidna were Cerberus, the Lernaean hydra, and the Chimaera. He was also the father of dangerous winds, and by later writers is identified with the Egyptian Set

BIBLIOGRAPHY—*See* Eduard Meyer, *Set-Typhon* (1875), and M Mayer, *Die Giganten und Titanen* (1887); Preller-Robert, *Griechische Mythologie*, i. p. 63–66; O. Gruppe, *Griechische Mythologie*, ii 845, 1,333.

TYPHOON. The name is applied to the extremely violent circular storms, 50 to 100m in diameter, which occur in autumn and travel slowly in the western Pacific between the Philippine Islands and Japan. (The term is of uncertain origin but probably connected with the Chinese *t'ai fung*, great wind, or the Arabic and Hindustani *tufān*, a tempest) A similar storm in the West Indies is termed a hurricane William Dampier entered in his log book under July 4, 1687, the earliest known European description of a typhoon (tuffoon).

TYPHUS FEVER, an acute infectious disease, highly contagious, lasting for about fourteen days, and characterized mainly by great prostration of strength, severe nervous symptoms, and a peculiar eruption on the skin It has received numerous other names, such as pestilential, putrid, jail, hospital fever, exanthematic typhus, etc It appears to have been known for many centuries in epidemic form, in all countries in Europe. The best accounts of the disease are those given by old English writers, who narrate its ravages in towns and describe many "black assizes," in which it was communicated by prisoners brought into court to the judges, jurymen, court officials, etc, with fatal effect Typhus fever has been observed in almost all parts of the world; but it is most frequent in temperate or cold climates

Of predisposing causes the most powerful are overcrowding and poverty. Armies in the field are also liable to suffer from this disease; for instance, during the Crimean War it caused an enormous mortality among the French troops. It is now known to be conveyed by lice (*see* ENTOMOLOGY, MEDICAL).

Typhus is now regarded as certainly due to the action of a filter passing virus (*q v*) but the relation of this to certain minute bodies found in the spleen and known as Rickettsia bodies from their discoverer is not yet certain.

Course of the Disease.—The course of typhus fever is characterized by certain well-marked stages 1 The stage of *incubation* is believed to vary from a week to ten days. During this time, beyond languor, no particular symptoms are exhibited

2. The *invasion* begins in general, with a rigor, headache and sleeplessness The temperature rises to 103°–105° F, at which it continues with little daily variation until about the period of the crisis. The pulse is rapid (100–120 or more) and at first full, but later feeble The tongue, at first coated with a white fur, soon becomes brown and dry, while sordes (dried mucus, etc) accumulate upon the teeth; the appetite is gone; and intense thirst prevails. The bowels are as a rule constipated, and the urine is diminished in amount and highly coloured.

3 The third stage is characterized by the appearance of the *eruption*, which generally shows itself about the fourth or fifth day or later, and consists of dark red (mulberry-coloured) spots or blotches varying in size from mere points to three or four lines in diameter, very slightly elevated above the skin, at first disappearing on pressure, but tending to become both darker and more permanent. They appear chiefly on the abdomen, sides, back and limbs, and occasionally on the face. Besides this characteristic typhus rash, there is usually a general faint mottling all over the surface. The rash is rarely absent. In the more severe and fatal forms of the fever slight subcutaneous haemorrhages (petechiae) are to be seen in abundance After the appearance of the eruption the patient's condition seems to be easier, so far as regards the headache and discomfort which marked the outset of the symptoms; but this is also to be ascribed to the tendency to pass into the typhous stupor which supervenes about this time, and becomes more marked throughout the course of the second week Marked leucocytosis is present and is considered to be diagnostic in doubtful cases when the rash is badly marked The patient now lies on his back, with a dull dusky countenance, an apathetic or stupid expression, and contracted pupils. Delirium, usually of a low muttering kind, but sometimes wild and maniacal (*delirium ferox*),

is present both by night and day. The peculiar condition to which the term "coma vigil" is applied, in which the patient, though quite unconscious, lies with eyes widely open, is regarded, especially if persisting for any time, as an unfavourable omen. Through the second week the symptoms continue unabated.

4. A *crisis* or favourable change occurs about the 14th day, and is marked by a more or less abrupt fall of the temperature and of the pulse, slight perspiration, discharge of loaded urine, return of moisture to the tongue, and a change in the patient's look, which shows signs of returning intelligence. Although the sense of weakness is extreme, convalescence is in general steady and comparatively rapid

Typhus fever may prove fatal during any stage of its progress, either from sudden failure of the heart from the supervention of some nervous symptoms, such as meningitis or of deepening coma, or from some complication, such as bronchitis.

The mortality from typhus fever is estimated by Charles Murchison (1830–1879) and others as averaging about 18% of the cases, but it varies much according to the severity of type (particularly in epidemics), the previous health and habits of the individual, and very specially the age—in children under fifteen the death rate is only 5%, in persons over fifty, about 46%.

Treatment.—The treatment of a patient with typhus fever is general and symptomatic So far as preventive treatment is concerned, chief importance attaches to methods for delousing the population. Naturally all methods tending towards personal cleanliness, good housing, sufficiency of food militate against the occurrence of epidemics.

The main element in the treatment of this fever is good nursing, and especially the regular administration of nutriment, of which the best form is milk, although light plain soup may also be given. The food should be administered at stated intervals, not, as a rule, oftener than once in one and a half or two hours, and it will frequently be necessary to rouse the patient from his stupor for this purpose Sometimes it is impossible to administer food by the mouth, in which case recourse must be had to nutrient enemata. Alcoholic stimulants are not often required, except in the case of elderly and weakly persons who have become greatly exhausted by the attack and are threatening to collapse. When the pulse shows unsteadiness and undue rapidity, and the first sound of the heart is but indistinctly heard by the stethoscope, the prompt administration of stimulants (of which the best form is pure spirit) will often succeed in averting danger. Should their use appear to increase the restlessness or delirium they should be discontinued and the diffusible (ammoniacal or ethereal) forms tried instead.

Many symptoms demand special treatment. Opiate and sedative medicines in any form, although recommended by many high authorities, must be given with great caution, as their use is often attended with danger in this fever, where coma is apt to supervene. When resorted to, probably the safest form is a combination of the bromide of potassium or ammonium with a guarded amount of chloral. Alarming effects sometimes follow the administration of opium The height of the temperature may be a serious symptom, and antipyretic remedies appear to have but a slight influence over it as compared to that which they possess in typhoid fever, acute rheumatism, etc. Hugo Wilhelm von Ziemssen (1829–1902) strongly recommended baths in hyperpyrexia, the temperature of the bath being gradually reduced by the addition of ice Cold sponging of the hands and feet and exposed parts, or cold to the head, may often considerably lower the temperature. Throughout the progress of a case the condition of the bladder requires special attention, owing to the patient's drowsiness, and the regular use of the catheter becomes, as a rule, necessary with the advance of the symptoms.

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TYPOGRAPHER is a derivation of the word typography and means "a printer" The term has recently been revived and is used by those engaged in designing books of an exclusive character, such as those printed at private presses, where a specially designed type may be employed for some specific work It is also sometimes adopted by "layout hands" employed in advertising departments where booklets and other advertisement matter is prepared and sent to the printer to produce.

TYPOGRAPHY is the art of printing (*See* also the articles PRINTING, PRINTING TYPE and CALLIGRAPHY.) It has as its first object not ornament, but utility. The printer must never distract, even with beauty, the reader from his text In the printing of books there is less room for individuality of style than in the typography of propaganda The laws of typography in books intended for general circulation are based upon (a) the essential nature of alphabetical writing; (b) the force of tradition But strict as the conventions are, there is not, and can never be, a rigid character of typography applicable to all books produced in a given geographic or ethnic area; or a universal formula acceptable to all books printed in Roman types The strength of tradition expresses itself in the details of book arrangement and these vary widely. Certain laws of linear composition are, however, obeyed by all printers who use the Roman letter

A fount of Roman type consists of (1) Roman. CAPITALS, SMALL CAPITALS, lower case, : . " ; 1 2 3 4 5 etc (); and (2) *Italic: CAPITALS, lower case.* In addition to these, as necessary adjuncts, the printer possesses (3) spaces, (4) leads, (5) straight lines of metal known as *rules*, and (6) a collection of mobile ornaments, head- and tail-pieces, flowers, decorated initial letters, vignettes and flourishes, wood blocks of borders, etc Another decorative medium at his command lies in his use of (7) colour (red being the most widely used) For emphasis he possesses (8) special types of notably heavy face, and may use colour for the same purpose (9) Space is another valuable element, margins, blanks, etc being filled in with what are known as "quotations" Finally (10) there is the nature (colour, weight and texture) of the paper

Composition is the selection and arrangement of all these elements; *Imposition* is the due placing of the composition upon the sheet; *Printing* comprises the press-work, securing a perfection of register (backing up), the quality and crispness of inking Typography, therefore, controls composition, imposition and paper. The paper (*q v.*) must be of a character capable of expressing the value of the composition The margins must be proportionate to the area of the text, allowing convenient space for thumbs and fingers at the side and bottom of the page The mediaeval margins as adopted by the Kelmscott Press, are handsome and agreeable in certain books, but, are neither agreeable nor convenient in other books, *e g.*, where the page dimension is necessarily small or narrow, and the book is to be carried in the pocket. For this and other books, the type may well be centered on the measure of the page, and slightly raised above ocular centre.

Composition.—The fundamental principles of page-composition are deducible from the ocular facts of alphabetical printing in the Roman letter The eye cannot, with ease, read pages of words composed of letters designed with sharply contrasting thicks and thins Nor can the eye agreeably read a mass of words composed even in a rightly constructed letter, unless the line is kept to a certain maximum length; that is to say, the reader's eye cannot comfortably seize more than a certain number of words in any given size except in a proportionate length of line. Nor can a reader comfortably seize a letter, a word or a line, unless the printer's setting is related to the reader's normal habit of vision when holding a book for reading. The typographer's respect for these principles will generally protect the reader from the risk of "doubling" (that is, reading the same line twice), or from being given a book in a large and "staring" type.

The average number of words which the reader's eye can conveniently seize is between 10 and 12 (some 48 characters). The typographer, while exerting himself to the utmost to respect this ocular limitation, may often be confronted with certain conditions

which make it impossible for him to secure a type of the right related size. He is often forced to the use of a small type, and in order to obviate the risk of "doubling," he inserts leads between the lines of type and thus increases the space between them.

The practice of leading, denounced in certain quarters, is an essential necessity. The typographer, therefore, in making the best use of his material, must make legitimate use of leads. It may be added, too, that in certain compositions, leads produce a happy effect; and in not a few cases, their absence may ruin a composition set even in a relatively large type.

The typographer should know how to extract the utmost from thé use of a type which is narrow in relation to its height—leading and spacing play a decisive part here A round, open, wide letter may, for certain purposes, be set "loose"; *i e*, the space between the letters will be greater (or appear greater by reason of the curves of the c, o, e, g, in the lower case), than in a relatively condensed letter. Consistency will here insert a satisfactory lead between the lines

The space between words composed in a condensed letter is less than that between words in a round, wide form. A lead should always precede and follow quoted matter Where there is no leading between the lines, and the composition is necessarily tight, it may be an advantage to set leads between the paragraphs.

Indention is a most important detail. The opening sentence of every work should automatically manifest itself as such This may be contrived by using a large initial letter, by printing the first word in CAPITALS, or SMALL CAPITALS, or CAPITALS and SMALL CAPITALS. The first word may be set into the margin; but it should *not* be indented Indention marks paragraphs—the subsequent sections of the text Where for any reason it may be necessary to avoid indention in paragraphs, a lead is plainly desirable Absence of indention and of lead means the virtual extinction of the paragraph

The depth of the page will be related to the length of line. The measure must be symmetrical, displaying a form pleasing to the eye A rectangle is more pleasing than a square

A rectangular page composed of lines of 10–11–12 words long will generally be satisfactory It remains to add the running page-heading, and the folio The page-heading may either range to the left and right in the opening (fixing the two pages as a unity), or range to the right and left, or it may be centred. The folio may be centred at the foot, or range either way at the top or bottom; but it cannot be centred at the top without abolishing the running page headline This may be done, but it is an undesirable practice. The running headlines may be set in capitals of the text, in upper- and lower-case of the text, or in any combination of capitals. The use of full-sized capitals renders over-conspicuous a repetitive feature inserted for extrinsic convenience—that is, the identification of loose leaves By reason of its position, the headline looks ragged if set in upper- and lower-case. It seems best, therefore, to employ small capitals; all capitals are best separated by hair spaces as their rectangular structure and preponderance of perpendiculars tend to solidify the composition

Full-sized capitals may well be used for chapter headings, the number of the chapter being kept in small capitals, and both indications being hair spaced The practice of dropping the chapter opening is justified by the fact that the eye, in travelling from the generally occasional blank at the end of a chapter to the beginning of the next, finds a companion blank an agreeable consistency. It has also the psychological advantage of saving the reader from feeling overpowered by the text. The rectangle of type is so imposed upon the edge as to allow centre, head, fore-edge and tail margins of a dimension proportionate, first, to the length of line and, secondly, to the disposition of space at points where the text is cut into chapters, and where the body joins the prefatory and other pages known as "preliminaries." These last, less strictly governed by convention than the text pages, offer the maximum opportunity of design to be found in the volume.

The history of printing is in large measure the history of the title-page. The title when fully developed occupied a recto page, either partially or wholly; and the title-phrase, or a catchword of it, has generally been set in a conspicuous size of type. Sixteenth century Italian printers generally used large capitals, copied from inscriptions, or more exceptionally, from caroline manuscripts; while English use followed the French in employing a leading line of large upper- and lower-case, followed by a few lines of pica capitals. Next came the printer's device, and at the foot of the page, his name and address. The large sizes of upper- and lower-case, being an inheritance from printers who were accustomed to black-letter (never set in solid capitals), have gone. The device also has vanished, except from the University Presses.

The contemporary title-page is a bleak affair; in nine out of ten cases the blank between the title and the imprint of the printer-publisher tends to be the most outstanding feature. When the device was first abandoned, the author, printer or publisher took advantage of the leisure of the reader and the blank at their disposal to draft a tediously long title, sub-title and indications of the author's qualifications, designed to fill the entire page The present day publisher goes to the other extreme, reducing the title to as few short words as possible, followed with "by" and the author's name A professional writer may insert, *e g*, "Author of *The Deluge*" under his name, but three and sometimes four inches of space separate this from the first line of the imprint. Consequently unless the title be deliberately set in a size of type out of all relation to that of the remainder of the book, this space is over-conspicuous. It is clear that a volume in 12-point does not require a 48-point title unless it be a 300-page folio in double-column.

Care for the typography of a book means care for its unity There is no reason for a title-page to bear any line in a type larger than twice the size of the text-letter. If the book be set in 12-point, the title need be no larger than 24-point—or even slightly smaller It should be set in spaced capitals as a rule The author's name, like all displayed proper names, should also be in capitals The headings to the preface, table of contents, introduction, etc, should be in the same size and fount as the chapter heads; and should be dropped if they are dropped The order of these pages remains unsettled, except that all begin on a recto page. The logical order of the preliminary pages is half-title, title, dedication, contents, introduction, preface This rule is applicable to most categories of books Novels need neither table of contents nor list of chapters, though one or the other is generally printed If it is decided to retain either, it would be reasonable to print it on the back of the half-title and facing the title page, so that the entire nature of the book will be indicated to the reader at a single opening. Where the volume is made up of a few short stories, their titles can be listed in the blank centre of the title-page.

Book Sizes.—In addition to fiction, belles-lettres and educational books are habitually published in portable, if not in pocketable formats, crown octavo $7\frac{1}{2}''\times5''$ (in America known as 12 mo) being an invariable rule for English novels published as such The novel in the form of biography will be published as a biography, $6''\times8\frac{1}{2}''$, the size also for history, archaeology, science, art and almost everything but fiction. Novels are only promoted to this format when they have become "standard" Size, therefore, is the most manifest difference between books.

Another obvious difference is bulk, calculated in accordance with the publisher's notion, first, of the general sense of trade expectation, and, secondly, of the purchasing psychology of a public habituated to certain selling prices vaguely related to number of pages and thickness of the proffered volume. Inconsistently enough, weight does not enter into these expectations. These habits of mind affect the choice of fount and size of type, and may necessitate the adoption of devices for "driving out," *i e*, making the setting take up as much room as possible. By putting the running headline between rules or rows of ornaments; introducing unnecessary blanks between chapters; contracting the measure; exaggerating the spaces between the words and the lines; excessively indenting paragraphs; isolating quoted matter with picas of white space; inserting wholly unnecessary sectional titles in the text and surrounding them with space; contriving to drive a chapter ending to the top of a recto page so that the rest of it and its verso may be blank; using thick but not heavy paper; in-

creasing the depth of chapter beginnings and inserting very large capitals thereto; the volume can be inflated to an extra 16 pages—a feat which the able typographer accomplishes without showing his hand to the reader.

Limited editions of standard authors, or of authors who desire to rank as such, are commonly given a rubricated title. Under no circumstances, however, should red appear anywhere else in the work. Hand-made paper is generally used for editions-de-luxe, and none but the brave among typographers will disregard the superstitious love of the book-buying classes for its untrimmed, ugly and dirt-gathering rough edges. There is another category of limited edition produced by typographers working freely, without the handicap of trade conditions. These books are rapidly increasing in number, and use a wide variety of format, of type, of illustration and of binding.

Because, rather than in spite of, mechanical methods and standardization, printing is more various to-day than ever before. Whereas English books of whatever category of 20 years ago were printed in only three designs of type, no fewer than eight founts are employed to-day. It has been necessary that most of these are reproductions of classic old-faces, but it may well be that the near future will witness a real renaissance of type design based upon a sensitiveness to rightly-controlled type forms, and not animated by an uninformed curiosity for the original and the bizarre. (S. Mo.)

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TYPOLOGY. Typology results from a study of the various kinds of objects fashioned by man and the sorting of them into categories The objects in each category can be often further classified, a geographical, chronological or evolutionary basis being taken. For example, in the case of artefacts made by primitive man in the Fiji islands the typologist might begin by sorting out all the paddles. These would then be further classified according to their locality and age. On studying such a group of objects it is often possible to make out an evolutionary series in a tool family, a certain type being clearly derived from an earlier one and itself the parent of some further development.

In prehistory, a typological study of the artefacts made by man is one of the four methods which yield information before written documents existed; the other three being stratigraphy (*q v*), a study of the state of preservation of the artefacts found, and of the objects associated with them. The two latter methods are useful as checks on the information obtained from stratigraphy and typology.

Although as shown above typology sometimes enables us to determine a chronological sequence, this is primarily obtained by the stratigraphical method; typology enables us to study systematically the industries belonging to the various cultures. By noting the peculiarities of the various tools which make up the industries we obtain type standards for each culture with which new finds, otherwise undatable, can be compared. Thus, it is found by experience that a particular implement, viz., the beaked burin, is almost exclusively confined to industries which on stratigraphical and other grounds, can be assigned to a Middle Aurignacian culture. If then a new industry is discovered otherwise undatable, but including a large number of beaked burins, we can assume, with some probability, that the age is Middle Aurignacian. Again, a certain type of celt, showing a rectangular cross-section and elaborate trimming, can at once be recognized not only as being of Scandinavian origin, but also as belonging to a definite period of late Neolithic date.

Typology can be applied to styles and techniques of painting. Thus, for example, in Southern Rhodesia palimpsests of Bushman paintings occur. The typologist can observe several different styles which are always found occurring in the same stratigraphical sequence, painted one over the other. In this way a succession of art styles has been determined. (M. C. B.)

TÝR, the Scandinavian god of battle, was not such a prominent figure in Northern mythology as among other Teutonic peoples. In Anglo-Saxon he was called Tī (*Ti, Tiig,* gen. *Tīwes* whence "Tuesday") and equated with the Roman Mars. His Teutonic name is the same as the word for "god" in several Indo-European languages, *e.g.,* Lat. *diuus,* Lith. *dēvas,* Skr. *devas,* even in Old Norse the plural (*tīvar*) was still used in the same sense. (*See* TEUTONIC PEOPLES, s. *Religion, ad fin.*)

TYRANNOSAURUS: *see* DINOSAUR.

TYRANT, a term applied in modern times to a ruler of a cruel and oppressive character (Gr. τύραννος). This use is based on a misapprehension of the Greek word, which implied nothing more than unconstitutional sovereignty. Such rulers are not confined to a single period, the 7th and 6th centuries B.C (the so-called "Age of the Tyrants" [*see* GREECE: *History*]), but appear sporadically at all times. The use of the term "tyrant" in the bad sense is due largely to the ultra-constitutionalists of the 4th century in Athens, to whom the democracy of Pericles was the ideal of government. Thus the government which Lysander set up in Athens at the close of the Peloponnesian War is called that of the "Thirty Tyrants" (*see* CRITIAS).

TYRAS, a colony of Miletus, founded about 600 B.C., some 10 m. from the mouth of the Tyras (Dniester). The types of its coins suggest trade in wheat, wine and fish During the 2nd century B C. it fell under the dominion of native kings. It was destroyed by the Getae about 50 B C. In A.D. 56 it seems to have been restored by the Romans and henceforth formed part of the province of Lower Moesia. Its coins now display heads of emperors from Domitian to Alexander Severus. Soon after the time of the latter it was destroyed by the Goths. Its government was in the hands of five archons, a senate, a popular assembly and a registrar The few inscriptions are mostly concerned with trade Its remains are scanty, as its site is covered by the mediaeval fortress of Monocastro or Akkerman (*q v*)

See E H Minns, *Scythians and Greeks* (Cambridge, 1909); V. V Latyshev, *Inscriptiones Orae Septentrionalis Ponti Euxini,* vol. i.

TYRCONNEL, RICHARD TALBOT, EARL (TITULAR DUKE) OF (1630–1691), Irish Jacobite, son of Sir William Talbot (d. 1633), a Roman Catholic lawyer and politician, served as a royalist in the Great Rebellion, and was present at the storming of Drogheda by Cromwell (Sept 3, 1647), afterwards escaping to Spain. He was arrested in London in Nov 1655 for acting as agent in plots to upset the Commonwealth, but escaped once more. After the Restoration he was employed in the household of the duke of York (James II.) even after his participation in an intrigue to ruin the character of Anne Hyde, the duke's wife In 1678 he was arrested in connection with the Popish plot agitation, and went into exile for a time During the reign of James he was appointed commander-in-chief in Ireland and created earl of Tyrconnel (1685); in Feb 1687 he was appointed lord deputy. Tyrconnel, who foresaw the revolution in England, intrigued for the handing over of Ireland to France, in the interests of the Roman Catholics, and in 1688, when James fled to France after the battle of the Boyne, Tyrconnel was left to carry on the struggle against William III. When the latter raised the siege of Limerick Tyrconnel fled to France for help On his return to Ireland, in Jan. 1691, he was of little use, and was compelled to retire to Limerick, where he died on Aug. 14, 1691. In 1689 James created him duke of Tyrconnel, but the title was only recognized by the Jacobites.

TYRCONNELL (*Tir-Conaill*), an ancient kingdom of Ireland. Conall Gulban, a son of Niall of the Nine Hostages, king of Ireland, acquired the wild territory in the north-west of Ulster (the modern Co. Donegal, etc.), and founded the kingdom about the middle of the 5th century. Of the several branches of his family, the O'Connells, O'Cannanans and O'Dohertys may be mentioned. The kings of Tyrconnell reigned until 1071.

TYRE, a famous seaport of Phoenicia, now in the State of Great Lebanon, in French mandated territory (mod. *Sur*); pop., 5,700. Tyre is built on a peninsula, formerly an island, has nar-

row streets and evident traces of antiquity in the material of its buildings. Of the two harbours which it formerly possessed, the northern, or Sidonian, still survives; the southern, or Egyptian, has disappeared. Once the great mart of the Mediterranean world, it has now an insignificant export trade in cotton and tobacco. It has a French garrison and a French adviser.

History.—The name Usu (Ushu), the designation of the mainland town, appears in the Tell el Amarna letters (14th century B.C.), and in Papyrus Anastasi I. (13th century). As it is not found in the list of Syrian cities tributary to Thutmoise III. (15th century B.C.), it is reasonable to conclude that it was founded before the beginning of the 14th century, but not before the beginning of the 15th. The earliest settlement, a colony of Sidon (*q.v.*), was in all probability divided between the mainland and the island. The building of a causeway connecting the island with the shore is attributed to Hiram, well known as the king of Tyre, who had commercial dealings with Solomon and supplied skilled labour and material for the erection of the temple at Jerusalem. Jezebel was a daughter of Ethbaal, a Tyrian king.

From her island fortress, Tyre, the mistress of the seas, could defy her enemies and for the most part Assyrian and Babylonian might spent itself against her defences in vain. Shalmaneser IV., after an unsuccessful attack by sea, maintained a blockade on the land side for five years until his death intervened. Ashurbanipal stormed the city in 664 B.C. In the 6th century B.C. it endured a 13 years siege from Nebuchadrezzar.

However, Tyre, with the marvellous vitality of those early times, recovered in a comparatively short time. The city passed under the sway of the Seleucids (198 B.C.) and the Romans (68 B.C.). Herod the Great endowed it with a temple. St. Paul spent a week there while the ship "unloaded her burden" on his journey from Ephesus to Jerusalem. By the 2nd century it had become the see of a bishop. With the rest of Syria it passed into the hands of the Muslims in the 7th century. The crusaders captured it (1124), and made it one of the chief cities of their kingdom of Jerusalem. After the fall of Acre, the Muslims destroyed it.

In Roman times Tyre, "seething with commerce" (*ebulliens negotiis*) was famous for the manufacture of silk and silken garments, as well as the famous Tyrian purple from the murex shell. Lucan (*Phars.* x. 41) tells how Cleopatra appeared at a banquet arrayed in thin-spun and clinging silk garments, made by the skilful Tyrians and then a new luxury.

A French archaeological expedition visited Tyre in 1921 and explored the neighbourhood. *See* PHOENICIA.

See Mme. D. le Lasseur, "Mission archéologique à Tyr" (1921); *Syria* 3 (1922); R. Dussand, *Topographie Historique de la Syrie Antique et Médiévale* (1927), 19 *seq.* (bibl.) (E. Ro.)

The most important references to Tyre in the Bible are 1 Kings v., vii, ix; Is. xxiii., Am. i. 9 *seq.*; Ezek. xxvi.–xxviii.; 2 Macc. iv. 18 *sqq.*; Mark iii. 8, vii. 24 *sqq.*; Matt. xi. 21 *seq.* (and parallels); Acts xii. 20. *Cf.* also Joshua xix. 29; 2 Sam. xxiv. 7; Ezra iii. 7; Neh. xiii. 16; Ps. xlv. 12, lxxxiii. 7, lxxxvii. 4.

Siege of, by Alexander the Great (332 B.C.).—After the battle of Issus, Alexander, as he marched southwards towards Egypt, called upon the Phoenician cities to open their gates, as it was part of his general plan to deny their use to the Persian fleet. The citizens of Tyre, who owed allegiance to the king of Persia, refused to do so, whereupon he laid siege to the city. New Tyre was built on a small island, about half a mile from the main land upon which the old city stood. Possessing no fleet Alexander demolished old Tyre, and with the *débris* built a mole 200ft. in breadth across the straits, and erected towers and war engines at its further end. Thereupon the Tyrians destroyed the towers by fire ships and damaged the mole. Many curious devices were made use of to defeat the Greeks, such as pots of burning naptha and sulphur, and red-hot sand hurled from catapults. Alexander next widened the mole and rebuilt the towers, but he saw that without assistance of a fleet success could not be assured since the Tyrians had free access to the sea. From Sidon he obtained 80 Phoenician ships, and 24 from Rhodes, Mallus, Soli, Lycia and Macedonia. Then the king of Cyprus, hearing of the defeat of Darius at Issus, joined Alexander with 220 warships. The reduction of Tyre was now but a matter of time, for if the assault from the mole proved unsuccessful, starvation must accomplish its work. Alexander was, however, impatient to complete the siege before Darius could raise another army, so he constructed floating batteries upon which rams were mounted, and forced his way into the Egyptian and Sidonian harbours, and scaled the city walls. Thus after a siege of seven months the city was taken, 8,000 of the citizens were slaughtered, 2,000 later on executed, and 30,000 sold into slavery.

See Arrian, *Anabasis of Alexander;* Diodorus Siculus; G. Grote, *History of Greece* (1906); *The Cambridge Ancient History*, vol. vi. (1927). (J. F. C. F.)

TYRE. The tyre of a wheel is the outer circumferential portion that rolls on the ground or the track prepared for it. Railway vehicle wheels usually have hard steel tyres, which together with the hard steel rail give the maximum endurance and the minimum rolling resistance. The common tyre made for the exterior rim of non-motor road-vehicles serves to hold together the parts of the wheel and resists wear in travelling. It is ordinarily made of iron or steel, and consists of a flat hoop formed so as to fit tightly over the exterior of the wheel, it is expanded by heat and placed on the wheel while hot so that when cooled it is tightened by contraction. It may also be bolted to the rim of the wheel. The chief considerations are strength and durability. In bicycles, motorcars, and other road vehicles in which freedom from vibration and shock is desired, solid or pneumatic rubber tyres are employed.

The principle of the pneumatic tyre was patented by Robert William Thompson in England in 1845, in France the following year and in 1847 in the United States. Thompson's patent substantially covers the tyre as it is known to-day. It showed a non-stretchable outer cover and an inner tube of rubber to hold air. An early set of tyres made on this basis covered 1,200 miles when placed on an English brougham.

Almost half a century later, when the bicycle became popular, pneumatic tyres were revived by John Boyd Dunlop of Belfast, Ireland. He obtained certain patents in 1888 and 1889 on English bicycle tyres. A year after Dunlop's patents were issued, Charles K. Welch patented a tyre shoe of fabric having wire edges and a rim to clinch the shoe and hold it to the felloe of the wheel. About this time, William Erskine Bartlett, an American living in England, patented a tyre which did not necessitate wire clinchers. The thread or cord tyre was patented by John Fullerton Palmer in England. Pneumatic tyres were first applied to motor-vehicles by a firm of French rubber manufacturers, Michelin and Company. After some improvements were made, rubber tyres were adopted by Panhard and Levassor and other French automobile manufacturers.

RUBBER TYRE MANUFACTURE

Rubber tyres may be considered in two classes—

(a) Solid or cushion tyres being those in which the rubber compound of which they are formed, fulfils the combined functions of carrying the load, absorbing the shocks of meeting road surface irregularities, and resisting abrasion.

(b) Pneumatic tyres—being those in which the load is carried and the shocks absorbed by compressed air. The structure of the pneumatic tyre is primarily designed to provide a non-extensible covering with air-proof lining to contain and restrain under compression the column of air. This covering is provided with a rubber tread portion which takes up the abrasive wear of road contact and protects the contained column of compressed air. Such a structure has, as distinct from a solid rubber or cushion tyre, no capacity in itself either to carry load or to absorb shocks. It is entirely dependent on the contained compressed air to enable it to function, and is therefore correctly named a "pneumatic" tyre.

Solid Tyres have been made in a wide variety of forms, and have been developed from a mere covering of the periphery of small wheels with a strip of vulcanised rubber, and the cementing of a round cord of solid rubber into a concave metal rim, as in the earliest forms of rubber tyres used on bicycles and tricycles, to the modern solid and cushion tyres used on the heaviest types of modern road transport.

Solid rubber tyres have been made for all types of road vehicles; they were the equipment of the earliest motor cars.

The many forms in which they were produced, differed principally in the adaptation of the tyre to a method of attachment to the wheel. In the main, the attachments have been of two types, one in which the tyre was provided along the sides of the base with beads or recesses which were adapted to engage with lips or inturned edges formed on the metal rim. This form of tyre and rim was used mainly in the smaller sizes for lighter work. The stresses imposed by the heavier and faster motor vehicles demanded a fixing which secured the whole base of the tyre to its rim, and this resulted in the production of the metal base band type in which the rubber tyre is mounted on and vulcanized to an endless metal ring of the full width of the base of the tyre. Such metal base-bands have to be of a substantial thickness to withstand the hydraulic pressure used to force the band with its tyre over the periphery of the wheel. A pressure of 10 to 30 tons is employed for this purpose, and a tyre so applied remains fixed to its wheel for the period of its life.

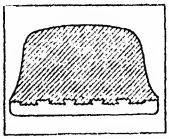


FIG. 1.—STANDARD SOLID RUBBER TYRE

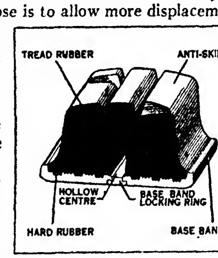
Simple though the structure of a solid tyre may appear, it is really one of the most difficult problems of the tyre manufacturer. The difficulties lie in combining in one tyre a rubber compound which, whilst having reasonable cushioning properties, is capable of carrying heavy loads at the high speeds of modern road transport. This demands a rubber compound with a maximum resistance to abrasion and cutting, which will also best resist the development of high internal temperatures under the pounding of high speed running on the road.

There are limits to the capacity of rubber compounds in these directions, which is one of the factors now tending to the displacement of solid rubber tyres by large pneumatic tyres.

Cushion Tyres.—This is a title somewhat loosely applied to variations of the solid rubber tyre in which the object of the maker is to provide a tyre which will deflect more under its running load, and yield more to shocks than the solid tyre.

Solid tyres have thus been made from a much softer rubber compound. Another device is the provision of cavities in the mass of the solid tyre. In some cases the cavities take the form of circumferential hollows moulded in the centre of the tyre; in other types hollows are moulded in the external surface of the tyre walls; and again in others, hollows are moulded transversely in the tyre section. In all, the purpose is to allow more displacement of the tyre tread under a given load. This provides greater cushioning against shocks, but of course, the load carrying capacity of the tyre is reduced.

The principal attraction of the cushion tyre to users, is the freedom from the risk of failure by puncture associated with the use of pneumatic tyres. The improving pneumatic tyre is gradually displacing both cushion and solid rubber tyres.



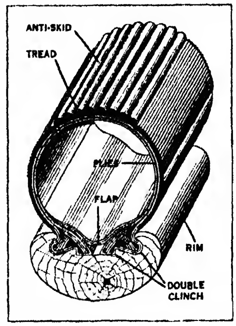
BY COURTESY OF U.S. RUBBER CO.

FIG. 2.—CROSS SECTION OF CUSHION TRUCK TYRE SHOWING LOCKING RING

Pneumatic Tyres.—Whilst Thompson (Patent No. 10990 of 1845) was the first to conceive the possibility of supporting a road vehicle on a contained column of compressed air, and did in fact equip a horse-drawn brougham with 5 in. air-inflated tyres, it was to J. B. Dunlop (Patent No. 10607 of 1888) that the introduction of the pneumatic tyre must be credited; for from the production of his first crude inflated tyres at Belfast in 1888, the manufacture of pneumatic tyres has continued without break, with constant improvement in the product, until today it is essential to all high speed road motor transport, and has remained since its introduction the only equipment of cycles of all forms.

The simplest form of pneumatic tyre is that known as the single-tube tyre. It consists of an endless tube of rubber-coated cotton fabric having on its inner face an air-proof rubber lining, and on its outer surface a covering of rubber sufficient at the base and sides to protect the fabric from wet or damage, with an additional thickness of rubber on the tread portion to resist road wear, the whole being vulcanised together in a mould under fluid pressure supplied to the inside of the tyre.

Repair of single tube tyres is effected in the case of small punctures by injecting a quick drying rubber solution through the puncture, but in the case of serious cuts or damages, necessitates the attention of an expert workman and involves revulcanization of the repair. Tyres of this type have disappeared from use, except in America where they are still used on bicycles. They never had any considerable use as equipment for motor cars.



BY COURTESY OF U.S. RUBBER CO.

FIG. 3.—CROSS SECTION OF A DOUBLE CLINCHER BICYCLE CASING AND RIM

The necessity for a ready means of repairing punctures resulted in tyres taking the form of a separate inflatable inner tube, with a detachable outer cover. Out of a multitude of types of detachable covers introduced in the early nineties, two emerged—the *Wired On* type and the *Beaded Edge* type.

The *wired on* type quickly secured a dominating position in respect to cycle tyres, but in the earlier years of the motor industry it was the *beaded edge* type which was universally used. The advantages of the *wired* type of tyre for use on motor vehicles were recognised for a considerable period, but the rapid growth of the motor car industry made it very difficult to introduce a type of tyre demanding a rim differing from that so generally in use for the *beaded edge* type of tyre. Protracted competition over a period of years has only recently resulted in a complete victory for the *wired edge* type of tyre. The *beaded edge* has now been almost entirely dropped.

With the standardization of all tyres to one type (the *wired* or *straight side* type) the design of rim applicable to such tyres has undergone some change. In America the straight-side rim of the flat base type has been most commonly used. Its construction varies principally in the method of mounting the tyre and in attaching the rim to the wheel. Some of these rims are made with a loose flange of a self-locking type; some have two loose flanges with a separate locking ring; and there is also the transversely split type. They all require the use of a "flap" or band of rubber

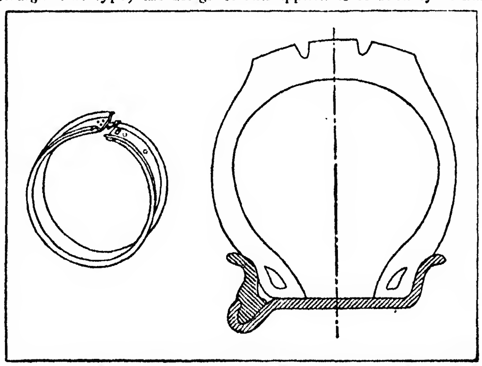
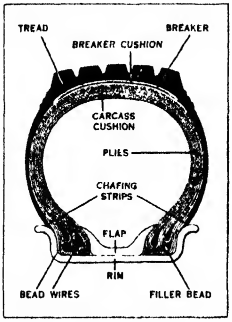


FIG. 4.—WIRED OR STRAIGHT SIDE PNEUMATIC TYRE ON FLAT BASE RIM WITH DETACHABLE FLANGE

or rubberized fabric to cover the line of contact between the beads and the rim to prevent chafing of the inner tube A rim which embodies the principle of the Welch tyre of 1890, and which has been continuously used for cycle tyres and known as the *well base* or *drop centre* rim, has now been largely adopted for motor cars in England, and to a limited extent in America. This rim has neither the loose flange, nor the transverse split These *well base* rims are much lighter and less complicated than the flat base rims, and enable the tyres to be very readily and easily mounted and dismounted The method is well known to all cyclists, and may be briefly described as depressing the endless wired edge of the tyre into the *well* of the rim at one point in its circumference—this allowing the wired edge to be lifted over the *edge* of the rim at the opposite point of its circumference



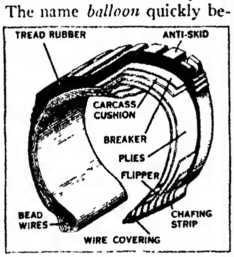
BY COURTESY OF U S RUBBER CO
FIG 5.—CROSS SECTION OF A MOTOR COACH PNEUMATIC TYRE, FLAP AND RIM

Cord and Canvas Tyres.—Nearly all pneumatic tyres to-day, whether for cycles, motor cycles, private cars, buses or commercial vehicles, are cord tyres, that is to say, the use of a fabric constituted wholly or almost wholly of warp is universal

High Pressure and Low Pressure (or Balloon) Tyres—When motor tyres were being almost exclusively made of square woven cotton fabric, the dimensions of the various sizes of tyres required for carrying certain loads had become fairly well stabilised, and equally the inflation pressures necessary for each size of tyre had also been uniformly accepted

The superiority of the cord type, due partly to the cord construction and partly to its increased sectional dimensions led to further developments in which the sectional sizes of tyres were still further increased, and, as the larger the section of the tyre employed to carry a given load the lower the inflation pressure necessary within that tyre to support the load, these larger tyres could be made with considerably thinner retaining casings because of the lower inflation pressure which they had to withstand

Such larger tyres quickly received the name of *balloon* tyres—a title naturally suggesting itself to an observer struck by the abnormal dimensions of the tyre The name *balloon* quickly became very generally applied to all tyres of larger sectional dimensions and employing lower pressures



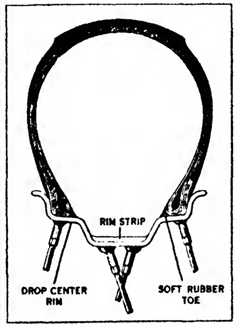
BY COURTESY OF U S RUBBER CO
FIG 6—STEP-DOWN SECTION OF A BALLOON AUTOMOBILE TYRE

The *balloon* or *low pressure* motor tyre has demonstrated its superior cushioning properties to motorists generally, and to-day low pressure tyres are the standard equipment of all private cars

As is commonly the case when a change of this character is made, there was a tendency to go to extremes Many of the first low pressure tyres were made with casings of extreme thinness, with the result that the disadvantage of extremely thin casings of the largest dimensions quickly demonstrated the disadvantages of such tyres under average service conditions Their liability to accidental damage was too marked; they required the maintenance of their inflation pressure within very close limits, and a small departure from the proper figure resulted in excessive and erratic tread wear and frequently produced serious difficulties in the steering control of vehicles.

However, these difficulties have all been overcome, and the standard tyre equipment today represents only a small sectional increase in dimensions over the original cord tyres, now referred to as *high pressure* tyres, and the inflation pressures commonly used are of an order intermediate between those pressures employed in high pressure cord tyres, and those used in some of the earlier balloon tyres, the result being that the user today secures an improved cushioning without sacrificing anything of the durability of the high pressure cord tyre

Precisely similar development in respect to the pneumatic tyre equipment employed upon the heavier types of passenger and goods-carrying vehicles is also being carried out, and in this case makers are profiting by their earlier experience with low pressure tyres for private cars in avoiding extremes both in dimensions, casing thinness and lowness of inflation pressure.



BY COURTESY OF U S RUBBER CO
FIG 7.—CROSS SECTION OF A STRAIGHT SIDE AEROPLANE TYRE ON A DROP CENTRE RIM

Briefly, the construction of a pneumatic tyre can be summarized as consisting in—first, the preparation of the cord material, which is now a specialized operation on which many of the largest cotton mills in the world are exclusively employed The cord, after passing from the cotton mills, is first treated in the tyre factory by a coating of rubber applied to both sides of the sheets of cord fabric These rubberized sheets are then cut into bias strips of suitable widths, and brought to case building machines on which the casing is built up, and the wire rings which retain the finished cover upon its rim, are enclosed within the edges of the casing Various details of fabric and rubber are added in the form of chafing strips, filler strips, rubber insulation plies and cotton breaker strips, and finally the tread and side wall coverings are added, the whole forming a tyre cover in a raw state

In some cases this structure is built up to approximately its finished shape, and in others is built up as a wide flat endless band which is afterwards given its approximate finished shape by being subjected to a separate shaping process

Such covers are then mounted upon an inflatable bag, and the whole enclosed in steel moulds The moulds are then introduced into a vulcanising vessel, where the bag within the raw tyre is inflated with air, steam or hot water, according to the particular process used, and the whole subjected externally to high temperature steam which effects a process known as "vulcanisation" Heat is supplied for vulcanising only from outside the moulds when air is used in the bags When hot water or steam is used the tyre is heated from both sides and more uniform heating throughout the tyre is secured Leakage of air into the steam around the moulds will reduce the heat transfer seriously and cause irregularities of vulcanisation This process of vulcanisation under pressure results in the moulding of the tyre into its finished form, uniting all parts firmly together, and producing within the rubber mass certain reactions between the rubber and the sulphur and other ingredients which have been previously incorporated in the rubber, resulting in a tough and durable product

Inner tubes are made by various processes—all of which, however, necessitate the formation of the tube first in the raw state from a mixture of rubber with the necessary vulcanising and compounding materials Such a raw tube is afterwards vulcanised, sometimes on tubular mandrels and sometimes in closed metal moulds. The tubes are, of course, fitted with non-return valves

Non-skid Devices.—In the earlier days of the pneumatic tyre, treads were plain and no attempt was made to provide any greater hold upon road surfaces than that due to the coefficient of friction as between rubber and road surface

An early attempt, popular for many years, to avoid slipping difficulties, consisted in providing the tyre tread with several rows of hardened steel studs. These were efficient on certain

types of road surface, but were highly dangerous on others.

Modern tyres are invariably provided with some form of design moulded into the rubber of the tread. The designs employed are numerous, each maker has his own design; in fact, frequently a number of designs, although it is difficult to find in many of them any special advantages. The value of the non-skid varies greatly in relation to the particular type of road surface on which it is running, and a design will vary in its ability to resist a forward slip or a side slip, or a combination of both The tyre maker has of necessity to consider in his tread design, in conjunction with the wearing capacity of the tread as a whole, not its non-skidding properties alone, but its average capacity for holding the road surface under all conditions.

Rolling Resistance in Tyres.—The rolling resistance of all tyres, whether of the solid, cushion or pneumatic type, is affected by a number of different factors which may be divided into two groups—

(1) Internal factors.
(2) External factors.

1 *Internal Factors*—

(a) *Solid and Cushion Tyres.*

The type of rubber used is the most important factor High internal friction will cause rapid heating of the tyre and may possibly lead to internal disintegration The condition is aggravated if the rubber is soft and the tyre runs under a large deflection A high heat conductivity is also desirable so that the heat generated has the best possible chance of escaping to its surroundings

The power consumption of a solid tyre of 120 mm section running at 20 m p h under a load of 3,300 lb may vary from 0 5 h.p to over 2 h p according to the quality of the rubber mixing used

(b) *Pneumatic Tyres*

About 50% of the power losses in a pneumatic tyre occur in the tread, and in selecting the tread quality, this point must be borne in mind

Other internal factors affecting pneumatic tyres are the type and thickness of insulation rubbers used between the fabric layers and the type and method of building of the materials used in the casing.

2 *External Factors.*

Both in solid and pneumatic tyres, the power consumption of a given tyre is very nearly proportional to its speed, other things being equal

Increase in the load causes an increase in the running deflection and a consequent increase in power consumption In pneumatic tyres a reduction of inflation pressure produces the same effect.

A hot tyre has a lower rolling resistance than a cold tyre; consequently, if a tyre is run at a constant speed as it warms up the power consumed falls off until it eventually reaches a steady value at which the amount of heat generated is just sufficient to balance the losses by radiation and conduction.

In the case of touring cars running at normal speeds, the power losses in the tyres do not represent more than 30 or 40% of the total power losses in the whole car. The power consumed by small cord tyres (3″–4″ in section) under normal conditions of load and inflation pressure and at a speed of 25 m p h is of the order of 0·6 to 0·9 h p. per tyre

The four 6″ tyres of a heavy racing car travelling at 200 m p h may absorb as much as 15 h.p each, or a total of 60 h.p.

BIBLIOGRAPHY—Most of the published matter dealing with tyres, takes the form of articles concerned with purely technical phases of the processes of manufacture and the preparation of materials, etc. These are to be found in the various technical journals associated with the rubber manufacturing, chemical and motor car industries. Of published work dealing with tyres themselves, the following are of the most general interest: A. Michelin, "The Pneumatic Tyre: Its Application to Autocars and Horsedrawn Carriages" (paper read before the French Society of Civil Engineers), in *The Autocar* vol. i. pp. 495, 507, 522, 534, 545, 567, 603, 698 (1895); S. F. Edge, "Pneumatic Tyres as Applied to Automobiles" (paper read before the Automobile Club), in *The Autocar*, vol. iv. pp. 213–218 (March 1899); W. H. Paull, "Pneumatic Tyre" (paper read before Cycle Engineer's Institute) in *Proceedings*, Cycle Engineer's Institute, pp. 44–70 (1901); H. C. Pearson, *Rubber Tires and all about Them* (New York, 1906); A. Healey, "The Tyre as Part of the Suspension System" (London, 1926), reprint of paper read before the Institute of Automobile Engineers, 1924; C. Macbeth, "Pneumatic Tyres for Heavier Loads," *Journal of Institute of Automobile Engineers*, pp. 549–562 (March, 1926); W. L. Holt and P. L. Wormeley, "Endurance Tests of Tyres," U.S. Bureau of Standards, *Technological Papers*, vol xx. No. 318, pp. 545–551 (May 1926); H. O. Duncan, "The Story of Pneumatic Tyres, Experiments, Patents and Finance," *World on Wheels*, pp. 583–622 (Paris, 1926), W. C. Geer, "The Bicycle Tyre, Pneumatics and Solids," *Reign of Rubber*, pp. 120–167 (London, 1926); H. C. Pearson, "Pneumatic Tires," *An Encyclopedia of Tyre Manufacture, History, Processes, Machinery, Modern Repair and Re-building, Patents, etc.* (New York, 1926); "Tyres and the Causes of Tyre Wear," *Journal of Society of Automotive Engineers*, vol. xx, pp. 790–792 (1927), "Use and Care of Automobile Tires," U.S. Bur. of Standards *Circular No. 341* (1927). (W. H. P)

TYREE, island of the Inner Hebrides, Argyllshire, Scotland. Pop. (1921), 1,716. It is situated fully 2 m. S.W. of Coll, the isle of Gunna lying in the channel between the two islands, and has an extreme length from north-east to south-west of nearly 12 m. and a breadth varying from ¾ m. to 4½ m. Carnan Mor (460 ft) is the highest point; there are several lakes On the south-western point of Balephuill bay are ruins of St. Patrick's temple, besides duns and chapels; an ancient underground dwelling was found in 1916 Steamers call from Oban regularly at the small harbour of Scarinish Horses are bred on the island Marble has been worked Skerryvore, a lonely rock in the Atlantic, with a lighthouse, 14 m south-west, belongs to the parish of Tyree.

TYROL: *see* TIROL.

TYRONE, EARLS OF: *see* O'NEILL, IRISH FAMILY.

TYRONE, a county of Ireland in the province of Ulster, bounded north and west by Donegal, north-east by Londonderry, east by Lough Neagh and Armagh and south by Monaghan and Fermanagh The area is 806,658 acres or about 1,260 sq m Pop. (1926) 132,777 Running along the north-eastern boundary with Londonderry are the schist ridges of the Sperrin Mountains (Sawel, 2,240 ft., and Meenard, 2,061 ft) Most of the south of the county is occupied by sandstone formations Mullaghearn, north-east of Omagh, reaches 1,778 ft South of Clogher a range of hills, reaching 1,255 ft in Slieve Beagh (Upper Carboniferous sandstones and shales), forms the boundary between Tyrone and Monaghan.

From Coalisland to Dungannon true Coal Measures appear. This coalfield includes one seam 9 ft. thick at Coalisland, less important coals occur in the Millstone Grit series at Dungannon The field doubtless continues eastward under the Triassic sandstone that stretches towards Lough Neagh The pale clays, probably Pliocene, of the southern shore of the lake cover the flat land east of Coalisland, and are several hundred feet thick. North of Stewartstown, near Tullaghoge, a very small patch of Magnesian limestone contains Permian marine fossils; and, farther north, the county includes part of the basaltic plateaux, protecting Chalk, which extend into co. Londonderry.

The Foyle forms a small portion of the western boundary of the county, and receives the Mourne, which flows northward by Newton Stewart The principal tributaries of the Mourne are the Strule (constituting its upper waters), the Derg from Lough Derg, and the Owenkillew, flowing westward from Fir Mountain. The Blackwater rises near Fivemiletown and forms part of the south-eastern boundary of the county with Monaghan and Armagh Lough Neagh bounds the county on the east. Lough Fea is situated in the north-west, and there are several small lakes near Newtown Stewart

Tyrone became a principality of one of the sons of Niall of the Nine Hostages in the 5th century, and from his name—Eogan—was called Tir Eogan, gradually altered to Tyrone. From Eogan were descended the O'Neals or O'Neills and their numerous septs. The family had their chief seat at Dungannon until the reign of Elizabeth, when it was burned by Hugh O'Neill to prevent it falling into the hands of Lord Mountjoy. The earldom of Tyrone had been conferred by Henry VIII. on Conn O'Neill, but on his death, when the earldom should have descended to his heir Matthew, baron of Dungannon, another son, Shane, was pro-

claimed chief with the consent of the people Shane defied English authority, but his forces were defeated near the river Foyle in 1567, and shortly afterwards he was himself killed. Tyrone was one of the counties formed at Sir John Perrot's shiring of the unreformed parts of Ulster; but his work was interrupted by the rising of Hugh O'Neill in 1596 During the insurrection of 1641 Charlemont Fort and Dungannon were captured by Sir Phelim O'Neill, and in 1645 the parliamentary forces under General Munro were defeated by Owen Roe O'Neill at Benburb At the Revolution the county was for a long time in the possession of the forces of James II

Raths are numerous in the county There is a large cromlech near Newtown Stewart, another at Tarnlaght near Coagh and another a mile above Castlederg At Kilmeillie near Dungannon are two stone circles There are some ruins of the ancient castle of the O'Neills, near Benburb; mention may also be made of the ruins of the castles of Newtown Stewart, Dungannon, Strabane and Ballygawley. The hill pastures support a large number of young cattle Oats, potatoes and turnips are the principal crops The cultivation of flax, formerly an important industry, has greatly deteriorated Poultry-keeping is a growing industry. There are manufactures of linens and coarse woollens (including blankets); brown earthenware, chemicals, whiskey, soap and candles are also made There are a few breweries and distilleries

Branches of the Great Northern railway from Portadown (Co. Armagh) and Dungannon in the south-east, and from Enniskillen (Co Fermanagh) and Fintona, unite at Omagh, whence a line proceeds north by Newtown Stewart and Strabane to Londonderry From Dungannon a branch runs north to Cookstown, where it joins a branch of the Northern Counties (Midland) railway From Victoria Bridge on the Londonderry line the Castlederg light railway serves that town The south of the county is served by the Clogher Valley light railway Water communication includes Lough Neagh, and the Blackwater entering it, and navigable to Moy, whence the Ulster canal skirts the boundary of the county with Co Armagh to Caledon

The administrative counties of Tyrone and Fermanagh together return 8 members to the Parliament of Northern Ireland and 2 members to the Parliament of Great Britain

TYRONE, a borough of Blair county, Pennsylvania, U S A, 15 m. N.E of Altoona, on the Little Juniata river and Federal highways 220 and 322, served by the Pennsylvania railroad Pop (1920) 9,084 (94% native white); 1928 local estimate 12,000 The borough is 910 ft above sea-level, in an agricultural and lumbering district, with deposits of limestone, iron and zinc. It is a distributing point for coal from the Clearfield region. The village was platted in 1851 and incorporated in 1857

TYRRELL, GEORGE (1861–1909), Irish divine, was born in Dublin on Feb 6, 1861 He was educated under Dr Benson at Rathmines School and entered Trinity College in 1878. He was greatly influenced by the writings of Cardinal Newman, and early in 1879 entered the Roman Catholic Church In 1880 he joined the Society of Jesus and became teacher of philosophy at Stonyhurst He had a keen sympathy with the difficulties experienced by the ordinary lay mind in trying to reconcile the conservative element in Catholicism with the principle of development and growth, and in *The Faith of the Millions, Hard Sayings* and *Nova et vetera* he attempted to clear them away Tyrrell privately circulated among his friends writings in which he drew a clear line of distinction between religion as a life and theology as the incomplete interpretation of that life. One of these, the *Letter to a Professor of Anthropology,* was translated without his knowledge into Italian, and extracts from it were published in the *Corriere della Sera* of Milan in Jan. 1906 For at least eight years before this he had been more or less in conflict with the authorities of his order, through his sympathy with "modernist" views, but the publication of this letter (afterwards issued by Tyrrell as *A Much Abused Letter*) brought about his expulsion from the order in Feb. 1906. "The conflict," he wrote, "such as it is, is one of opinion and tendencies, not of persons; it is the result of mental and moral necessities created by the antitheses with which the Church is wrestling in this period of transition " Tyrrell found no bishop to give him an ecclesiastical status and a *celebret,* and he never regained these privileges In July 1907 the Holy Office published its decree condemning certain modernist propositions, and in September the pope issued his encyclical *Pascendi Gregis* Tyrrell's criticism of this document appeared in *The Times* on Sept 30 and Oct 1, and led to his virtual excommunication from the Church On July 6, 1909, he was suddenly taken ill, on the 10th he received conditional absolution from a priest of the diocese of Southwark, and on the 12th extreme unction from the prior of Storrington His intimate friend, the Abbé Brémond gave him absolution, being with him at his death on July 15, 1909

His works include: *Lex Orandi* (1903); *Lex Credendis* (1906); *Through Scylla and Charybdis* (1907), *Mediaevalism* (1908); and *Christianity at the Cross Roads* (1909)

See the estimates by Baron F von Hugel and Rev C E Osborne in *The Hibbert Journal* for Jan 1910, also the obituary in *The Times* (July 16, 1909), and the *Life,* by M D Petre

TYRRELL, SIR JAMES (d 1502), the supposed murderer of the English king Edward V and of his brother Richard, duke of York, was a son of William Tyrrell and a grandson of Sir John Tyrrell (d *c* 1437), who was treasurer of the royal household and was on three occasions Speaker of the House of Commons The family is said to descend from Walter Tirel, the murderer of William Rufus During the Wars of the Roses James Tyrrell fought for the Yorkists, in 1471 he was knighted; and in 1477 he was member of parliament for Cornwall With regard to his share in the murder of the prince in 1483 he appears to have been selected by Richard III and sent to the Tower of London where he supervised the crime which was carried out by his subordinates Afterwards he received several appointments from Richard and was sent to Flanders He was also employed by Henry VII and was made governor of Guisnes, but he seems to have incurred the king's displeasure through his friendship with Edmund de la Pole, earl of Suffolk Having been treacherously seized he was conveyed to England and was executed on the 6th of May 1502 Just before his death he made a confession about the murder of the princes

TYRTAEUS, Greek elegiac poet, lived at Sparta about the middle of the 7th century B C According to the older tradition he was a native of the Attic deme of Aphidnae, and was invited to Sparta at the suggestion of the Delphic oracle to assist the Spartans in the second Messenian war Later accounts reject his Athenian origin but it is admitted that Tyrtaeus flourished during the second Messenian war (*c* 650 B C)—a period of musical and poetical activity at Sparta, when poets like Terpander and Thaletas were welcomed—that he not only wrote poetry but served in the field, and that he endeavoured to compose the internal dissensions of Sparta (Aristotle, *Politics,* v 6) About 12 fragments (three of them complete poems) are preserved They are mainly elegiac and in the Ionic dialect, written partly in praise of the Spartan constitution and King Theopompus (*Εὐνομία*), partly to stimulate the Spartan soldiers to deeds of heroism in the field (Ὑποθῆκαι—the title is, however, later than Tyrtaeus) The interest of the fragments preserved from the *Εὐνομία* is mainly historical, and connected with the first Messenian war The Ὑποθῆκαι were very popular in the army (Athen xiv 630 F) Of the marching songs (Ἐμβατήρια), written in the anapaestic measure and the Doric dialect, only scanty fragments remain

Verrall (*Classical Review,* July 1896, May 1897) definitely places the lifetime of Tyrtaeus in the middle of the 5th century B C, while Schwartz (*Hermes,* 1889, xxxiv) disputes the existence of the poet altogether, *see* also Macan in *Classical Review* (Feb 1897), H Weil, *Études sur l'antiquité grecque* (1900), and C Giarratani, *Tirteo e i suoi carmi* (1905) There are English verse translations by R Polwhele (1792) and imitations by H J Pye, poet laureate (1795), and an Italian version by F Cavallotti, with text introduction and notes (1898) The fragment beginning Τεθναμέναι γὰρ καλὸν has been translated by Thomas Campbell, the poet

TYRWHITT (tĭr'ĭt), **THOMAS** (1730–1786), English classical scholar and critic, born March 27, 1730, in London, where he died Aug 15, 1786. He was educated at Eton and Queen's college, Oxford In 1756 he was appointed under-secretary for war, in 1762 clerk of the House of Commons His principal classical works are: *Fragmenta Plutarchi II. inedita* (1773), from a Harleian ms: *Dissertatio de Babrio* (1776), containing

some fables of Aesop, hitherto unedited, from a Bodleian ms.; the pseudo-Orphic *De lapidibus* (1781), which he assigned to the age of Constantius; *Conjecturae in Strabonem* (1783); Isaeus *De Meneclis hereditate*, editio princeps (1785); Aristotle's *Poetica*, his most important work, published after his death (1794). Special mention is due of his editions of Chaucer's *Canterbury Tales* (1775–78); and of *Poems, supposed to have been written at Bristol by Thomas Rowley and others in the Fifteenth Century* (1777–78), with an appendix to prove that the poems were all the work of Chatterton. In 1782 he published a *Vindication of the Appendix*. While clerk of the House of Commons he edited *Proceedings and Debates of the House of Commons*, 1620–21 from the original ms. in the library of Queens' college, Oxford, and Henry Elsynge's (1598–1654) *The Manner of holding Parliaments in England*

TYTLER, ALEXANDER FRASER, Lord Woodhouselee (1747–1813), Scottish judge, was born at Edinburgh on Oct. 15, 1747, the son of William Tytler. He was called to the Edinburgh bar in 1770 His first work, a supplement to Lord Kames's *Dictionary of Decisions*, entitled *The Decisions of the Court of Session*, was published in 1778, and a continuation appeared in 1796. In 1780 he was appointed a professor of universal history at Edinburgh His lectures appeared finally in 1801 as *Elements of General History*. In 1790 he was appointed judge-advocate of Scotland, and wrote a *Treatise on the Law of Courts-Martial*. In 1801 he was raised to the bench as Lord Woodhouselee. He died at Edinburgh on Jan 5, 1813

Besides the works already mentioned, he wrote *Life and Writings of Dr. John Gregory* (1788), *Essay on the Principles of Translation* (1790), a dissertation on *Final Causes*, prefixed to his edition of Derham's *Physico-Theology* (1799); a political pamphlet entitled *Ireland profiting by Example* (1799), an *Essay* on Laura and Petrarch (1801), and *Memoirs of the Life and Writings of Henry Home of Kames* (1807)

TYTONIDAE: *see* Barn-Owls.

TYUMEÑ, a town in the Uralsk Area of the Russian S F S R, in 57° 15′ N, 65° 18′ E, on the Tura river, which is difficult for navigation owing to its shallowness, though dredging has somewhat improved it; it is usually ice-free from May 8 to Nov 15 Pop (1926) 50,161 The highway across the Urals passes through the town, and the railway links it with Sverdlovsk and Omsk In 1580, Yermak wintered on the site and in the following year captured Isker or Sibir, the fort from which Siberia took its name; the fort of Tyumeñ was established in 1585 Later it became the centre for the colonization of the Tura, Tavda, Tobol and Ob rivers, but was superseded by Chelyabinsk, which had a railway link earlier than Tyumeñ. In 1893 the first dairy farm was begun near Tyumeñ by the English wife of a Russian, and this led to the immediate and rapid development of that industry in western Siberia. It has the largest tanning and leather industry in Siberia, and has smelting works, saw-mills, match factories and steamer and boat building yards. Wool is dressed, and there are potteries. The koustar (peasant) industries include cooperage, the making of carts, furniture, sledges, horse-collars and wooden household utensils. The Tyumeñ carpets, with bright floral and animal designs are famous; the former Samoyede vegetable dyes are being replaced by aniline. The ploughs of the Kamen volost are also noted

TZETZES, JOHN, Byzantine poet and grammarian, flourished at Constantinople during the 12th century A D. Tzetzes has been described as a perfect specimen of the Byzantine pedant. Excessively vain, he resented any attempt at rivalry, and violently attacked his fellow grammarians Owing to want of books, he was obliged to trust to his memory; hence he is to be used with caution But he was a learned man, and deserves gratitude for his efforts to keep up the study of ancient Greek literature Of his numerous works the most important is the *Book of Histories*, usually called *Chiliades* ("thousands") from the arbitrary division by its first editor (N. Gerbel, 1546) into books each containing 1,000 lines (it actually consists of 12,674 lines in "political" verse) It is a collection of literary, historical, theological and antiquarian miscellanies, subsequently re-edited by the author with marginal notes The *Chiliades* is based upon a collection of letters (107 in number) which are addressed partly to fictitious personages, and partly to the great men and women of the writer's time They contain a considerable amount of biographical details. He is the author of the *Iliaca*, an abridgment of and supplement to the *Iliad* in 1676 hexameters, and the Homeric *Allegories*, dedicated to the empress Irene, two didactic poems in which Homer and the Homeric theology are explained on euphemistic principles. Tzetzes also wrote commentaries on Greek authors, for instance, on the *Cassandra* or *Alexandra* of Lycophron (ed C G Müller, 1811), in which his brother Isaac probably helped him. He is our earliest authority (*Chil* 3, 88, 339–48) for the story of the beggary of Belisarius Mention may also be made of a dramatic sketch in iambic verse in which he describes the wretched lot of the learned

Editions:—*Chiliades: Corp Poet Graec* (Lyons, 1612); ed. Kiessling (1826) *Iliaca*: ed Lehrs & Dübner (Paris, 1868) *Allegories* in Matranga, *Anecdota Graeca*, vol i (1850), *Scholia to Lycophron*, ed. Müller (1811).

For the other works of Tzetzes *see* J A Fabricius, *Bibliotheca graeca* (ed Harles), xi. 228, and C. Krumbacher, *Geschichte der byz Lit* (2nd ed, 1897); monograph by G. Hart, "De Tzetzarum nomine, vitis, scriptis," in Jahn's *Jahrbücher für classische Philologie*. Supplementband xii. (Leipzig, 1881).

U In the Semitic alphabet the letter Y (*vau*) was sixth in order, and represented a labial spirant (equivalent to English *v* or *w*) The Greeks used the letter to represent a vowel and placed it last in their aphabet following T (*tau*). In the place occupied by Y (*vau*) in the Semitic alphabet the western Greek alphabets had the letter digamma Ϝ, which they used to represent the bilabial spirant (modern English *w*), a sound that had fallen out of use in the eastern dialects Greek forms of the letter were Y, V or V and the last of these passed from the Chalcidic alphabet into Latin. The form Y was identical in both the Etruscan and Lydian alphabets

The Latins, who at first used the combination FH to express the unvoiced labial spirant (English *f*), came under Etruscan influence to represent this sound by F alone Thus, this letter, which in Greek had represented the bilabial spirant (English *w*), was no longer available, and *v* had to do duty for both the vowel

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	B C 1200	𐤅
CRETAN	1,100-900	V
THERAEAN	700-600	V
ARCHAIC LATIN	700-500	V
ATTIC	600	V
CORINTHIAN	600	Y V
CHALCIDIAN	600	Y
IONIC	403	V Y
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	V
URBAN ROMAN		V V
FALISCAN		V
OSCAN		Y V
UMBRIAN		V
CLASSICAL LATIN AND ONWARDS		U

THE DEVELOPMENT OF THE LETTER "U" FROM THE EARLIEST TIMES TO THE PRESENT DAY

(English *u*) and the bilabial spirant (English *w*). In later Latin before the separation of the Romance languages the bilabial passed into the voiced spirant equivalent to English *v* Meanwhile, while the majuscule letter retained its form V, the minuscule and uncial had a rounded form, e g , u (uncial), u (cursive of the 6th century) and, later, Carolingian u. Thus the letter passed into the mediaeval hands having the majuscule pointed form V and the minuscule rounded form *u* and representing two sounds, the vowel (*u*) and the spirant (*v*). In the later middle ages a differentiation took place similar to that between the letters *i* and *j* The majuscule form, being generally used initially, came to represent the consonant, which usually occurred initially, in all positions, while the rounded form was used exclusively for the vowel As a result a minuscule *v* and a majuscule *U* were adapted for use when required The differentiation was wise and useful, and reversed the process by which in the Latin alphabet the single symbol had done duty for both consonant and vowel

In Attic Greek the sound represented by the letter was a high front rounded vowel (similar to French *u*, German *ü*). In Latin the vowel was a middle high rounded one (similar to the sound of *oo* in *shoot*) In modern English short *ŭ* has become in most positions a low middle vowel closely resembling the original sound of short *ă* (e g , in the words *but, dumb*). There are certain exceptions, however (cf *bull, bush, put*) The long vowel has within the last two hundred years developed a palatal spirant (the sound of *y*) before it except when it follows a liquid (*r* or *l*) Contrast the sound of the pure vowel in the word *brute* with that in the words *huge, rebuke* This change is sufficiently recent for such words as begin with long *ū* (e g , *University*) to be preceded, when the indefinite article is required, by the form *an*, not *a*, showing that the sound was a pure vowel sound It is still so pronounced in certain cases in the United States of America It is an interesting fact that this change was exactly paralleled in the Boeotian dialect of Greek (B. F C A)

UAKARI, the name of certain tropical American monkeys, distinguished by their short tails They constitute the genus *Uacaria* and are confined to the forests of Amazonia. (*See* PRIMATES)

UBANGI, a river of equatorial Africa (extreme length 1,400 m), the chief northern affluent of the Congo (*q v*). The Ubangi (otherwise Mubangi or Mobangi) enters the Congo by various mouths between 0° 22′ and 0° 37′ S and 17° 40′ and 17° 50′ E The Ubangi is formed by the junction of the Bomu and the Uele (Welle), the latter rising a few miles from the western edge of the western rift-valley, north of Lake Albert and after a course of 700 m it joins the Bomu at Yakoma. Both streams, which have hitherto received numerous affluents, flow westward as a wide river. A short distance below the junction of the Bomu and Uele, the Kota coming from the borders of Darfur, and forming the most northerly extension of the Congo basin enters the united stream (right) The remaining tributaries, mostly on the right bank are smaller Below the confluence with the Kouma, which river offers water communication to within easy reach of the Shari basin, the Ubangi makes a great bend south and immediately it flows between hills and passes the Zongo or Grenfell rapids, which are a barrier to navigation save for small boats in flood season Above Zongo rapids the river is navigable up to the confluence of the Uele and Bomu, and the former is navigable at high flood up to the Bomokandi confluence in 26° 8′

The Uele was discovered from the north by G A Schweinfurth in 1870, who believed it to belong to the Chad system, but W Junker, who (1882–1883) followed the river to near its confluence with the Bomu, showed that it belonged to the Congo system In 1885 George Grenfell, ascended the Ubangi as far as the Zongo rapids He was followed in 1886–1889 by the Belgian, A van Gèle, who established the identity of the Ubangi with Schweinfurth's Uele. The Bomu was discovered from the north in 1877 by a Greek, P Potagos, and its upper course was followed for some distance by Junker. The Ubangi and the Bomu form the frontier between Belgian Congo and French Congo, the northern banks of both streams belonging to France

ÜBERWEG, FRIEDRICH (1826–1871), German historian of philosophy, was born on Jan 22, 1826 at Leichlingen, in Rhenish Prussia, where his father was Lutheran pastor. Educated at Göttingen and Berlin, he qualified himself at Bonn as *Privatdozent* in philosophy (1852). In 1862 he was called to Königs-

berg as extraordinary professor, and in 1868 was advanced to the ordinary grade He died on June 9, 1871. His compendious, accurate and impartial *History of Philosophy* has been repeatedly re-edited At first he followed Beneke's empiricism, and opposed the subjectivistic tendency of the Kantian system, maintaining in particular the objectivity of space and time, which involved him in a somewhat violent controversy. His own system he preferred later to describe as an ideal realism, which refused to reduce reality to thought, but asserted a parallelism between the forms of existence and the forms of knowledge

Überweg's works include *System der Logik* (1857; 5th ed., 1882; Eng trans. of 3rd ed by T. M. Lindsay, 1871), *Grundriss der Gesch. der Phil* (1863–66, 12th ed 1923–28), an essay (1861) on the authenticity and order of Plato's writings; *Schiller als Hist. und Phil.* (published by Brasch from his papers, Leipzig, 1884) *See* F A Lange, *F. Ueberweg* (1871), M Brasch, *Die Welt- und Lebensanschauung F. Ueberwegs* (Leipzig, 1889).

U-BOAT: *see* SUBMARINE CAMPAIGNS

UCCELLO, PAOLO (1397–1475), Florentine painter His name was Paolo di Dono, but he was commonly called Uccello from his love of painting birds He was born in Florence, the son of a surgeon barber When about ten years of age he was apprenticed to Lorenzo Ghiberti, who was then engaged on his first doors of the Florentine Baptistery It is not known who was Paolo's master in painting, and only a small number of his works have survived He went to Venice in 1425 and designed a mosaic of St Peter for the façade of St Mark's On his return to Florence in 1433 he was employed in the cathedral, he painted the equestrian figure of Sir John Hawkwood, an English adventurer and soldier of reputation, who had died in the service of Florence in 1393. The painting, now hanging over the door of one of the aisles, was transferred from wall to canvas in 1842 It is a chiaroscuro in terra verde, the first equestrian picture of the Renaissance In 1443 Paolo designed cartoons for the circular windows of the cupola A year later he probably went to Padua, perhaps in the company of his friend Donatello His paintings there of giants, in chiaroscuro, at the entrance of the Casa Vitaliani, were much admired by Mantegna They are, unfortunately, no longer extant Of the frescoes in the cloisters of S Maria Novella, Florence, showing the stories of the Creation and the Deluge, only fragments remain. The series of three battlepieces, representing the Rout of San Romano, dispersed in the galleries of Florence, Paris and London, once formed part of the decoration of a large ground floor room, the bedchamber of Lorenzo the Magnificent, in the Medici (Riccardi) palace The Louvre has a panel, much repainted, of the portraits of Giotto, Brunellesco, Donatello, Antonio Manetti and himself Paolo's last work is said to have been a fresco painted over the door of the church of S Tommaso in the Mercato Vecchio This work apparently met with the disapproval of his friend, Donatello, and Paolo thereupon gave up painting and devoted himself to the study of perspective He died on Dec 10, 1475 He had a fine feeling for the decorative value of shapes and colour He excelled in the representation of the picturesque armour and costumes of his time, and introduced birds, horses and animals of all kinds He contributed much towards the development of the art of representing natural objects in three dimensional space

See Vasari, *Vite* (edit Milanesi); Herbert Horne, *Monthly Review* (Oct 1901); Kern, "Der Mazzocchio des P. Uccello" (*J. preusz. K.*, xxxvii, 1915), Sir Dominic Colnaghi, *A Dictionary of Florentine Painters* (1928). (I. A. R.)

UDAD, AOUDAD or **AUDAD,** the Barbary sheep, *Ovis lervia,* the only wild sheep found in Africa, where it inhabits all the mountain ranges of the north, descending eastward far into the Sudan. It is distinguished by the abundant hair on the throat and fore-quarters of the rams, the length of the tail, the absence of face-glands, and the goat-like structure of the horns.

UDAIPUR or **MEWAR,** an Indian state in the Rajputana agency. Area, 12,756 sq.m. Pop. (1921), 1,380,063. The greater part of the country is level plain. A section of the Aravalli Mountains extends over the south-western and southern portions, and is rich in minerals, but the mines have been long closed. The general inclination of the country is from south-west to north-east, the Banas and its numerous feeders flowing from the base of the Aravalli range There are many lakes and tanks in the state, the finest of which is the Debar or Jaisamand, with an area of nearly 21 sq m. The ancient coinage is of the Sassanian or Persian type

The chief, whose title is maharana with a salute of 19 guns, is the head of the Sisodia clan of Rajputs, and claims to be the direct representative of Rama, the mythical king of Ajodhya He is universally recognized as the highest in rank of all the Rajput princes The dynasty offered a heroic resistance to the Mohammedans, and boast that they never gave a daughter to a Mogul emperor They are said to have come from Gujarat and settled at Chitor in the 8th century. After the capture of Chitor by Akbar in 1568 the capital was removed to Udaipur by Maharana Udai Singh During the 18th century the state suffered greatly from internal dissension and from the inroads of the Mahrattas It came under British protection in 1817

The name of *Mewar* is derived from the Meos, or Minas, a tribe of mixed Rajput origin, who have likewise given their name to a different tract in northern Rajputana, called Mewat, where they are now all Mohammedans The Mewar Bhil Corps, raised as a local battalion in 1840, which was conspicuously loyal during the Mutiny, was in 1897 attached to the Indian army.

The picturesque city of UDAIPUR is 2,469 ft above sea-level Pop (1921), 34,789 It is situated in a valley amid wooded hills, on the bank of a large lake (Pichola), with palaces built of granite and marble The maharana's palace, which crowns the ridge on which the city stands, dates originally from about 1570, but has had additions made to it till it has become a conglomeration of various architectural styles On Lake Pichola are two islands, on which are palaces dating respectively from the middle of the 17th and of the 18th centuries In the neighbourhood are Eklingji (with a magnificent temple of the 15th century), and Nagda, the seat of the ancestors of the chiefs of Udaipur

There is another UDAIPUR STATE in the Central Provinces (till 1905 one of the Chota Nagpur states of Bengal) Its capital is Dharmjaygarh

UDAL, NICHOLAS (1504–1556), English schoolmaster, translator and playwright, author of the earliest extant English comedy, *Roister Doister,* came of the family of Uvedale, who in the 14th century became lords of Wykeham, Hants, by marriage with the heiress of the Scures He latinized the name as Udallus, and thence anglicized it as Udal He is described as Owdall of the parish of St Cross, Southampton, 12 years old at Christmas 1516, when admitted a scholar of Winchester College in 1517 (*Win Schol Reg.*). He was therefore 16½ years of age when admitted a scholar of Corpus Christi college, Oxford, in June 1520, he is called Wodall as a lecturer at that college in 1526 to 1528 (T Fowler, *Hist C C C*)

With John Leland he produced "dites" (ditties) "and interludes" (B M. MS 18A lxiv) at Anne Boleyn's coronation on May 31, 1533. Leland's contributions are all in Latin; those of "Udallus," which form the chief part, are mostly in English, the speeches being each spoken by a "child," at Cornhill beside Leadenhall "at the Conducte in Cornhill" and "at the little Conducte in Cheepe." From the dedication to his *Floures for Latine Spekynge, selected and gathered out of Terence and the same translated into Englysshe,* published by Bartlet (*in aedibus Berthelett*) (1534), it is inferred that Udal was usher at St Anthony's school next door to Austin Friars, London. At midsummer 1534 he became head master of Eton. At Eton Udal's salary was £10 and £1 for livery, with "petty receipts" of 8s 4d. for *obits,* 2s 8d for laundress, 2s for candles for his chamber, and 23s. 4d. "for ink, candles and other things given to the grammar school by Dr. Lupton, provost."

There was a yearly play, 3s. being paid for the repair of the dresses of the players at Christmas, and 1s. 4d. to a servant of the dean of Windsor for bringing his master's clothes for the players. A payment for repair of the players' dresses recurs every year. Udal has been credited (E. K. Chambers, *Mediaeval Stage,* ii. 144, 192) with producing a play at Braintree while vicar there, recorded in the churchwardens' accounts for 1534 as "Placidas *alias* Sir Eustace." The play is actually called in the accounts

(only extant in 17th-century extracts) "Placy Dacy *alias* Sir Ewestacy," and is the old play of Placidas, mentioned in the 9th century. Udal only became vicar of Braintree in 1537 but did not reside there at that time. He held the benefice until 1554. The accounts of Cromwell for 1538 include "Woodall, the scholemaster of Eton, to playing before my lord, £5." Presumably he brought a troupe of Eton boys with him. In that year he published a second edition of his *Floures of Terence* for the benefit of Eton boys. The often-questioned account of Thomas Tusser (*Five Hundred Pointes of Good Husbandrie*) is typical of Eton at the time, as Udal's predecessor Cox is said in Ascham's *Scholemaster* to have been "the best scholemaster and greatest beater of our time" —

> From Powles[1] I went to Aeton sent,
> To learn straightwaies the Latin phraise,
> Where fifty-three stripes given to me at once I had,
> For fault but small or none at all
> It came to pass thus beat I was;
> See, Udall, see, the mercie of thee to mee, poor lad.

Udal's rule of the rod at Eton was short He was brought up before the privy council on March 14, 1541 for being "counsail" with two of the boys, Thomas Cheney and Thomas Hoorde, for stealing silver images and chapel ornaments He denied the theft, but confessed to a much more scandalous offence with Cheney, and was sent to the Marshalsea prison He tried, but failed, to get restored to Eton

He seems to have maintained himself by translating into English, in 1542, Erasmus's *Apophthegms* and other works In 1544 he published a new edition of the *Floures of Terence* He seems to have taken a schoolmastership in Northumberland or Durham, as Leland in one of his *Encomia* speaks of him, probably at this time, as translated to the Brigantes He purged himself, however, by composing the *Answer to the Articles of the Commoners of Devonshire and Cornwall* (Pocock, *Troubles of the Prayer Book of 1549*, Camd Soc, new series, 37, 141, 193), when they rose in rebellion in the summer of 1549 against the First Prayer Book of Edward VI In 1551 he received a patent for printing his translation of Peter Martyr's two works on the Eucharist and the Great Bible in English (Pat 4 Edw VI. pt 5, m 5, Shakespeare Soc iii xxx) He was rewarded by being made a canon of Windsor on Dec. 14, 1551 On Jan 5, 1552 he edited a translation of Erasmus's *Paraphrases* of the Gospels, himself translating the first three, while that on St John was being translated by the princess Mary, till she fell sick and handed her work over to Dr Malet The work was done at the suggestion and expense of the dowager queen Katharine, in whose charge Mary was A translation by Udal of Geminus's *Anatomie* or *Compendiosa totius anatomiae delineatio*, was published in 1553 Udal's preface is dated July 20, 1552 "at Windesore" In June and September 1553 (*Trevelyan Pap* Camd Soc 84, ii 31, 33) "Mr Nicholas Uvedale" was paid at the rate of £13, 6s 8d. a year as "scholemaster to Mr Edward Courtney, beinge within the Tower of London, by virtue of the King's Majesty's Warrant"—the young earl of Devon, who had been in prison ever since he was twelve years old

Queen Mary on Dec. 3, 1554 issued a warrant on Udal's behalf directing "the maister and yeomen of the office of the Revells" to deliver whatever Udal should think necessary for setting forth dialogues and interludes, while the exchequer was ordered to provide the money to buy them (Loseley mss. Kempe 63, and *Hist. mss. Com Rep.* vii 612) One of these interludes was probably *Roister Doister;* for it was in January 1553, *i e*, 1554, that Thomas Wilson, master of St Katharine's Hospital by the Tower, produced the third edition of *The Rule of Reason,* the first text-book on logic written in English, which contains, while the two earlier editions, published in 1551 and 1552 respectively, do not contain, a long quotation from *Roister Doister* "taken out of an interlude made by Nicholas Udal." The play was entered at Stationers' Hall, when printed in 1566. Only one copy is known, which was given to Eton by an old Etonian, the Rev. Th. Briggs, in 1818, who privately printed thirty copies of it. There are strong reasons for believing that *Roister Doister* first appeared in 1553, and therefore could not have been written at Eton or for Eton boys

Nor could it have been written at Westminster school or for Westminster boys, as argued by Professor Hales in *Eng Studien* (1893) xviii 408. For though Udal did become head master of Westminster, he only became so on Dec 16, 1555, nearly two years after Wilson's quotation from *Roister Doister* appeared He was at Winchester in the interval, perhaps as master of the old City Grammar or High School When the monks re-entered Westminster, on Mary's restoration of the abbey (Nov. 21, 1556), the school did not, as commonly alleged, cease, nor had Udal ceased to be master (Shakespeare Soc. iii xxxiv) when he died a month later He was buried on Dec 23, 1556

Roister Doister well deserves its fame as the first English comedy It is infinitely superior to any of its predecessors in form and substance It has sometimes been described as a mere adaptation of Plautus's *Miles Gloriosus* Though the central idea of the play—that of a braggart soldier (with an impecunious parasite to flatter him) who thinks every woman he sees falls in love with him and is finally shown to be an arrant coward—is undoubtedly taken from Plautus, yet the plot and incidents, and above all the dialogue, are absolutely original, and infinitely superior to those of Plautus

The play was printed by F Marshall in 1821; in Thomas White's *Old English Dramas* (3 vols, 1830); by the Shakespeare Society, vol. iii, the introduction to which contains the fullest and most accurate account of his life; in Edward Arber's reprints in 1869; and Dodsley's *Old Plays* (1894), vol iii. A R Moon (Times Lit Supp Ap. 19, 1928) suggests the ascription to Udal of a lost play *Ezechias* acted at King's College, Cambridge, before Queen Elizabeth, on Aug. 8, 1564, eight years after Udal's death He identifies this piece with the *Tragoedia de papatu* referred to by Gale (*Scriptores Britanniae*) as Udal's work

UDAL, a kind of right still existing in Orkney and Shetland, and supposed to be a relic of the old allodial mode of landholding existing antecedently to the growth of feudalism in Scotland (*see* ALLODIUM). The udal tenant holds without charter by uninterrupted possession on payment to the Crown, the kirk, or a grantee from the Crown of a tribute called scat, or without such payment, the latter right being more strictly the udal right Udal lands are convertible into feus at the option of the udallers

UDINE, a town and archiepiscopal see of Venetia, Italy, capital of the province of Udine, situated between the Gulf of Venice and the Alps, 84 m by rail N E of Venice, 450 ft above sea-level Pop (1921) 55,671 (town); 56,041 (commune). The interesting Porta Aquileia (14th cent.) is almost all that is left of the old city walls Some of the streets are arcaded and there are some fine palaces The old castle on a hillock in the centre of the town, at one time the residence of the patriarchs of Aquileia, and now used as a museum and picture gallery, was erected by Giovanni Fontana in 1517 in place of the older one destroyed by an earthquake in 1511 The Romanesque cathedral contains some interesting examples of native art by Giovanni Martini da Udine, a pupil of Raphael, and others The church of S Maria della Purità has frescoes by Giovanni Battista and Domenico Tiepolo In the picturesque principal square stands the town hall, built in 1448–1456 in the Venetian-Gothic style, and skilfully restored after a fire in 1876, opposite is a clock tower resembling that of the Piazza di San Marco at Venice with the elegant loggia of S Giovanni leading to the church of the same name (1533). In the square is a statue of Peace, erected in commemoration of the peace of Campo Formio (1796), which lies 5 m to the W S W and two columns, one with the tier of S Mark, the other with a statue of Justice The archiepiscopal palace contains frescoes by G B Tiepolo. The leading industry of Udine is silk-spinning, but it also possesses manufactures of linen, cotton, hats and paper, tanneries and sugar refineries, and has a considerable trade in flax, hemp, etc. Branch railways lead to Cividale del Friuli and S Giorgio di Nogaro

Udine lay on the line of the Via Iulia Augusta, and there is proof of its existence in Roman times. In 983 it was given by the emperor Otto II to the patriarch of Aquileia, to whom it may have belonged even earlier. In 1222 or 1238 the patriarch Berthold made it the capital of Friuli, and in 1420 it became Venetian In 1752 it became an archbishopric It was the seat of the Italian

[1]Tusser was a chorister of St. Paul's.

Comando Supremo (G H Q) during the World War from 1915 to 1917.

UFA, the chief town of the Bashkir A S S R , situated at the confluence of the Ufa river and the Byelaya, in 54° 44′ N , 56° E., at the western edge of the Ural forests Pop. (1926) 96,423. Its industries include copper-smelting, saw-milling, flour-milling, rope-making, brewing and fruit-liqueur distilling After the fall of Kazan, which destroyed the centre of unity of the non-Russian elements in the district, the Russians advanced through the Finnic-Bashkirian state and founded Ufa in 1574

UGANDA, a British protectorate in Eastern Equatorial Africa, lying between Lake Victoria and Lakes Albert and Edward, and between the Mountain Nile and Lake Rudolf The same name was originally applied to the Bantu kingdom of Buganda, which is one of the provinces of the protectorate, and is now styled officially by the correct native name of "Buganda" The Swahili followers of the first explorers always pronounced the territorial prefix, Bu, as a simple vowel, U, hence the incorrect rendering "Uganda" It was first applied to the kingdom on the north-west shores of Lake Victoria discovered by J H Speke in 1862, and in time came to include the large protectorate which grew out of the extension of British influence over Buganda

Frontiers and Area.—The area of the protectorate has varied considerably since Buganda was placed under British protection in 1894. From that date up to 1901 various regions were added Its then eastern province, which included the northern half of the eastern shores of Lake Victoria, was transferred in 1903 to the East Africa Protectorate (now Kenya Colony) The northern frontier is, roughly, about the line of 4° N and is conterminous with the Anglo-Egyptian Sudan On the Nile itself the frontier was at Lado (a little north of 5° N) By agreement, made in 1914, the frontier on the river was drawn back to Nimule, while the Sudan surrendered to Uganda approximately 4,000 sq m W of the Nile which had been part of the Lado enclave On the south the protectorate includes part of Lake Victoria, and west of the lake the frontier, for the most part, is the 1st degree of S lat. This frontier coincided with the northern frontier of German East Africa On the west, where German, British and Congo Free State territories met, the Uganda frontier was to begin along the 30th meridian of east longitude In 1904 it was found, however, that the 30th meridian had been placed some 25 m W of its true position on the maps used when the frontier was agreed upon, and the adjustment of claims caused by this "wandering meridian" gave much trouble As finally settled in 1912 the Uganda-Belgian Congo frontier is drawn so as to include Kizegi, a highland region containing some of the peaks of the Mfumbiro volcanoes, in Uganda, and to put most of Lake Edward in Belgian territory From that lake the frontier goes across the Ruwenzori range and along the Semliki river to Lake Albert, the western half of which, nearly to the north end, fell to the Belgian Congo Thence the frontier follows the Congo-Nile watershed In 1922 further frontier changes were made The Didinga district east of the Nile was taken over by the Sudan, while in 1926 Kenya Colony took over administration of the Rudolf province These arrangements relieved Uganda of responsibility for remote, unsettled, semi-arid regions where Abyssinians, Somali and Turkana carried on gun-running and raided peaceful tribes The area of Uganda protectorate, allowing for the changes stated, is approximately 94,000 sq m. (including 15,000 sq m of water) The division into provinces is (1) Buganda, (2) Eastern (originally Central), (3) Western, (4) Northern (originally Nile). The following description includes in part the former Rudolf province.

Physical Features.—The protectorate, with a singularly diversified surface of lofty plateaux, snow-capped mountains, vast swamps, dense forests and regions of desolate aridity (valley of Lake Rudolf) offers a remarkable variety of climates The Eastern province is abundantly watered near Victoria Nyanza and around Mt. Elgon and the noble Debasien mountain (about 50 in. to 100 in. annually); elsewhere in Karamojo and the northern regions, the rainfall lessens to about 20 inches. Busoga and the western part of the Elgon district have a regular West African climate—hot, moist and not over-healthy. These are the conditions of Buganda, a country with an annual rainfall of from 60 to 80 in., a regular West African climate, and severe and frequent thunderstorms. Much the same may be said about the Western province, except for the cooling influence of the Ruwenzori snow range, which pleasantly affects Toro and northern Ankole. The rainfall on Ruwenzori and the central Semliki valley is quite 100 in per annum. Along the Ruwenzori range are glaciers and snowfields nearly 15 m. in continuous length and some 5 m. in breadth The Northern province is, perhaps, the hottest part of Uganda. Like the districts round Lake Rudolf, the average altitude (near the Nile) is not more than 2,000 ft., but the rainfall is more abundant, being an average of 30 in per annum.

Mt. Elgon (*q v*), a vast crater, the rim of which rises to over 14,000 ft , and its surrounding heights form a mountain country notable for innumerable cascades and dense forests. Elgon dominates a large area and can be seen from the north-east coast of Victoria Nyanza, from near the main Nile stream, from the heights overlooking Lake Rudolf and from Kikuyu escarpment The Eastern province consists of well-forested, undulating land (Busoga) on the coast of the lake, a vast extent of marsh round the lake-like backwaters of the Victoria Nile (Lakes Kioga or Ibrahim, Kwania, etc), and a more stony, open, grain growing country (Bukedi, Lobor, Karamojo) The Turkana country west of Lake Rudolf is now arid, and most of the rivers have ceased to show running water in their lower courses A good deal of high land—rising in some peaks to near 10,000 ft.—is found in the eastern part of the Northern province, and these heights attract moisture and nourish permanent streams flowing Nilewards But much of the lower ground is stony and poor in vegetation, while the lowland near the main Nile is exceedingly marshy.

The Ripon falls in the centre of the northern coast of the Victoria Nyanza, at the head of the exquisitely beautiful Napoleon gulf, mark the exit of the fully born Nile from the great lake. The Victoria Nile tumbles over 50 m of cascades and rapids (descending some 700 ft in that distance) between Ripon falls and Kakoge Here it broadens into Lake Kioga (Ibrahim), in reality a vast backwater of the Nile, and continues navigable (save for sudd obstacles at times) through Lake Kioga and thence northwards for 100 m to Foweira and Karuma falls. Between Karuma and Murchison falls the Victoria Nile is unnavigable At Fajao the navigation can be resumed into Lake Albert. The main Nile stream, when it quits Lake Albert, continues navigable as far north as Nimule (3° 40′ N) Navigability begins again 100 m lower down at Rejaf, from which point steamers ply to Khartoum (*see* NILE)

The topography of the Western province includes the eastern part of Lake Edward, Lake George, the eastern and northern shores of Albert Nyanza (*q v*), part of the great snowy range of Ruwenzori (*q v.*), the dense Semliki, Budonga, Mpanga and Bunyaraguru forests, the salt lakes and salt springs of Bunyoro and western Toro, the innumerable and singularly beautiful crater lakes of Toro and Ankole, part of the volcanic region of Mfumbiro (*q v*) and the healthy plateaux of Ankole. The water of Lake Victoria is perfectly fresh. In Lakes Albert and Edward the water ranges from salt to slightly brackish.

Geology.—Although a good deal of geological work has been done, much more remains to be done. What may be called the foundation formation, consisting of Archaean rocks—gneiss, schist and granite—covers large areas through which the Nile cuts its way in alternate narrow gorges and open reaches. In Ankole and Koki rocks consisting of granular quartzite, schistose sandstone, red and brown sandstone, and shales with cleaved killas rest on the Archaean platform. Clay rocks of very varying texture and appearance occur over a wide area in Buganda, the western province, and the south part of the northern province. The Nile, at the Ripon falls, leaps over a basalt dike. The rocks on the verge of the Kisumu province of Kenya Colony are mainly volcanic (basalt, tuff, lava, kenyte). Thick beds of crystalline limestone occur in the Eastern province, with sandstone in Musoga, basalt round Mt. Elgon, slate (Busoga) and iron stone (Busoga and Bukedi). In the Rudolf province there are the basalt, lava, tuff and kenyte of the volcanic Rift valley, overlying a formation of gran-

ite, gneiss, and quartz. Gneiss, granite and quartz—the decomposed granite giving the red "African" clay—are the leading features in the formation of the Northern province, of Buganda, and of the Western province, with some sandstone in the littoral districts of Buganda and in Ankole, and eruptive rocks and lava in south-western Ankole and on the eastern flanks of Ruwenzori. Laterite is a surface deposit of wide occurrence, and iron ore (haematite) is abundant. Deposits of Karroo age have been found at Entebbe and elsewhere. It may be added that there is abundant evidence of man's presence in Uganda in the Palaeolithic and Neolithic ages.

Flora.—The vegetation is luxuriant, except in the Rudolf region, which has the sparse flora of Somaliland. In the Western province, Busoga and the Elgon district, the flora is very West African in character. The swampy regions of the Nile and of the Eastern province are characterized by an extravagant growth of papyrus and other rushes, of reeds and coarse grass. There are luxuriant tropical forests in the coast region of Buganda, in Busoga, west Elgon, western Unyoro, eastern Toro, the central Semliki valley and north-west Ankole The upper regions of Mt. Elgon, Mt. Debasien and Mt. Agoro are clothed with forests of conifers—juniper and yew—and witch hazels (*Trichocladus*) There are also giant yew-trees (*Podocarpus*) on the flanks of Ruwenzori and the Mfumbiro volcanoes between 7,000 and 9,000 ft., but no junipers. The alpine vegetation on all these lofty mountains is of a mixed Cape and Abyssinian character—witch hazels, senecios, lobelias, kniphofias, everlasting flowers, tree heaths and hypericums. The really tropical vegetation of Buganda is nearly identical with that of West Africa

Fauna.—The fauna also has many West African affinities in the hot, forested regions In the adjoining Kisumu province of Kenya Colony there are several West African mammals, such as the broad-horned tragelaph and the forest pig These are also found in part of the Semliki forests. As a rule, however, the fauna of the Upper Semliki valley, of parts of Ankole, Buganda and Bunyoro, of the Northern, Rudolf and Eastern provinces, is of that "East African," "Ethiopic" character which is specially the feature of South and East Africa and of the Sudan right across from Abyssinia to the river Senegal Among notable mammals the chimpanzee is found in Bunyoro, Toro and north-west Ankole, and has only recently become extinct in Buganda; the gorilla is found in the Mfumbiro region, the okapi inhabits the Semliki forests on the Congo frontier, the giraffe (the male sometimes developing five horn cores) is common in the Northern, Eastern and Rudolf provinces; there are three types of buffalo—the Cape, the Congo and the Abyssinian; two species of zebra—one of them Grévy's—the African wild ass, the square-lipped ("white") and pointed-lipped ("black") rhinoceroses, the elephant—in 1928 it was estimated that there were 20 000 elephants in the protectorate —hippopotamus, water tragelaph ("Speke's antelope"), Cape antbear, aard-wolf (*Proteles*), hunting-dog, and nearly every genus and most of the species of African antelopes. The birds are more West African than the mammals, and include the grey parrot, all the genera of the splendidly-coloured turacoes, the unique "whale-headed stork" and the ostrich.

Inhabitants.—Europeans in 1927 numbered 1,752, of whom 590 were females. There are some traders and planters, but most of the whites are officials or missionaries. (The white pop. in 1909 had been 507.) Asiatics, some 3,000 in 1909, numbered 11,613 in 1927. Most of them are British Indians. The African pop in 1927 was estimated at 3,149,000 The races indigenous to the protectorate are mainly of the negro species (with slight Caucasian intermixture), and may be divided into the following categories: (1) *Pygmy prognathous* (so-called "Congo" pygmies of the Semliki forest, of Kiagwe in Buganda and of the western flanks of Mt. Elgon, and the types of Forest negroes); (2) *Bantu negroes* (Banyoro, Bairu, Basese, Basoga, Bakonjo, Baganda, Masaba and Kavirondo); (3) *Nile negroes* (Aluru, Bari, Madi, Acholi, Gang, Lango, Latuka, Tesi, Sabei [Nandi], Turkana and Karamojo); (4) *Hamitic* (the remarkable "Hima" or "Huma" aristocracy in Bunyoro, Buganda, Toro and Ankole). The pygmies are generally known as Bambute or Bakwa in the Semliki forests. They are reddish-yellow and brownish-black (according to individual variation) in skin colour, with head hair often tending to russet, and body hair of two kinds—black and bristly on the upper lip, chin, chest, axillae and pubes; and yellowish and fleecy on the cheeks, back and limbs. Their faces are remarkable for the long upper lip and the depressed broad nose with enormous alae. Associated with these pygmies is the "Forest negro" type (Lendu, Lega, Baamba, Banande), of normal human stature, but short-legged and unusually prognathous. The Bantu negroes include the remarkable Baganda people These last, before the arrival of Arabs and Europeans, displayed a nearer approach to civilization than has as yet been attained by an unaided negro people. Their dynasty of monarchs can be traced back with tolerable certainty to a period coincident with the reign of Henry IV. of England (A D 1400). The first Buganda king was probably a Hamite of the Hima stock (from Bunyoro). Until the coming of the white man the Baganda and most of the other Bantu peoples of the protectorate worshipped ancestral and nature spirits, who had become elevated to the rank of gods and goddesses. The Baganda are now mainly Christian. A "totem" system is still in vogue. All the Baganda belong to one or other of 29 clans, or "Bika," which are named after and have as totem familiar beasts, birds, fish or vegetables. The Baganda are not sexually a very moral people, but they have an extreme regard for decency, and are always scrupulously clothed (formerly in bark cloth, now in calico). As a general rule all the Bantu tribes in the western half of the protectorate, including the Basoga, are careful to consider decency in their clothing, while the Nilotic negroes are, or until recently were, often completely nude in both sexes More or less nudity among men is characteristic even of the Bahima (Hamites) But in this caste the women are scrupulously clothed.

The Nile negroes and Hima are tall people The Bahima are often markedly handsome, even to European eyes In the Bahima the proportion of Caucasian blood is about one-fourth; in the Nile negroes and Bantu from one-sixteenth to none at all. The aboriginal stock of the Uganda Protectorate is undoubtedly the pygmy-prognathous, which has gradually been absorbed, overlaid or exterminated by better developed specimens of the negro subspecies, or by Negro-Caucasian hybrids from the north and north-east.

The languages spoken in the Uganda Protectorate belong to the following stocks: (1) *Hamitic* (Murle and Rendile of Lake Rudolf); (2) *Masai* (Bari, Elgumi, Turkana, Sûk, etc); (2*a*) Sabei on the northern slopes of Elgon and on Mt Debasien; (2*b*) *Nilotic* (Acholi, Aluru, Gang, etc); (3) *Madi* (spoken on the Nile between Aluru and Bari, really of West African affinities); (4) Bantu (Lu-ganda, Runyoro, Lu-konjo, Kuamba, Lihuku, the Masaba languages of west Elgon and Kavirondo, etc); and lastly, the unclassified, isolated Lendu and Mbuba spoken by some of the pygmy-prognathous peoples. Among the Baganda a knowledge of English is common, and Kiswahili is used by the trading classes

Agriculture and Trade.—Over 2,500,000 ac , or fully 75% of the land under cultivation, is devoted to food crops In Buganda plantains are the staple food: sweet potatoes are grown all over the protectorate; millet is of chief importance to the Nilotic tribes, cassava, peas and beans are other common food crops. The natives also possess large herds of cattle—mostly humped, short-horned breeds—and flocks of sheep, all of the flat-tailed species, and goats. This live stock gives rise to a large trade in hides and skins. Of crops for export cotton holds a pre-eminent place; it is an industry entirely in the hands of the natives. Next in importance comes coffee, grown mostly on European-owned plantations. Formerly there was a fair trade in "wild" rubber; that died out about 1912, but plantation (Para) rubber exports began to be of value by 1918. Maize, ground nuts, simsim, chillies, tea and tobacco are among the minor crops. Cotton is grown by a multitude of small cultivators from seed supplied by the Government, experiments favouring a "Nyasaland Upland" variety The swampy lands of the Eastern province are particularly suitable for the crop. The cotton is ginned at a large number of small ginneries instead of, as in the Sudan and elsewhere, by a few large ginneries Cotton exports began modestly in 1904–05 with the despatch of

180 lb. worth £236. By 1910 the value of cotton exported had grown to £60,000; in 1918–19 it was £965,000. A "boom" followed and in 1924 the cotton exported was 196,000 bales and fetched £3,486,000. Thereafter there was some decline, due mainly to adverse weather conditions and the fall in world prices, and aggravated probably by the system of small and expensive ginneries. Exports of cotton fell in value to £3,051,000 in 1926, and in 1927, when a larger area suffered from drought and the crop failed, to £1,690,000. The crop of 1928 was about 120,000 bales.

In 1901–02, when trade returns were first compiled, the value of exports was about £50,000—the chief articles being rubber, ivory, skins and hides These, with some transit trade from Belgian Congo, continued the chief commodities up to 1908–09, when the exports were valued at over £150,000 From 1910–11 cotton became the leading export, while coffee first figured to a noticeable extent during the World War. Imports are of a very miscellaneous character, cotton goods being the largest single item Inevitably, during the process of development, imports exceeded exports in value. Between 1904 and 1917 imports increased from £190,000 to £1,296,000 In the same period exports increased from £60,000 to £1,076,000. In 1917 a customs union was entered into with the East Africa Protectorate (Kenya Colony). Separate statistics for imports have not since been available, but it was soon obvious that exports exceeded imports in value Exports had risen to £2,393,000 in 1923, and were valued at £5,096,000 in 1925. The great effect of decreased cotton output and lower prices was seen in the export figures for 1926 (£3,597,000), and 1927 (£2,310,000) But the industry was too firmly established to be more than temporarily shaken. The cotton is sent mainly to England, India and Japan.

The mineral resources of the protectorate are but little known or developed. Since 1926 tin has been mined in the Kagera area, and it is also worked in Ankole; copper has been found in the Ruwenzori region, and mineral oils in the neighbourhood of Lake Albert. Tin first figured in the exports in 1927, when the ore exported was worth £20,000.

Towns and Communications.—The administrative capital is Entebbe (*a throne*) on a peninsula projecting into Victoria Nyanza in 0° 4′ N, 32° 27′ E. Some 20 m N by E of Entebbe is Kampala (or Mengo), the capital of Buganda. Strictly, Kampala is the name of one of seven steep hills on which the town (pop about 60,000) is built. The European quarters, fort, Government offices and Indian bazaar are on Nakasero hill; on Namirembe hill is the Anglican cathedral of St. Paul, replacing the church destroyed by lightning in 1910; on another hill (Rubaga) are the mission and cathedral of the Roman Catholics; on Mengo hill are the town residence of the kabaka of Buganda and the buildings of the *lukiko* (the Baganda parliament). On Kampala hill is the museum, and on Kasubi hill the tomb of Mtesa. The port of Kampala is Port Bell, 7 m distant, a railway joining the two places Of other towns the chief is Jinja, by the Ripon falls, a busy cotton and transport centre

The protectorate is well provided with roads, which have the deserved reputation of being the best in East Africa Access to the outer world was provided, in 1902, on the completion of the railway from Mombasa to Kisumu, on the Victoria Nyanza, and by the provision of steamers on the lake This sufficed until the great development of the cotton trade after the World War Meanwhile, a railway, 61 m. long, had been built (1912) through Busoga by the eastern side of an unnavigable stretch of the Nile from Jinja to Namasagali. To avoid the need to transport goods across Victoria Nyanza a railway (320 m. long, begun in 1921 and completed in 1928) was built from Nakuru, on the Mombasa-Kisumu line to a point on the Busoga railway. This new railway —165 m. of which are in Uganda—became the main line. It passes through a great cotton belt, and its usefulness was increased in 1929 by the building of a railway from Jinja to Kampala (about 60 miles). By this route Uganda is in direct railway communication with the Indian ocean. The distance between Kampala and Mombasa is 896 miles. There are steamer services (besides the boats on Lake Victoria) on the Victoria Nile, Lake Kioga, and Lake Albert and on the Mountain Nile to Nimule. From 1920 onwards efforts were made to connect the Sudan and Uganda by air routes, and there are aerodromes at Nimule and Jinja. Motor traffic was first introduced in 1908.

Administration and Revenue.—The protectorate is administered on Crown Colony lines The governor is assisted by an executive and (since 1921) by a legislative council, on which are nominated unofficial members. At the head of each province is a commissioner. The native States have a large measure of home rule Of these Buganda is the chief and relations with it were settled by treaty in 1900. The kabaka (king) is assisted by a ministry and by a *lukiko* or parliament. Similar arrangements have been made with the States of Bunyoro, Ankole and Toro, while in regions where no well-defined native State existed, administrations under recognized chiefs have been built up wherever possible Revenue is derived from poll taxes, customs duties, an export-cotton tax, trading licences and land rents The chief item is the poll tax. Since 1915–16 the protectorate has been self-supporting The figures for 1926 were: revenue, £1,389,000, expenditure, £1,295,000. In 1927 revenue dropped to £1,292,000 and expenditure was £1,430,000, the balance being made good from accumulated surpluses With growing revenue the administration devoted large sums to education, which up to 1925 had been mainly in the hands of missionaries, and to public health For the education of the natives a system was developed from village school to public school

HISTORY

The countries grouped under this protectorate were invaded at some relatively remote period—say, three to four thousand years ago—by Hamitic races from the north-east, who mingled extensively with the Nile negroes first, and then with the aboriginal inhabitants of Buganda, Bunyoro and Nandi These Hamites brought with them a measure of Egyptian civilization, cattle and the arts of metallurgy, pottery and other adjuncts to neolithic civilization. There was probably no direct intercourse with Egypt by way of the Nile, owing to the lake-like marshes between Bôr and Fashoda, but instead an overland traffic with Ethiopia (the land of Punt) via Mt Elgon and the Rudolf regions In time even this intercourse with the non-negro world died away, and powerful kingdoms with an aristocracy of Galla descent grew up in Buganda, Bunyoro, Busoga and Ankole

The kingdom of Buganda especially dominated the lands of Victoria Nyanza in the 19th century. King Suna of Buganda first heard of the outer world of white men in 1850 from a runaway Baluch soldier of Zanzibar Speke in 1862 reached Buganda, the first of all Europeans to enter that country In the early 'seventies Sir Samuel Baker extended the rule of the Egyptian Sudan as far south as the Victoria Nile General Gordon, who succeeded Baker, attempted through Colonel Charles Chaillé Long, in 1874, not only to annex Bunyoro but also Buganda to the Egyptian dominions. But owing to the indirect influence of the British government, exercised through Sir John Kirk at Zanzibar, the Egyptian dominions were prevented from coming south of the Victoria Nile.

First Christian Missions.—Suna, the powerful king or emperor of Buganda, who was the first to hear of a world beyond Negroland, had been succeeded in 1857 by his still more celebrated son, Mtesa or Mutesa (*Mutesa* means the measurer) Mutesa had received Speke in a most friendly manner. In 1875 he received an epoch-making visit from H M. Stanley. Stanley, in response to Mutesa's questions about religion, obtained from that king an invitation to Anglican missionaries, which he transmitted to London through the *Daily Telegraph* The letter was entrusted to Linant de Bellefonds, a Frenchman in the Egyptian service, who had been sent to Buganda by Gordon. On his return Bellefonds was murdered by the Bari. When his body was recovered Stanley's letter was found concealed in one of his boots and was forwarded to England.

Meanwhile the Zanzibar Arabs had reached Buganda in ever-increasing numbers as traders; but many of them were earnest propagandists of Islam, and strove hard (with some success) to convert to that religion the king and chiefs of Buganda and

adjoining countries. In 1877 the Rev. C. T. Wilson, one of a party of missionaries sent in answer to Stanley's appeal, arrived in Uganda, and towards the end of 1878 was joined by Alexander Mackay. In 1879 another party arrived by the Nile route. In the same year the French Roman Catholic mission of the White Fathers of Algeria was inaugurated, and thus from 1879 dates the triangular rivalry of the creeds of Anglican and Roman Christianity and of Islam.

In 1882 Islam gained an ascendancy, and the French withdrew for a time. In the autumn of 1884 Mutesa died. A great change had been wrought in Uganda during the latter years of his reign Calico, fire-arms and swords had replaced the primitive bark-cloth and spear, while under the teaching of the missionary-engineer Mackay the native artisans had learnt to repair arms and use European tools Mutesa was a clever man of restless energy, but regardless of human life and suffering, and consumed by vanity. He was succeeded by his son Mwanga, a cruel, weak and vicious youth then about 18. The intrigues of the Arabs led him to suspect the designs of the missionaries. He became alarmed at their influence over numbers of his people and resolved to stamp out Christianity. The identification of the missionaries with political embassies and their letters of introduction from secular authorities, added to Mwanga's fears and early in 1885 he determined to crush Christians and Muslims alike. Mackay and the Rev R P Ashe were seized and their followers persecuted Then in the autumn of that year Bishop Hannington, unwisely, approached Buganda by Busoga, *i.e.*, from the east—the route by which native tradition held that the conquerors of Buganda would come. By Mwanga's orders Hannington was murdered (Oct 1885). In May 1886 there began a renewed and more terrible persecution of Christians Converts were butchered wholesale; on one occasion 32 were burnt at the stake together. The Baganda Christians showed great heroism and the persecution but increased the number of converts In 1888 a scheme of Mwanga's to entice all the Christian and Muslim converts on to an island in the lake and leave them there to starve miscarried Mwanga then fled and after a time made his way to a French mission station at the south end of Victoria Nyanza In his absence his eldest brother Kikewa was made king and the principal offices were divided among the three parties—the Ba-Ingleza ("English" Protestants), the Ba-Fransa ("French" Roman Catholics) and the Ba-Islamu (Muslims). But the Muslims, under Arab instigation, treacherously attacked and murdered many of the Christian chiefs and the Christians fled to Ankole For a time the Arabs were in the ascendant and as Kikewa refused to be circumcised he was dethroned. His brother Karema was made king and large numbers of the peasantry were forced to submit to the hated circumcision.

The "French" and "English" factions even in these straits could not avoid quarrelling. They asked Mwanga to come back on conditions which he accepted, and he was brought across the lake by a trader named Stokes (formerly a mission-agent) whose main aim seems to have been to secure ivory. Mwanga's attempt to recapture Mengo was unsuccessful and he took refuge in an island on the lake. The Christians now asked the missionaries to return to keep the peace between them and among those who came was Père Lourdel, who gained much ascendency over Mwanga The Christians defeated the Muslims in Oct. 1889, most of the Arabs with the Baganda being killed. The Muslims however rallied, gained a victory in November, but were finally beaten in Feb 1890. Before this decisive victory Mwanga had appealed for help to a caravan then near the lake, led by Frederick John Jackson, who had been sent by the newly formed Imperial British East Africa Company (the I.B.E.A) to extend British influence (*see* KENYA COLONY). Jackson had instructions not to go to Uganda. While he was absent from his camp Karl Peters, at the head of a so-called German Emin Pasha Relief Expedition, arrived. He read Jackson's correspondence and hastened on to Buganda. There with the help of Père Lourdel—who in Dec. 1889 in Mwanga's name had offered to accept the British flag—Peters concluded a treaty with Mwanga. Jackson hearing of Peters's doings followed him up to Mengo—but Peters had hurriedly departed to the south end of the lake. Jackson was in a difficulty; finally he decided to take back to the coast an envoy from each faction. The day before he left Père Lourdel died.

Lugard's Work.—All these local intrigues were rendered useless by the Anglo-German agreement of July 1890 which placed Uganda in the British sphere of influence. Thereupon the I.B E.A company, in Oct. 1890, instructed Capt. F. D. Lugard (afterwards Lord Lugard), then at Kikuya, half way between the coast and the lake, to go to Uganda Marching with unprecedented rapidity, Lugard entered Mengo on Dec. 18 with a force of 50 Sudanese soldiers and some 250 armed carriers Lugard, by introducing the names "Protestant" and "Catholic"—till then unknown—and by insisting that all religion was free. endeavoured to dissociate it from politics. This attitude was welcome to neither faction, and for some days the position of the new arrivals on the little knoll of Kampala was very precarious Lugard's first object was to obtain a treaty which would give him a right to intervene in the internal affairs of the country and after some critical episodes such a treaty was signed on Dec. 26 Lugard's position was strengthened by the arrival in Jan. 1891 of Captain W. H Williams, R A, with a small force of Sudanese and a maxim gun. Seeing however that the situation in Buganda was impossible unless they had a strong central force, which the I B E A company could not provide, Lugard and Williams formed the idea of enlisting the Sudanese who had been left by Emin and Stanley at the south end of the Albert Lake Passing through Ankole and Bunyoro, along the northern slopes of Ruwenzori, Lugard reached Kavali at the south end of Lake Albert He brought away with him 8,000 Sudanese men, women, children and slaves, under Selim Bey (an Egyptian officer) Some of these he left at posts he established along the southern border of Bunyoro After an absence of six months from Buganda Lugard reached the capital at the end of the year (1891) with 200 or 300 Sudanese soldiers and two or three times that number of followers Meanwhile Williams, amid endless difficulties, with a mere handful of men, had managed to keep the two factions from civil war.

Not long after Lugard's return lawlessness again broke out and several murders were committed In spite of strenuous efforts on Lugard's part to avert war the French party early in 1892 attacked the English, who had assembled round Kampala. The king and French party were defeated and fled to the Sese islands. The king and chiefs (except two ringleaders) being offered reinstatement, they appeared anxious to accept Lugard's terms, but the French bishop joined them in the islands, and from that day all hopes of peace vanished Fighting was recommenced by a "French" attack on "English" canoes, and Williams thereupon attacked the island and routed the hostile faction After this the "French" slowly concentrated in Buddu in the south, the Protestants migrating thence Mwanga who was eager to accept Lugard's offers of reinstatement, succeeded in escaping from the custody of his own party and arrived in Mengo on March 30 (1892). A new treaty was made, and the British flag flew over the capital, while the French party were given a proportion of chiefships and assigned the province of Buddu These were liberal conditions; while later, to close a controversy with France, the British government paid £10,000 to the French priests for damage

The Mohammedans now clamoured for recognition. Lugard went to meet them, and succeeded in bringing back Mbogo, a half brother of Mtesa—Karema had died—to Kampala, and in assigning them three minor divisions of Uganda (since reduced to one).

A British Protectorate.—Lugard on his return to Uganda at the end of 1891 had received orders to evacuate the country with his whole force, as the I B E.A company could no longer maintain their position A reprieve till the end of 1892 followed, funds having been raised by the Church Missionary Society and friends The lives of many Europeans were at stake, for anarchy must follow withdrawal, and the repudiation of British pledges to the natives Moreover abandonment would have left the headwaters of the Nile to fall into the hands of some other—possibly hostile—European power In June 1892, therefore, Lugard determined to leave for England to appeal against the decision for abandonment. Williams remained in Uganda, where the outlook was now fairly promising, and every effort was made to reduce expenses

On arrival in England Lugard found that the British Government had decided not to give the company any help to maintain its hold upon Uganda. A strong section of the Liberal party, headed by Sir William Harcourt, demanded the abandonment of Uganda; an equally strong agitation was set on foot for its retention, with the result that Lord Rosebery (then prime minister) despatched Sir Gerald Portal to report on the best means of dealing with the country. Portal and his staff reached Uganda in March 1893, the country at the time showing every mark of returning prosperity Portal was not long in making up his mind; he recommended to the imperial government the retention of Uganda (*i e.,* Buganda), the abandonment of Unyoro (Bunyoro) and Toro, and the construction of a railway half-way only to the lake. He departed after two and a half months' residence, leaving Capt J. R. L. Macdonald in charge.

In Nov. 1893 Colonel (Sir Henry) Colvile arrived to take charge, and at once led the Baganda army against King Kabarega of Bunyoro. That country was completely overrun and Colvile built a line of forts from Buganda to Lake Albert, of which he left Major A. B. Thruston in command. In June 1894 Uganda (*i.e ,* the kingdom of Buganda) was declared a protectorate, and at the end of the year Sir Henry Colvile was invalided. Peace seemed assured in Uganda; territorial limits to religious teaching were abolished, English Roman Catholic priests were added to the French Fathers, and the material progress of the country was marked. A few European traders settled in the country, good permanent houses were built, roads were made and kept in repair, and many new industries introduced, chief among which were the expression of oil from various oilseeds and the cultivation of coffee. Trees were imported and land set aside for planting forests. In 1896 the building of a railway from the coast to Uganda was begun. In the same year the protectorate was extended over Bunyoro and Busoga

The Sudanese Mutiny.—In the middle of 1897 this era of peace was rudely interrupted Macdonald had returned to East Africa in command of an exploring expedition, for which Colonel Trevor Ternan, the acting commissioner, had been ordered to supply 300 Sudanese In June George Wilson, sub-commissioner at Kampala, discovered a plot to revolt, and in July Mwanga fled to the south of Buddu and raised the standard of rebellion The rebels were defeated, while Mwanga was made a prisoner by the Germans. Ternan, unaware of the disaffection of his men, now sent three companies to Macdonald, selecting those who had been continuously fighting in Bunyoro, Nandi and Buddu. This caused great discontent, which was increased by the fact that their pay was six months in arrears and their clothing long overdue. The men, too, had other grievances; they were especially sore at again being sent on service without their wives.

After Colonel Ternan's departure on leave the three companies who had joined Macdonald broke out into revolt in the Nandi district (East Africa Protectorate) and set off to Uganda, looting the countries they passed through. Macdonald and F. J Jackson followed with a force of Zanzibaris Meanwhile Major Thruston—a man justly loved by his soldiers, in whom he had complete confidence—hurried to the garrison at Luba's near the Ripon Falls, relying on his personal influence to control the men. He and two other Europeans were seized and made prisoners. On Oct. 19 the mutineers were defeated by Macdonald's force. The same night the Sudanese leaders, fearful lest their men might submit, murdered Thruston and his companions and sent letters to Uganda to incite their comrades to mutiny. Wilson, however, had already disarmed the troops in Kampala, who remained loyal, as also did the Baganda Mohammedans there. A large Protestant army now went to the assistance of Macdonald, and up to Jan. 9, 1898, the siege of Luba's continued, with constant skirmishes. Early in January Mwanga escaped from the Germans, and, declaring himself a Mohammedan, reached Buddu with a large force, which Macdonald defeated with the aid of the Baganda army. Meanwhile the Sudanese at Luba's escaped and crossed the Nile, making their way to Mruli. It appeared probable that if they reached that point the Sudanese garrisons in Bunyoro would revolt as well as the Baganda Mahommedans, and the situation of the Europeans became desperate. Macdonald pursued the mutineers, overtook them in the swamps of Lake Kioga, and after a couple of skirmishes returned to Kampala, leaving Captain E. G. Harrison in command That officer attacked the rebel stockade at Kabagambi and carried it with great gallantry. A large number of Indian troops arrived early in 1899 and in May Colonel C G. Martyr inflicted another heavy defeat on the mutineers at Mruli. Mwanga, however, managed to get through and join Kabarega and the rebels in the north. In June 1899 Colonel J. T. Evatt had the good fortune to capture both Mwanga and Kabarega, who were subsequently removed to the Seychelles, where Mwanga died in 1903. (For Kabarega *see* UNYORO.) Colonel C. Delmé-Radcliffe subdued the last of the Sudanese mutineers in 1900–1901.

In the autumn of 1899 Sir Harry Johnston was sent out to Uganda as special commissioner and he remained there till 1902. During that period he settled many disputes, included Toro, Ankole, Bukedi and other regions in the protectorate, reduced expenditure and increased revenue. He gave the kingdom of Buganda a definite constitution, settled the land question in that kingdom and in other regions and also the question of native taxation. The land settlement had very important, if undesigned, results for its effect was to do away with tribal tenure and substitute the freehold and leasehold system, with certain undesirable results. By the treaty of Mengo, signed in March 1900, the young king of Buganda, Daudi Chwa, a son of Mwanga, born in 1896, was accorded the title of his highness the Kabaka During his minority the kingdom of Buganda was governed by regents. Of these the most notable was Sir Apolo Kagwa (d. 1927), a true statesman. An epidemic of sleeping sickness, which between 1901 and 1909 caused over 250,000 deaths, did not prevent the country making progress, the material development being accompanied by the conversion of most of the Buganda to Christianity. The completion in 1902 of the railway from the Indian ocean to Lake Victoria did much to facilitate trade. With settled conditions the administration was transferred, 1906, from the Foreign to the Colonial office, Sir Hesketh Bell being the first governor.

Social Conditions.—Christianity and Western civilization increasingly made their influence manifest, while material prosperity brought new problems. Uganda being, however, a "black man's country," there was no clash between European and African interests. Officials and missionaries continued to play a leading part in the evolution of the people, and they were backed up by the native administration of the various states included in the protectorate, which have a large degree of autonomy. Daudi Chwa, who attained his majority on Aug 8, 1914, and was created a K C M G. in 1925, and Sir Apolo Kagwa, who on ceasing to be regent became prime minister, were foremost in giving aid to the British in the World War. Other rulers and tribes were equally willing, and by supplying 10,000 soldiers, a native medical corps and over 160,000 carriers Uganda helped substantially to defeat the Germans in East Africa.

The country suffered from a severe famine in 1919 and from the general trade depression in 1921–2. But it quickly recovered In cultivating cotton, an industry which started on a small scale in 1904 and 20 years later had attained great proportions, the natives found an easy method of acquiring wealth; a fact not without danger and adversely affecting the labour supply for other work. However, there was steady growth in education and a power of adaptability to new conditions was clearly noticeable. At a critical period of development Uganda owed much to the wise guidance of Sir R. T. Coryndon, governor from Feb. 1918 to Sept. 1922. It was during this period, in 1921, that a (nominated) legislative council was created.

Being dependent upon the railway through Kenya Colony for her outlet to the sea Uganda had with that colony a customs and railway union. The question of political federation, which was raised after the World War, presented, however, difficulties, arising chiefly from the presence of a large white population in Kenya, whereas Uganda depended upon the African for prosperity. It was chiefly to meet the demands of the native cotton-growers in Uganda that the railway extension was undertaken which on its completion in 1928 enabled the crop to be sent direct to

Mombasa. In January, 1929, a Commission, with Sir E Hilton Young as chairman, recommended the appointment of a High Commissioner for Kenya, Uganda and Tanganyika, with executive powers. This was to be "a preliminary step" to a Governor-Generalship for "Eastern Africa." Action (May 1929) had yet to be taken on the Report. The cotton exported during 1926 was 180,859 bales, of the value of approximately £3,500,000 The excise duty of 6 cents (¾d.) per lb. collected by the Government from Jan to Dec 1926 amounted to £199,897.

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(H H. J , F. R C)

UGRO-FINNISH LANGUAGES: *see* FINNO-UGRIAN LANGUAGES.

UHLAND, JOHANN LUDWIG (1787–1862), German poet, was born at Tubingen on April 26, 1787. He studied jurisprudence at the university of his native place, but also devoted much time to mediaeval literature Having graduated as a doctor of laws in 1810, he went for some months to Paris, and from 1812 to 1814 he worked at his profession in Stuttgart, in the bureau of the minister of justice He had begun his career as a poet in 1807 and 1808 by contributing ballads and lyrics to L von Seckendorff's *Musenalmanach*, and in 1812 and 1813 he wrote poems for J Kerner's *Poetischer Almanach* and *Deutscher Dichterwald.* Uhland's ballads follow the form of the masterpieces of Goethe and Schiller, but they have some of the spirit of naive wonder of the mediaeval poet, *i e*, they belong definitely to the Romantic school But his style has a precision and grace which distinguish his best work from that of most of the contemporary Romantic poets His work strengthened the national spirit, and he himself did good practical work as a liberal member of the Wurttemberg assembly, and, later, as a member of the Frankfurt parliament. In 1815 he collected his poems in a volume entitled *Gedichte.* To almost every new edition he added some fresh poems He wrote two dramatic works—*Ernst, Herzog von Schwaben* and *Ludwig der Baier*—the former published in 1818, the latter in 1819

Uhland was not only a poet and politician; he was also an ardent student of the history of literature In this field he published *Das altfranzosische Epos* (1812), *Der Mythus von Thôr nach nordischen Quellen* (1836), and *Alte hoch- und niederdeutsche Volkslieder* (1844–45) He died at Tubingen on Nov 13, 1862.

Uhland's *Gesammelte Werke*, edit by H Fischer, were published in 1892 in 6 vols, also by L Frankel (2 vols, 1893) and L. Holthof (1901). His *Gedichte* passed through nearly 50 editions in the poet's lifetime; jubilee ed of the *Gedichte und Dramen* (1886) A critical ed. by E Schmidt and J Hartmann appeared in 1898 (2 vols). Uhland's *Schriften zur Geschichte der Dichtung und Sage* were published in 8 vols. (1865–73); his *Tagebuch von 1810–1820* by J. Hartmann (1893) *See* H Mayne, *Uhlands Jugenddichtung* (1899), H. Schneider, *Uhland. Leben, Dichtung, Forschung* (1920).

UHRICHSVILLE, a city of Tuscarawas county, Ohio, U S A, 85 m S by E of Cleveland, on Stillwater creek and Federal highway 21, served by the Baltimore and Ohio, the Pennsylvania and electric railways Pop (1920) 6,428 (95% native white). Coal is mined in this region, and the city is one of the principal centres in the country for the manufacture of sewer pipe and other clay products. It was settled about 1803 and incorporated in 1832

UIGHUR, the name of a Turkish tribe and dynasty who came from the East and ruled in Kashgaria from the 10th to the 12th century. They used a variety of the Syriac alphabet (*See* TURKS.)

UIST (oist), **NORTH AND SOUTH,** islands, outer Hebrides, Inverness-shire, Scotland. North Uist lies south-west of Harris (Long island), from which it is separated about 8 m. by the Sound of Harris. The island measures 13 m in length by 17 m. in greatest width, but the coasts are extremely indented. The highest point is Mt. Eaval (1,138 ft.). The principal sea-lochs are Loch Maddy and Loch Eport, both on the east On the east coast the surface is mostly swampy moorland, but on the west there is some fertile soil. The inhabitants are chiefly engaged in crofting, fishing and cattle-rearing. The principal village, Lochmaddy, is a trade centre, and a favourite resort of anglers, being a regular calling station for the steamers from Glasgow and Kyle of Lochalsh. The islands belonging to the parish of North Uist (pop 2,579) comprise—to the south-west Baleshare (pop, 134), Kirkibost, Heisker (66), and the Monach group, with a lighthouse on Shillay, to the south, Grimisay (315) and Ronay; to the north-east, Levera; to the north, Boreray (63) and Vallay (43).

South Uist has a population in the parish (1921) of 3,235, an extreme length of 27 m and an extreme width of 7 m Towards the north-east it is mountainous The chief sea-lochs are Loch Boisdale, frequented by anglers, Loch Eynort and Loch Skiport on the east coast On the east side the surface is mainly alluvial peat, broken by hills, but on the west there is a belt of productive land. Besides crofting, the inhabitants are engaged in the fisheries and cattle-raising Steamers from Glasgow, Portree, Oban, etc., call regularly at the village of Lochboisdale, where there is a wireless station The islands attached to the parish of South Uist include, to the south, Eriskay (pop 427), where Prince Charles landed on Aug 2, 1745; to the north-east, Wiay; to the north, Grimsay; Flodday, just off the north-east shore of Benbecula; and Benbecula (pop. 1,116), with an area of 40 sq m, from which there are low-tide fords to North Uist and South Uist

UITENHAGE, 33° 46′ S. 25° 27′ E; altitude 169 ft; 21 m by rail from Port Elizabeth, South Africa. Pop (1921) 7,815 whites, 3,187 natives, 160 Asiatics, 3,052 coloured; in 1926 the whites numbered 8,121 The town was founded by De Mist in 1804, on the Zwartkops river Water-courses flow along the sides of the streets, which are lined with trees On the banks of the river are two large wool-washing establishments In the town are railway workshops, the main industry of the place.

UITOTOAN (WITOTOAN), a group of tribes of South American Indians, forming an independent linguistic stock The Uitotos (Witotos), from whom the stock takes its name, and the tribes related to them live in the region of the Peruvian-Colombian border, between the Yapura and Putumayo rivers, especially on the Caraparana and Igaraparana, northern tributaries of the latter The Witotos are a short, dark-skinned folk, with almost negroid faces They are on a lower level of culture than their neighbours in many respects On the other hand they have developed the drum language to a surprisingly high point Their religious beliefs and mythology are of great interest

See T Koch-Gruneberg, *Zwei Jahre unter den Indianern* (Berlin, 1909), K Th Preuss, *Religion und Mythologie der Uitoto* (Leipzig, 1921).

UJIJI, a town of East Africa, on the east side of Lake Tanganyika, in 4° 55′ S and 29° 40′ E Pop (1926) about 25,000, largely Swahili Ujiji was the meeting point of merchants from all parts of the lake and the terminus of a caravan route from Dar-es-Salaam The Zanzibar Arabs made it their headquarters in the first half of the 19th century and it became a great slave and ivory mart. In 1858 Richard Burton and J H Speke reached Ujiji, being the first white men to see Lake Tanganyika David Livingstone, coming from the south, reached Ujiji in 1869, and it was there that H M Stanley found him on Oct 28, 1871 The first steamer on the lake was launched at Ujiji in 1884 Soon afterwards it became part of German East Africa and was chosen as the lake terminus of the railway (completed in 1914) from Dar-es-Salaam Owing, however, to an alteration in the level of Tanganyika, Ujiji harbour had become very shallow and the terminus of the railway is at Kigoma, 4 m to the north Ujiji was occupied by Belgian Congo troops in 1916, and in 1921 was transferred to Great Britain as part of the mandated territory of Tanganyika.

UKRAINE, a socialist soviet republic of European Russia, recognised by the Soviet government in December 1920, when a treaty was signed defining the relations between the Ukraine and the Union of Socialist Soviet Republics. Area 451,730 sq km. Pop. (1926) 28,887,007 It lies between 46° and 52° 20′ N. and

26° 10′ and 40° 14′ E. and is bordered on the south by the Black Sea, the Crimean A.S.S.R. and the Sea of Azov, on the west by Bessarabia, on the north by the White Russian S.S.R. and the province of Bryansk and on the north-east and east by the provinces of Kursk and Voronezh and by the North Caucasian Area. The Moldavian A.S.S.R. (*q.v.*) is linked administratively with the Ukraine.

GEOLOGY AND CLIMATE

Geologically and structurally the Ukraine is distinct from Russia to the north of it; the Tertiary sea covered most of it, but extended very little further to the north, and the ice of the glacial epoch hardly reached it, except in the north-west and where Don and Dnieper mark southward extensions of glacial river systems Its plateau system, the Azov Horst of Suess, composed of granite gneisses, stretches north-westwards from the Sea of Azov through Volhynia and Podolia, and is generally supposed to be the eastward continuation of the Hercynian system This horst exerted a strong tectonic effect on the fold system of the Donetz which was thrown up from the end of the palaeozoic to the beginning of the Tertiary period, and also caused the tectonic disturbances of the post-Cretaceous period indicated by the lines of Karpinsky, a northern line stretching from the Volga through the bend of the Don, the source of the Donetz, the delta of the Desna and Polyesie to Warsaw and a southern from the delta of the Don, past the falls of the Dnieper to the source of the Bug. Recent seismic observations indicate that tectonic disturbances are still going on in the district and there is some evidence that elevation of the plateau region has occurred in post-glacial times.

River Formations.—The chief rivers are the Dniester, Bug, Dnieper and the Donetz, a tributary of the Don; tectonic disturbances may account for their parallelism The soils of the region fall into three main groups In the ancient forest zone of Polyesie, where morainic clays and sands form the base, are ash-coloured or podzol soils. (*See* Russia: *Soils.*) A zone of black earth formed on loess under steppe climatic conditions lies south of this region, but the humus content has been diminished by the spread on it of forests as the moister and milder climatic zone pushed southward. The town of Kiev stands on the northern limit of this zone and its rise may be connected with the lesser density of the forest on the loess to the south of it. Spurs of the central Russian plateau are thrust into the north-west.

But the main feature of the Ukraine is its steppe land, covered with *chernozyom* (black earth) formed on loess, more sandy to the north and more clayey to the south. The rich black earth belt runs generally south-west to north-east, diminishing in humus content towards the north and towards the south In the south-east, in accordance with more arid conditions, it displays a tendency to salt efflorescences Along the north shores of the Black Sea extends the Pontic steppe. The Black Sea was part of an Upper Miocene and Sarmatian Sea, which formerly extended inland as far as the Vienna basin, but which shrank in Tertiary times; the Pontic steppe bears traces of this transgression. It approaches the sea by a steep incline only broken by the river estuaries, characterised in this region by *limans*. These are submerged, eroded river valleys locked from the sea by detritus.

Where a stream of great volume enters the sea (*e.g.*, Dniester, Bug, Dnieper), the bar is pierced in one or two places and something resembling a delta is formed. But in the case of those streams which do not bring down enough water to cover the loss from evaporation in the liman, the bar becomes continuous and the water within the liman is increasingly rich in salts. The mud of these limans has curative properties and small health resorts are dotted along their shores Along the river valleys are thickets of sedge and reed, with marsh forest and meadow. The Pliocene lime which predominates in the Pontic steppe covers the crystalline substratum, which is, however, often laid bare by the action of streams. Forest destruction at the source of the streams has led to flooding after each melting of the snows. The heavy mantle of black earth and loess, the loose chalk and the marl, sand and clay of the Tertiary strata on the Ukrainian steppe are readily cut into by running water, and many acres of fertile agricultural soil have been washed away from the ravine slopes. An institute for research into amelioration of this problem now exists and efforts are being made to prevent further forest cutting, to encourage replanting and to introduce transverse ploughing across the slopes and drainage channels round the fields.

The chief river is the Dnieper (*q.v.*) which has formed one of the links between the Black Sea and the Mediterranean and the Baltic from ancient times. The Pripet river joins the Dnieper a little south of the northern boundary of the Ukraine and almost doubles its volume, the Dnieper from this point often dividing into two or more channels, and having many islands. The right bank is high and rocky and the left a low plain, though in three places the plain extends along both banks. During the melting of the snows the river overflows the islands and the plains along its shores, leaving them covered with fertile alluvium. At the mouth of the left bank Samara tributary both banks of the Dnieper become precipitous. The post-Tertiary elevation of the Azov horst forced the river to dig its bed into the granite-gneiss rocks, but in many places ledges of these rocks lie across its path and it descends in a series of waterfalls, now being harnessed for production of electric energy. Below the falls the river expands, flowing in several channels, and silting up its liman so quickly that constant dredging is necessary to keep the port of Kherson open even for small sea-going vessels. Of its numerous Ukrainian tributaries, the Teterev and Ingulez on the right, and the Desna on the left, are the most important, the latter being navigable for a great distance.

The present scheme of electrification of the falls includes a scheme for deepening the river channel so as to make it available for large steamers and for providing adequate canals in this region The lower course of the Dniester (*q v*) forms the boundary between Bessarabia and the Ukraine. Its left bank Ukrainian tributaries are short, and flow from the Volhynian-Podolian plateau. They are full at the melting of the snows and have carved deep canyons, but in summer they almost disappear. Between the Dniester and the Bug, no river reaches the sea, all being shut in by limans The Bug (*Boh*) is a shallow stream, not navigable even after the spring thaws except near its mouth, and its tributaries in summer become mere chains of ponds, rapids are formed in its bed by ledges of the granite-gneiss horst. The upper course of the Donetz with its white chalk cliffs lies in the Ukraine. On the whole the waterways of the Ukraine are not favourable to navigation, the Dnieper and its tributaries giving the greatest possibilities. In 1926–27 there were 76 motor driven boats and 188 barges on the rivers and the freightage carried, mainly grain, timber and metal goods, was 872,000 tons, the number of passengers being about two million

Climate.—The climate is everywhere continental, but increasingly so towards the south-east. The Ukraine south of a line through Dnepropetrovsk to Kishinev differs from the north in being exposed to east and south-east winds which prevent the snow brought by the south winds from the Black Sea from becoming very thick. If these easterly winds are prolonged and intense, the snow hardly remains at all, this being a contributory cause of bad harvests Sometimes these east winds bring snow and are so cold and violent that the flocks of sheep are destroyed.

Other causes of bad harvests are a rainless spring, and the return of easterly winds and frosts in May. The maximum rainfall is in summer and falls mainly in heavy showers which may wash away parts of the surface and which, in any case, run off quickly. Winter is severe, the average temperature at Kiev, lat. 50° 30′ N., in January being 1° C, colder than that of Hammerfest, lat. 70° 35′ N. The duration of frost on the Pontic steppe is 2 months and in the rest of the Ukraine 3 to 4 months. Spring in the south is liable to dry east winds bringing sandstorms, but towards the north-west it is moister, with frequent alternations of snow and frost. In summer most of the Ukraine lies south of the 20° C isotherm and high temperatures prevail in the south in July and August. The amount of rainfall diminishes from the north-west (550 mm.) to the south-east (300 mm.) and yearly fluctuations especially in the important spring rains are great; the bad harvests of 1921 and 1924 were due to spring droughts.

Forests.—In former times forest and forested glades covered

much of the area, coniferous in the north and west, and oak in the south, and patches of forest still remain especially in the northwest and in the Kharkov district. The beech occurs in a small region west of Kamenets Podolsk. The Pontic steppe is practically treeless and probably never had much forest except along the Dnieper river, where it still extends as far as Kherson and is found in patches south of that town Forest clearing was going on as early as the time of the Kiev principality. Later the Mongols and Tatars destroyed huge stretches of forest by setting fire to it, partly to provide pasture grounds for their flocks and partly to prevent the Slavs from taking refuge in the forest. In the 16th century the colonising Cossacks continued the process and also practically exterminated the wild horses, deer and bison

Finally the intensification of colonisation in the 19th century so diminished the forests that at present only 8% of the Ukraine is under timber, of which 23% is coniferous and 64 6% deciduous. The abundant wild life of the region has disappeared, the saiga antelope has retreated eastwards and only rodents, especially field-mice and marmots, the plague of agriculture, are abundant The loss of bird life has increased insect pests, though the locust which once did so much damage, has been exterminated. Destructive use of fine meshed nests, so that young as well as adult fish were caught, has markedly lessened the pike, tench, carp, crucian and shad in the rivers, and the sturgeon and sterlet which formerly swarmed up their lower courses are fast disappearing.

AGRICULTURE AND INDUSTRIES

Four-fifths of the population are engaged in agriculture and in spite of the destruction of the years of civil war 1917–21 and the famine of 1921, production in 1926–27 had reached about 90% of the 1913 level Despite war conditions and deaths from famine, the population has increased by 8 7% since 1913; rapid increase of population has always been a feature of the Ukrainian race. This increase of population in a region of lessened agricultural production and markedly diminished manufacturing output has still further impoverished the peasantry, and the two features of agricultural life which have been so marked a result of this fecundity of the race, emigration and seasonal wandering in search of work, still persist The redistribution of land after the revolution diminished the number of landless peasants, but 4·4% are still landless

Since the revolution and famine also, there has been a change in the type of cultivation, maize, which is a more drought resisting grain now occupies more than twice the share of 1913, and rye, potatoes, sunflower-seed, hemp, grasses and cultivation of melons, water melons and cucumbers are markedly above the 1913 level Barley, wheat and sugar beet are below that level The many field system is rapidly replacing the three-field system, artificial manures are increasingly used and mechanical traction in place of the former reliance on horses and oxen is slowly making its way; the peasants in many cases combine to purchase more up-to-date agricultural implements; here, as elsewhere in Russia the demand for such implements exceeds the supply In good years a surplus of grain for export is produced, but in drought years there is insufficient grain for the needs of the population

Stock raising is important, especially sheep and pig breeding; the former has surpassed the 1913 level, but the number of pigs is less Horses and working cattle are also below pre-war level, and they were deficient then, the crisis in lack of power for agriculture has been partly met by the use of tractors, more than 8,000 having been imported into the Ukraine since 1924 Meat, leather and wool are exported Communal farms and artels are increasing and pay special attention to improving the breeds of animals. The most important communal agricultural enterprise is the sugar trust which farms half a million hectares.

The manufactures depending on agricultural products in pre-war times occupied a smaller share than metal manufactures, but at present they surpass them; the depression of the metal trades and the more rapid return to normal conditions of food products, leather goods and textiles has been a common feature in most of the countries affected by the 1914–18 war. This is partly due to the more complex nature of the laws of demand and supply in metal industries and partly to the greater initial capital needed for construction and repair of plant. Flour milling is everywhere important, especially near the Black Sea ports and macaroni production is increasing Sugar refining diminished markedly during the disturbed conditions of 1917–1922, the peasants giving up sowing of sugar beet in their need for food grains. In 1925 a revival set in and by 1927 sugar-refining had reached ⅞ of its former level, syrup production has not yet revived to any great extent. Oil-pressing, brewing, distilling and tobacco manufactures are important A marked post-revolution feature is the development of leather preparation and the manufacture of leather goods and textiles, previously peasant industries, on factory lines. Smaller agricultural occupations are vine growing, fruit-cultivation and bee-keeping Apples, pears and cherries are produced in the north and apricots almonds and peaches in the south A recent development is the cultivation of *kenaph*, which is replacing jute in the manufacture of sacking

MINERALS

Minerals.—Of the mineral wealth, rock salt from Artemovsk (Bakhmut) and salt from the *limans* of the Kherson region, have long been exploited, salt from the latter district being an article of trade in the earliest days of Kiev Before the railways were built, the *Chumakhi*, or drivers of ox-carts, in which dried fish and salt were carried from the Black Sea to all parts of the Ukraine, and exchanged for grain, were a noted organisation Ox-cart transport is still the only available method in rural districts remote from the railway, the roads being too poor for motor transport In 1928 a society for road improvement was formed and a "road week" on American lines has been planned to encourage local councils to provide roads suitable for motor transport

The coal of the Donetz region began to be exploited in the latter part of the 19th century; it includes good anthracite beds and in 1927 production reached 24 5 million tons (97% of the 1913 production), this being 77% of all the coal raised in the U S S R. in that year. The important Krivoi Rog iron region was first developed about 1880 and produced 6 4 million tons in 1913; but in 1927 only 55% of this quantity was mined Manganese production from the oligocene strata of the Nikopol region, on the other hand, reached 179% of the pre-war level. Phosphorite beds are worked in the west and graphite north of Dnepro-petrovsk The mercury and copper of the Donetz are little worked at present Good pottery clays are found everywhere, fireproof clays, in the Donetz, slate near Dnepro-petrovsk, lithographic stone in Podolia and mineral paints in the Donetz, Krivoi Rog and Kherson districts. Building stone, lime, chalk, and gypsum (yielding alabaster) are also found

Among industries depending on mineral wealth, smelting occupies the first place; the production of cast-iron in 1927 was 77% of that in 1913 and 76% of all the cast-iron produced in Russia Engine construction, the manufacture of machinery and agricultural implements, steamer building, cycle, motor and aeroplane construction are developing rapidly. The manufacture of electro-technical goods has developed since 1917 as a result of the removal to the Ukraine of two such undertakings from Riga, when that city passed from Russia to Latvia Chemical industries, including the manufacture of artificial manure are markedly greater than in 1913. Other industries are brick, glass, and pottery manufacture

Electrification is proceeding rapidly, the Shterov station in the Donetz region, working on anthracite dust, was opened in 1925–26 and has a capacity of 20,000 kilowatts, that at Artemovsk (1928) 22,000 kilowatts, and others have been opened An important hydro-electric station is under construction (1928) on the falls of the Dnieper, as are sluices to allow vessels carrying corn and naphtha to the north and timber to the south to pass the falls. Cement, aluminium and ferro-manganese factories are being constructed near the falls to work on electricity when the scheme is completed. The export trade of the Ukraine is mainly grain and flour, as in pre-war times and it still fluctuates in dependence on meteorological conditions, though the famine of 1921 led to much more careful selection of drought resisting plants

Transport.—The network of railways is well developed in the

Donetz region, and there are several east-west and north-south lines; several new lines have been opened and others are under construction. Air transport is developing, the first route being opened in 1925. Regular air services link Moscow, Kharkov and Odessa, with stops at Poltava and Kiev if desired and from Odessa, a regular service goes to Batum.

The Black Sea ports form a trading outlet for the Ukraine, Odessa (*q v*) is the most important, others (*qq.v.*) are Nikolayev, Kherson, Mariupol and Berdiansk There are regular services to the Mediterranean and Vladivostok and there is much coastal trade. Trade through the Baltic Sea ports has been severely injured by the war time destruction of the fleet, by the severance of Bessarabia, by the unsettled external relations of Russia and by the decrease in production, and is far below the 1913 level, though some improvement took place in 1926–27.

Population.—The Ukraine includes within its borders about 20% of the total population of the U S S R, and is one of the most densely peopled regions in Russia, averaging 64·2 inhabitants per sq km, more than 80% of whom are occupied in agriculture. The village settlements are large and, as a rule, are situated on the high and often precipitous banks of streams, so as to be safe from the spring floods, and they form almost continuous belts along the higher right bank of the rivers The watersheds are less settled

In respect of the percentage of people living in towns, the Ukraine occupies third place in the republics of the U S S R., the Transcaucasian Federation coming first and White Russia second, the town population is, however, increasing rapidly, the Ukraine being in a transition stage towards industrialisation The six largest towns (*qq v*) are Kiev (493,873), Kharkov, the administrative centre (409,505), Odessa (411,416), Dnepro-petrovsk (187,357), Stalin (105,739) and Nikolayev (101,182). Seven towns have populations of over 50,000, nine of over 30,000 and ten of over 20,000 Though Kharkov is today considered the capital of the Ukraine, the administration having removed here owing to the unsettled conditions in Kiev, the latter is the real heart of the Ukraine, "the mother of cities" to the Ukrainians, foremost still in population and in its ancient culture dating back to the foundations of the Slav dominion in Russia. The site has been occupied since the dawn of history, and Aurignacian remains have been discovered. Of the whole population, about 80% are Ukrainians (Little Russians), 9% Russians and 5% Jews, other nationalities represented being Poles, Germans, Moldavians, Greeks, Bulgarians and White Russians The percentage of Russians in the towns rises to 25%, but is small among the agricultural population

The Ukrainians are broad-headed, tall, long-limbed and broad-shouldered As a rule they are dark-haired and dark-eyed, and have broad faces, bright complexions and straight noses, though here, as elsewhere there has been racial intermixture and light and medium colouring often occurs. Their language began to be differentiated from Great Russian even in the 11th century, and the wedge thrust between the two peoples by the Tatar domination and the subsequent subjection of the Ukraine to Lithuanian and Polish rule emphasised the divergence.

The use of Great Russian in schools and in printed works was a contributory cause of the illiteracy of the Ukrainian peasant. In 1926 the literacy rate was 41·3% among Ukrainians, as against 45·1% among Russians. Ukrainian is now the official language of the republic and a keen appreciation of the present linguistic freedom has resulted in marked development of education, and at present the Ukraine takes third place in Russia in the provision for education, though here, as everywhere in Russia, many children still receive no education. Kiev, Kharkov and Odessa have scientific and educational institutes and the museums and art galleries of Kiev are famous.

ARCHAEOLOGY

The Ukrainian steppes and South Russia are of peculiar interest historically and archaeologically. Rostovtzeff points out that the French emigrants who found a home in Russia after the Revolution first gave a stimulus to the study of the archaeology of the region. Russian scholars became interested and a copious literature and rich museum collections now exist. The presence of palaeolithic man has been demonstrated at Kiev, and the relics of neolithic man are everywhere abundant. The intersection here of routes from the Orient via the Caucasus and the Black Sea, of Greek influences, of influences from the west via the Danube and from the north via the Dnieper is reflected in the cultural wealth of the early civilisations, while the openness of the steppes to the east led to their repeated submergence by nomads from the steppe. Easy portages connected the rivers, the steppe to the south was open and treeless, while the forests on the loess to the north were younger and less dense than those of the north, and were also intersected by glades: the reasons for the lesser density of forest on the loess steppe are not yet fully worked out.

The conquerors in the region have too often been considered as transitory nomads, but there is ample evidence to prove that the fertility of the region and the ease with which tribute could be extracted from the inhabitants encouraged settlement as well as conquest, thus leading to a rich variety of cultural intermixture. Little is known of the Cimmerians and the extent of their kingdom, but the Iranian Scythians certainly had centres on the steppes between the Don and the Dnieper These Cimmerian and Scythian kingdoms were the base on which the Greek colonies of the Black Sea depended; later history goes to show that such colonies could not exist without a fairly stable civilisation on the steppe to the north. Sarmatian tribes, Iranians like the Scythians, succeeded to this kingdom, and the blending of Greek and Iranian culture had a marked influence on the civilisations of Central and Eastern Russia.

The neolithic civilisation of the Ukraine, the so-called Tripolye (*q v*) culture, named from the finds at that place, as evidenced by its incised and painted pottery was peculiarly rich and belonged to an agricultural people. The kurgan or barrow graves, common to steppe and woodland, and containing skeletons daubed with red paint and buried in the contracted position, though probably contemporary, show evidence of a nomadic people, while graves in the Kharkov district seem to indicate an absorption of the steppe nomads into agriculture. This juxtaposition of settled agriculture and nomadic tribes is still to be observed in the region to the east, where the Kalmucks and some Kirghiz tribes at the present time lead nomadic lives.

In the course of the eighth and seventh centuries B C the mouths of the Dniester, Bug and Dnieper were occupied by Milesian fishing colonies, Tyras on the Dniester and Olbia on the Bug and Dnieper. Olbia became the outlet for the furs, slaves and amber of the north and an inlet for Greek influences, which penetrated as far as the Kama; the Milesian power decayed in the fifth century B C. and Athens took its place in trading relations with Olbia, the corn of South Russia being increasingly needed for the Mediterranean civilisations. With the advance of the Sarmatians to the steppe between the Don and the Dnieper in the second half of the 3rd century B.C. the Scythians moved farther to the north and west, as evidenced by their remains in Kiev and Poltava, but their advance was checked by Germanic tribes, and anarchy began to prevail in the steppe. From their first appearance on the Dnieper the Sarmatian Alans allied themselves with the Germanic tribes in a struggle against Rome and destroyed Olbia and the Roman fortresses on the Crimea. Celtic civilisation in the region is represented in the basin of the Dnieper by La Tène finds, probably remains of the Galatian tribes. Roman influence was felt in the Black Sea region under Hadrian and his successors, who established a fort at Olbia, but in the third century A.D Roman influence declined on the Ukrainian shore. (R. M. F)

History.—The people of the Ukraine are for the most part descended from Ruthene immigrants from the north who, to escape the oppression of the Polish and Lithuanian princes and nobles, escaped "to the frontier" where, though nominally under Lithuanian rule, they formed free democratic communities, and came to be known as Cossacks (*q.v.*). The whole Ukraine formed part of the Polish-Lithuanian empire until 1667, when the portion east of the Dnieper was ceded to Russia by the treaty of Andrussowo. The rest was absorbed by Russia at the second partition of Poland, in 1793.

The "Great Russians" regarded the Ruthenes as belonging to the Russian nation, and their language as a mere dialect. Towards the middle of the 19th century, however, there began in the Ukraine a separatist movement, associated with the names of the Ruthene scholar Kostomarov and the poet Shevchenko, of which the political ideal was the union of all the Ruthenes, including those of Galicia, in an Ukrainian nation. This Ukrainophil movement gathered force, and became a very important factor in the politics of eastern Europe, especially after the outbreak of the World War.

The collapse of the Russian empire in 1917, and the downfall of the Habsburg monarchy which followed, seemed to give the opportunity for realizing the Ukrainophil ideal. In March 1917 a formal demand for the recognition of Ukrainian autonomy was made to the Provisional Government at Petrograd, and on April 19 an Ukrainian national convention met at Kiev to elect a *rada* (council) This took over the government in June, and was recognized by the Petrograd Provisional Government in August. On November 20, contemporaneously with the Bolshevik revolution in Petrograd, the *rada* proclaimed an Ukrainian People's republic, the independence of which was accepted in principle by the Bolsheviks, who made no objection when the Central Powers agreed to receive the Ukrainian delegates to the conference at Brest-Litovsk and to negotiate with them a separate peace.

In January 1918, however, the situation had altered. A Bolshevik Government had been set up at Kharkov, and was making rapid headway against the "compromising" Kiev *rada*, and at Brest-Litovsk Trotsky now declared that a separate peace with the Ukraine would involve the breaking-off of the negotiations with Soviet Russia The news from the Ukraine was, however, uncertain; the Central Powers were in urgent need of food supplies from southern Russia; and on February 9 they signed a peace treaty with the Ukrainian People's Republic By subsidiary treaties, signed on the 12th, the Ukraine agreed, *inter alia,* to provide supplies of grain, etc, in return for manufactured articles.

Meanwhile the Kiev Government had been hard-pressed by the Bolsheviks and, in March, appealed to the Central Powers for help German and Austrian troops now marched into and occupied the Ukraine, mainly with the object of securing the stipulated supplies of food, which had fallen far short of expectations A proclamation of the German General Eichorn ordering cultivation to be proceeded with, led to a quarrel with the *rada*, which was dissolved by the Germans, who made Skoropadski *hetman* of the Ukraine. Violent unrest followed among the peasants, who demanded the restoration of the People's Republic, and on July 30 General Eichorn was assassinated. An armistice had been concluded with Soviet Russia in May. In November, with the collapse of the Central Powers, there was a movement against the *hetman,* headed by Petliura, a former member of the *rada*. Skoropadski was overthrown, and Petliura and Vinnichenko, ex-president of the People's Republic, established themselves as dictators in Kiev, where they proclaimed the union of the Ukraine with the West Ukrainian republic set up at Lwów (Lemberg) by the Galician Ruthenes. This led to a short war with Poland, to whom Galicia had been assigned by the Allied Powers. Petliura marched to the aid of the Lemberg Government, which was threatened by the advance of General Haller's Polish legion from the Western front, but was decisively defeated.

In Feb. 1919 Petliura, driven from Kiev by a Bolshevik rising, took refuge with his armed followers in East Galicia and in 1920 joined forces with the Poles against the Bolsheviks. Meanwhile, in March 1919, a second Ukrainian Soviet Government had been set up, but was dissolved in June, when Denikin's "Whites" took Kharkov. In December, however, the Soviet forces recaptured Kharkov and Kiev, Odessa also falling to them in Feb. 1920, and a third Ukrainian Soviet republic was established. In May 1920 the Poles, with Petliura's troops, occupied large parts of the Ukraine, including Kiev, but were forced to retire when the Russian Soviet army took the offensive (*see* RUSSIA). By the treaty of Riga (Oct. 12, 1920 and March 18, 1921) Poland and Russia recognised the independence of the Ukraine. On Dec. 28, 1920 a Russo-Ukrainian treaty was signed defining relations between the two Soviet republics.

During 1921 the Ukrainian Socialist Soviet republic signed separate treaties with Georgia (Jan 31), Lithuania (Feb. 14), Latvia (Aug 3), Estonia (Nov. 25) and Italy (Dec 27); and also, in conjunction with the Russian Socialist Federated Soviet republic, with Austria (Dec. 7). In 1922 a treaty with Turkey was signed (Jan 2) and, again in conjunction with the R S F S R., a trade agreement with Czechoslovakia (June 5). On July 6, 1923 the constitution of the Union of Socialist Soviet republics was adopted, of which the Ukraine became a constituent member In Sept. 1924 the autonomous Moldavian Socialist Soviet republic was formed as part of the Ukraine

UKRAINIAN LITERATURE. The Ukrainians are the descendants of the South Russians of the Kiev period, and have consequent claims to regard the Russian literature of the 11–13th century as Ukrainian. But as the literary tradition was preserved only in Muscovy, the period has been treated under RUSSIAN LITERATURE (*q v*) There is a gap between the last South Russian chronicles of the 13th century and the Ukrainian revival of the 16th, the language of the latter being as different from that of the former as early Middle English is from late Anglo-Saxon

The Ukrainian literature of the 16–17th century is entirely dominated by the national and religious struggle against Rome and Poland. In its early stages it had its centre in Galicia and Volynia, and produced a polemist of genius in Ivan Vyshensky (*fl.* 1586–1614). Later it became centred in Kiev, and under the influence of Peter Mohila, metropolitan of Kiev (1596–1647), borrowed Latin methods to fight the Latins The writers of the period were polemists, rhetoricians and grammarians, they also wrote verse and plays after Latin school models. Some of the early 18th century interludes in the latter are of interest. In the later 17th and 18th centuries Ukraine was drained of its best intellectual forces, which were attracted to Muscovy, where the church from 1700 to 1760 was dominated by Ukrainian prelates. After 1750 the Ukrainian gentry began to be rapidly Russianized, many of them attaining to eminence in Russian letters (*e g*, Gogol, *q v*) Of those that remained Ukrainian the most remarkable was the wandering philosopher and "Christian epicure," Gregory Skovoroda (1722–94) The language used during this period was a mixture of Ukrainian, Church-Slavonic, Polish, and in the later 18th century, Great-Russian elements

Ukrainian folklore is very rich and original The best-known type of songs are the so-called *dumy* (collections by Antonovich and Drahomanov, 1874–75; Catherine Hrushevska, part i, 1927) They have an historical background (the Cossack wars of the 17th century), but they are elegiac rather than narrative There is also a great variety and wealth of the lyrical folksongs They have had a strong influence on modern Ukrainian literature The first publications of folksongs by Prince Tsertelev (1819) and Maksimovich (1827) were important landmarks in the first stages of the modern Ukrainian revival

Modern Ukrainian literature dates from Ivan Kotlyarevsky (1769–1838) His *Travesty of the Aeneid* (1798) and his comedy *Natalka of Poltava* (1816) are closely related to the Russian literary tradition, but the use of the vernacular was a new departure The successors of Kotlyarevsky did not rise above the level of a provincial *Heimatkunst*. A new spirit was introduced by Taras Shevchenko (1814–61) He was born a peasant and a serf, a fact that emphasizes the essentially democratic and rural character of modern Ukrainian literature A romantic nationalist in his early, a revolutionary internationalist in his later, work, Shevchenko had deep roots in Ukrainian folklore He has become the symbol of Ukrainian nationality. His younger contemporary Marko-Vovchok (pseudonym of Marie Markovich, *née* Velinsky, 1834–1907), a Great Russian by birth, wrote stories of peasant life which have made her a standard of good Ukrainian prose

The persecution of the Ukrainian movement in Russian Ukraine culminating in the practically prohibitive decree of 1876 favoured its growth in Galicia, where such scholars as Michael Hrushevsky (b. 1866), an *émigré* from Russia and Ivan Franko (1856–1916) made of Lwow the centre of Ukrainian culture Franko

was also the most remarkable Galician novelist of the period. In Russian Ukraine the most outstanding writers were the poetess Lesya Ukrainka (pseudonym of Larissa Kvitka, *née* Kossach, 1872–1913) and the novelist Michael Kotsyubinsky (1864–1913).

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UKULELE. A small guitar (*q.v.*) used by the natives of the Hawaiian Islands and adopted as a jazz and solo instrument in England and the United States.

ULAN (*Uhlan*), originally a Polish lancer. The Ulans were cavalry and wore the national dress and czapka (or lancer cap). They were first introduced into the Prussian army in 1740, but failed to distinguish themselves in the first Silesian War, and it was only after the Treaty of Tilsit (1807) that Ulan regiments were again formed in the Prussian army. In the present (1929) German army the old Ulan regiments are represented in most cavalry regiments by at least two squadrons. In the Austrian army a "Uhlan-pulk" of Poles was formed in 1784 and ordinary Uhlan regiments of Austrian cavalry in 1791. In the present Polish army there are a number of Uhlan regiments.

ULCER. Medically, a breach of either an external or an internal surface, occurring in the course of disease and accompanied by loss of tissue Common examples are cutaneous, varicose, corneal, typhoid, dysenteric, gastric and duodenal, tuberculous, syphilitic and cancerous ulcers. An ulcer has a depressed floor or base, and often the edges are raised somewhat above the general level of the surrounding surface. In all the instances given above, except the cancerous ulcer, the pathological process at work is inflammation, acting often on a tissue the vitality of which has been lowered, so that the destruction is disproportionately great compared with the agent that brings it about. This lowered vitality may result from constitutional diseases, *e g*, diabetes or renal or cardiac disease, or may depend upon local causes, *e g*, the poorness of cutaneous blood supply over such a bony surface as the shin, the embolic closure of an artery and death of the portion of tissue it supplies, as in some cases of gastric ulcer. The examples of acute bed sores in disease of the lower parts of the spinal cord, and of perforating ulcer of the toe in locomotor ataxy, indicate further, that in some instances interference with the conduction of afferent impulses from the part is fundamental in ulcer formation.

In a typical ulcer the floor differs in character according as the lesion is healing or not. If healing, the floor consists of granulation tissue (*see* INFLAMMATION AND ITS SEQUELS), covered by a thin layer of sero-purulent fluid, and the edges, when the skin is concerned, show a thin blue line of advancing epithelium whereby the ulcer is finally covered If recently formed or spreading, the floor usually consists of dead or dying tissue, with smaller or greater exudation of sero-purulent or purulent fluid. In some forms of ulceration, especially those that are chronic, *e.g.*, tuberculous or syphilitic, the floor of the ulcer presents special features (*e g*, the presence of giant cells or caseation), and the causal organism may be present in the tissues or exudation The cancerous ulcer is really an example of molecular necrosis, and the floor consists of dying or dead cancerous tissue, with superposed putrefactive changes. In dyspepsia, small local abrasions on the tongue or mouth or gastric mucous membrane may occur from the breaking down of papules, perhaps containing serous fluid. Popularly these are often termed "ulcers," but they only involve superficial layers of the epithelium, and hardly deserve the name. In its usual significance an ulcer involves tissue deeper than the epidermis, or in the case of internal surfaces, the entire mucous membrane.

Treatment.—The treatment of ulceration is conditioned by the underlying cause In all cases rest is necessary; an ulcer over the knuckle may persist for weeks if the hand be used, but heal within a day or two if the joint be fixed upon a splint But apart from this, it is clear that treatment of any underlying disease will help healing of the ulcer at least as much as local medication. In the case of cancerous ulcers, healing does not occur apart from a successful radiation treatment, but the patient's discomfort may be relieved very greatly by keeping the ulcer bacteriologically clean, and thus preventing the putrefaction that otherwise always occurs Naturally, this is easier in some situations than others. Sometimes a cutaneous ulcer becomes "indolent" or "callous," and remains unchanged in appearance for weeks. Often such an ulcer may be brought into a healthy healing condition by use of some stimulating lotion, or rubbing with a crystal of copper sulphate, the superficial destruction of tissue is thereby increased, it is true, but the induced inflammation is accompanied by stimulative processes beneath and around the ulcer, which more than compensate for the added inflammation. Healing of an ulcer, when it occurs, is always by the local formation of fibrous (scar) tissue; in the case of the skin, the newly-formed fibrous tissue is ultimately covered by squamous epithelium, in the case of mucous membranes the secreting epithelial system is not re-formed

(W. S. L-B.)

ULEABORG: *see* OULU.

ULEMA, the learned of Islām, theologians, canon-lawyers, professors, judges, muftis, etc, all who, whether in office or not, are versed theoretically and practically in Muslim science in general (Arab *'ulamā*, sing *'ālim*, literally, "knowers," in the sense of *scientes*) By "science" in this case is especially meant what is learned from tradition, books or men, and through the intellect In a narrower sense, Ulema is used, in a Muslim state, of a council of such learned men, holding government appointments. If all conception of intermediary priesthood be eliminated, the Ulema may be said to be equivalent to the secular clergy of Roman Christendom (*see* DERVISH). Opposed to them, again, are the *'ārifs* ("knowers," "perceivers," *sentientes*, as opposed to *scientes*), to whom religious knowledge comes in the vision of the mystic, not by tradition or reason (*see* ṢŪFIISM)

ULFILAS (*c.* 311–383), the apostle of Christianity to the Gothic race, and, through his translation of the Scriptures into Gothic, the father of Teutonic literature, was born among the Goths at the trans-Danubian provinces about the year 311 The Arian historian Philostorgius (*Hist eccl* ii 5) says that his grandparents were Christian captives from Sadagolthina in Cappadocia, who had been carried off to the lands beyond the Danube in the Gothic raid of 264, and became so naturalized that the boy received a Gothic name, *Wulfila* (Little Wolf) An authoritative record of the outlines of his life was only discovered early in the 19th century in a writing of Auxentius of Milan, his pupil and companion At an early age Ulfilas was sent, either as an envoy or as a hostage for his tribe, to Constantinople, probably on the occasion of the treaty arranged in 332. Ulfilas may therefore have been a convert to Christianity when he reached Constantinople But here probably he came into contact with the Arian doctrines which gave the form to his later teaching. For some time before 341 he worked as a lector (reader of the Scriptures). From this work he was called to return as missionary bishop to his own country, being ordained by Eusebius of Nicomedia and "the bishops who were with him," probably at Antioch, in 341

He was now thirty years of age, and his work as "bishop among the Goths" covered the remaining forty years of his life. For seven of these years he wrought among the Visigoths beyond the Danube, till the success which attended his labours drew down the persecution of the still pagan chief of the tribe. To save his flock from extinction or dispersion, Ulfilas decided to withdraw both himself and his people. With the consent of the emperor Constantius he led them across the Danube, "a great body of the faithful," and settled in Moesia at the foot of the range of Haemus and near the site of the modern Trnovo (349).

The life of Ulfilas during the following thirty-three years is marked by only one recorded incident (Sozomen iv. 24), his visit to Constantinople in January 360, to attend the council convened by the Arian or Homoean party. The part played by Ulfilas in these troublous times cannot be ascertained with certainty. It may have been he who, as a "presbyter christiani ritus," con-

ducted negotiations with Valens before the battle of Adrianople (378); but that he headed a previous embassy asking for leave for the Visigoths to settle on Roman soil, and that he then, for political motives, professed himself a convert to the Arian creed, favoured by the emperor, and drew with him the whole body of his countrymen—these and other similar stories of the orthodox church historians appear to be without foundation. The death of Valens, followed by the succession and the early conversion to Catholicism of Theodosius, dealt a fatal blow to the Arian party within the empire. In 383 he was sent to Constantinople by the emperor. A split seems to have taken place among the Arians at Constantinople Ulfilas was summoned to meet the innovators, and to induce them to surrender the opinion which caused the dispute. No sooner had he reached Constantinople than he fell sick, "having pondered much about the council," and before he had put his hand to the task which had brought him he died, probably in January 383

The Arianism of Ulfilas was a fact of pregnant consequence for his people, and indirectly for the empire. It had been his lifelong faith, as we learn from the opening words of his own confession—"Ego Ulfilas semper sic credidi" If, as seems probable from the circumstances of his ordination, he was a semi-Arian and a follower of Eusebius in 341, at a later period of his life he departed from this position, and vigorously opposed the teaching of his former leader He appears to have joined the Homoean party, which took shape and acquired influence before the council of Constantinople in 360, where he adhered with the rest of the council to the creed of Ariminum, with the addendum that in future the terms *ὑπόστασις* and *οὐσία* should be excluded from Christological definitions. Thus we learn from Auxentius that he condemned Homoousians and Homoiousians alike, adopting for himself the Homoean formula, "filium similem esse patri suo."

His version of the Scriptures is his greatest monument. By it he raised a barbarian tongue to the dignity of a literary language; and the skill, knowledge and adaptive ability it displays make it the crowning testimony of his powers as well as of his devotion to his work. For the linguistic value of the Gothic version of the Scriptures by Ulfilas *see* GOTHS *Gothic language*. It is preserved, though only in a fragmentary form, in the famous Codex Argenteus at Uppsala This ms, discovered at the monastery of Werden, near Cologne, was deposited at Prague, carried off by the Swedes in 1648 and presented to Queen Christina. From Stockholm it passed by some means into the hands of Isaac Vossius, and a transcript was made and published by Franciscus Junius in 1655. The ms. was bought by the Count de la Gardie and presented to the university of Uppsala. Its uncial letters are formed in silver on a surface of purple vellum

See Waitz, *Das Leben des Ulfilas* (1840), W L. Krafft, *Kirchengeschichte der deutschen Volker* (Abth. i, 1854), H Bohmer in Herzog-Hauck, *Realencyklopädie*, vol. xxi, W Bessell, *Das Leben des Ulfilas* (1860), C A Scott, *Ulfilas, Apostle of the Goths* (1885); G. H. Balg ed. *The First Germanic Bible* (1891); H. M. Gwatkin, *Studies in Arianism* (1900), Felix Dahn, *Die Konige der Germanen* (1861–1911). (C. A. Sc ; X.)

ULIANOVSK, a province of the Russian S.F S R. lying west of the Volga river, with the Chuvash A S.S R. and the Tatar A S.S.R. to the north, the provinces of Nizhegorod and Penza to the west, and Samara to the east. Area 34,986 sq. kilometres. Pop. (1926) 1,381,300. It occupies part of the former Simbirsk province. The south-east is occupied by the mid-Russian plateau, of which a part, known as the Zhegulev hills thrusts out a tongue which compels the Volga to make its great Samara bend The Svyaga rises in the Samarskaya Luka hills and flows parallel to the Volga, but in an opposite direction, at a distance of 2 to 20 miles. The Sura, flowing north, drains the west of the province and forms a navigable waterway. The geological formations include post-Pliocene upper layers containing mammoth bones.

There are extensive beds of bituminous shale with a high calorific value on the Volga-Svyaga watershed; and in 1919 work was begun at the Kashpir shale mine south of Syzran, and the shale is sent to Samara for fuel for electric plant By-products are used in the manufacture of sulphur, ichthyol, shale-tar, fireproof materials, etc. Asphalt is worked at Syzran. Salt, ochre, iron-ore and various building stones are produced in small quantities. There are patches of forest, but local demand for fuel, building and household purposes exceeds supply by more than 70% and the timber used in the province is mainly imported. The soils vary from rich black earth to grass-covered alkaline sands, and there is much water meadow along the rivers. The climate is continental, ranging between extremes of $-47°$ F and $+115°$ F, winter lasts for five months, and the rainfall is about 17 6 in per annum. Spring rains sometimes fail and cause severe famines, as in 1911 and 1921. Destructive hailstorms often occur in June and July.

Agriculture is the main occupation and 83·9% of useful land is cultivated, though mainly on a three-field system, with primitive implements. Maize cultivation is increasing and efforts are made to spread its use among the peasants for food and cattle fodder. Winter rye and oats are the chief crops Wheat, lentils, sunflower seed, potatoes, cabbages, onions and melons are also grown, and there is some cultivation of flax and hemp. Stock raising diminished disastrously after 1921, but sheep, goats and pigs have almost reached their normal level. Of factory industries the making of woollen goods, flour-milling, distilling and brewing are the chief, and there are some saw-milling, brick-making, nail and leather factories Koustar or peasant industries include the making of tombstones, saddlery, nets, purses and violins and guitars. They diminished markedly after the famine

There are only two towns with populations of more than 20,000, Ulianovsk and Syzran (*q v*). The literacy rate is very low, 26 8% for the whole province and 17 8% among women The district was originally peopled by Finnish tribes, Russian colonization began on the west of the Sura in the 14th century and reached the east two centuries later, lines of forts being established to protect the settlers; Ulianovsk (Simbirsk) was thus erected in 1648 Communications are mainly by river, the railway system is poor

Ulianovsk (formerly Simbirsk), the chief town of the province, lies on a hill 560 ft. above the Volga at a point where the Svyaga closely approaches it, in 54° 23′ N, 48° 25′ E Pop (1926) 70,194. Its suburbs extend to the Svyaga and to the Volga. Suburbs on the left bank of the Volga are cut off from communication during the spring and autumn, but are reached by boat in summer and sleigh in winter The town has a brisk river trade and has saw-mills, flour-mills, breweries, distilleries and brick-yards. It has railway communication across the Volga and with the west. The historian Karamzin was born here in 1766 Ulianovsk was the scene of much fighting during the Civil War of 1917–1920.

ULLSWATER, JAMES WILLIAM LOWTHER, 1ST VISCOUNT (1855–), Speaker of the British House of Commons (1905–1921), was born on April 1, 1855, the son of William Lowther, M P He was educated at Eton, Kings college, London, and at Trinity college, Cambridge. He represented Penrith in the House of Commons from 1886 to 1921, when he received a viscounty Lowther had been deputy-speaker for ten years when he was elected to the chair of the House He was a great Speaker, filling the duties of the office with humour, dignity and discretion He was chairman of the Speaker's Electoral Reform conference (1916–17), which prepared the way for the great extension of the franchise, including the granting of votes to women; of the Devolution conference (1919), and of the royal commission on London Government (1921–22).

ULM, a city of Germany, in the republic of Wurttemberg, situated on the left bank of the Danube, at the foot of the Swabian Alps, 58 m S E. of Stuttgart by rail and 63 m N W. of Munich. Pop. (1925) 57,278. Ulm is mentioned as early as 854; it became a town in 1027, and was soon the principal place in the duchy of Swabia Although burned down by Henry the Lion, it soon recovered from this disaster and became a free imperial town in 1155. Its trade and commerce prospered and in the 15th century it attained the summit of its prosperity, ruling over a district about 300 sq.m. in extent, and having a population of about 60,000. In 1803 it lost its freedom and passed to Bavaria, being ceded to Württemberg in 1809. In October 1805 General Mack with 23,000 Austrians capitulated here to Napoleon Ulm is remarkable in the history of German literature as the spot where the Meistersingers lingered longest, preserving without text

and without notes the traditional lore of their craft.

Ulm still preserves the appearance of a free imperial town, and contains many mediaeval buildings of historic and of artistic interest. Among these are the town hall, of the 16th century, in the Transition style from late Gothic to Renaissance, restored in recent years; the Kornhaus; the Ehingerhaus or Neubronnerhaus, now containing the industrial museum; and the commandery of the Teutonic order, built in 1712–1718 on the site of a habitation of the order dating from the 13th century, and now used as barracks. The magnificent early Gothic cathedral, begun in 1377, and carried on at intervals till the 16th century, was long left unfinished; but in 1844 the work of restoration and completion was begun, being completed in 1890. It has double aisles and a pentagonal apsidal choir, but no transepts Its length (outside measurement) is 464 ft, its breadth 159 ft; and the aisles are covered with rich net-vaulting. The tower in the centre of the west façade was completed in 1890, and is the loftiest ecclesiastical erection in the world (528 ft.). The cathedral contains some fine stained glass, and a number of interesting old paintings and carvings It belongs to the Protestant Church.

The Danube, joined by the Iller just above the town and by the Blau just below, here becomes navigable, so that Ulm occupies the important commercial position of a terminal river-port. There is water communication with the Neckar, and so to the Rhine The market for leather and wool is important, and the manufactures include wire ropes, borax, paints, cheese, jute, leather, lace, perfumes, and cement. Brewing and weaving, iron- and brass-founding are carried on as well. As a fortress Ulm has been famous and it is a garrison town.

See E Nubling, *Ulms Handel und Gewerbe im Mittelalter* (Ulm, 1892–1900), G. Fischer, *Geschichte der Stadt Ulm* (Stuttgart, 1863); Pressel, *Ulmisches Urkundenbuch* (Stuttgart, 1873), and *Ulm und sein Munster* (Ulm, 1877); Schultes, *Chronik von Ulm* (Stuttgart, 1881 and 1886); Hassler, *Ulms Kunstgeschichte im Mittelalter* (Stuttgart, 1872); and *Das rote Buch der Stadt Ulm*, edited by C. Mollvo (1904).

ULMACEAE, a family of dicotyledonous trees, the best known and most important members of which are the elms (*q v*), forming the genus *Ulmus*. The family contains 13 genera and about 130 species. *Celtis australis* is the nettle-tree, the fruit of which is edible *C. occidentalis* is the hackberry (*q v*).

ULMANIS, KARL (1877–), Latvian statesman, first prime minister and organizer of the independent republic of Latvia. Born Sept. 4, 1877, in Zemgale (Courland). He is an agronomist He also studied agriculture in Germany and the United States of America, and, before Latvia became an independent State, he gave many lectures in Latvia on agricultural questions. He was an active supporter of the movement to liberate the Latvian people from Russian and German domination After the Allied victory of 1918, when Latvia was still occupied by German military forces, he organized all political parties in Latvia around the Democratic block, which later in the same year, united with other political organizations of Latvian refugees in Russia, became the Latvian National Council. On behalf of this national council and in the name of the Latvian nation, the independence of Latvia was proclaimed on Nov. 18, 1918, and K. Ulmanis was appointed first prime minister of the interim Latvian Government. Under his leadership the young State waged its fight for freedom against the Russian Bolshevists and the combined German and Russian irregular forces, *i e*, the Bermondt army.

After the Latvian army's complete victory, K. Ulmanis led his country until the Constituent Assembly was elected and gave the country a Constitution Peace was concluded with Russia and Germany, and the young State concentrated all its force on the reconstruction and building up of the administration.

Ulmanis was prime minister from Nov. 18, 1918, to June 18, 1921, when a Coalition Government was formed by his party colleague, Z. Meierovics He was again prime minister from Dec. 24, 1925, to May 5, 1926, and from that date until Dec. 17, 1926, he was minister for foreign affairs.

He is leader of the strongest bourgeois party in the parliament, the Farmers' Union, is a member of the Latvian parliament, and, notwithstanding the fact that he has a strong opposition in the left wing political parties, is still considered the most popular and strongest political figure in Latvia.

ULPIAN (DOMITIUS ULPIANUS), Roman jurist, was of Tyrian ancestry. His literary activity lay between 211 and 222. He made his first appearance in public life as assessor in the *auditorium* of Papinian and member of the council of Septimius Severus; under Caracalla he was master of the requests (*magister libellorum*). Heliogabalus banished him from Rome, but on the accession of Alexander (222) he was reinstated, and finally became the emperor's chief adviser and *praefectus praetorio*. His curtailment of the privileges granted to the praetorian guard by Heliogabalus provoked their enmity, and he narrowly escaped their vengeance; ultimately, in 228, he was murdered in the palace, in the course of a riot between the soldiers and the mob

His works include *Ad Sabinum*, a commentary on the *jus civile*, in over 50 books; *Ad edictum*, a commentary on the Edict, in 83 books; collections of opinions, responses and disputations; books of rules and institutions; treatises on the functions of the different magistrates—one of them, the *De officio proconsulis libri x*, being a comprehensive exposition of the criminal law; monographs on various statutes, on testamentary trusts, and a variety of other works His writings altogether have supplied to Justinian's *Digest* about a third of its contents, and his commentary on the Edict alone about a fifth As an author he is characterized by doctrinal exposition of a high order, judiciousness of criticism, and lucidity of arrangement, style and language.

Domitii Ulpiani fragmenta, consisting of 29 titles, were first edited by Tilius (Paris, 1549). Other editions are by Hugo (Berlin, 1834), Bocking (Bonn, 1836), containing fragments of the first book of the *Institutiones* discovered by Endlicher at Vienna in 1835, and in Girard's *Textes de droit romain* (Paris, 1890).

ULSTER, EARLS OF. The earldom of Ulster was the first title of honour in Ireland of English creation, and for more than a century was the only one. It dates from a grant to de Lacy in 1205.

Hugh de Lacy, 1st Earl of Ulster (d. 1242?), was descended from Walter de Lacy (d. 1085), who fought for William the Conqueror at Hastings. The first earl was the brother of Walter de Lacy (d. 1241), who succeeded his father as lord of Heath in 1186. In 1203 Hugh de Lacy drove John de Courci out of Down, and was rewarded by grants of land, and in 1205 by the earldom of Ulster. He was then invested with quasi-viceregal authority, but in 1207 war broke out between the earl and the king's justiciar. King John came to Ireland, and banished the earl to Scotland. He returned to Ireland in 1226, and died at Carrickfergus. On his death the earldom reverted to the Crown

Second Creation.—Prince Edward (afterwards Edward I), transferred "the county of Ulster" (*c.* 1255), to Walter de Burgh, lord of Connaught. The earldom remained in the family of de Burgh until the death of William, 3rd earl of this line, in 1333, when it passed to his daughter Elizabeth, who married Lionel, afterward duke of Clarence, son of Edward III. Lionel was succeeded in the earldom of Ulster by his daughter Philippa, who married Edmund Mortimer, earl of March. The third Mortimer, earl of Ulster, died unmarried in 1425, when his titles were inherited by Richard Plantagenet, duke of York, whose son Edward ascended the throne as Edward IV. in 1461.

Since that date the earldom of Ulster, which then merged in the Crown, has only been held by members of the royal family. Its last holder was Alfred, duke of Edinburgh (d. 1900).

See, for the de Lacy and de Burgh earls of Ulster, *The Chronicle of Florence of Worcester*, edited by T. Forester (1854); *Annals of Ireland by the Four Masters*, edited by J. O'Donovan (7 vols, Dublin, 1851); The *Annals of Loch Cé*, edited by W. M. Hennessy, "Rolls Series" (2 vols, 1871); *Calendar of Documents Relating to Ireland*, edited by H. S. Sweetman (5 vols., 1875–86); W. W Shirley, *Royal and Historical Letters of the Reign of Henry III.*, "Rolls Series" (2 vols, 1862–66); Sir J. T. Gilbert, *History of the Viceroys of Ireland* (Dublin, 1865). For the later history of the earldom *see* G. E. C., *Complete Peerage*, vol. viii. (1898).

ULSTER, a province of Ireland occupying the northern part of the island. Before the passage of the Government of Ireland Act, 1920, and the establishment of a separate government for Northern Ireland (*q.v.*), Ulster included the counties of Donegal, Londonderry, Antrim, Fermanagh, Tyrone, Cavan, Monaghan, Armagh and Down (*qq.v.*). Ulster (*Uladh*) was one of the early provincial kingdoms of Ireland, but by A.D. 400 became divided

into three states, Oriel (Oirghialla) in the south, Ulidia in Antrim and Down, and Aileach or Tír Eoghain in the north. The O'Neills of Tír Eoghain became dominant over all Ulster, but after the Norman invasion Ulidia fell to John de Courcy and formed the Earldom of Ulster, while Oriel was partitioned. In the 15th century English rule practically disappeared from Ulster which, under the O'Neills and O'Donnells became the most Gaelic province of Ireland and found two great champions of native independence in Shane and Hugh O'Neill, Earl of Tyrone, whose grandfather Conn had accepted this English title in 1543 With the suppression of Tyrone (1603) the province was subjected to the Crown, and the Flight of the Earls (1607) gave the opportunity for the plantation of Ulster by English and Scottish settlers (*see* PLANTATION). The history is henceforth part of the national history.

ULTIMATUM, a formal intimation by one state to another state that unless the latter complies with certain terms certain consequences will follow. These consequences may be war or measures short of war; *see* INTERNATIONAL LAW (PUBLIC); PACIFIC BLOCKADE; REPRISALS; LAWS OF WAR

A declaration of war may be either absolute or conditional. Under the customary law of nations prevailing at the time of the Russo-Japanese War, 1904, hostilities might be commenced without any formal notice In this conflict Japan was charged by Russia with making a treacherous attack Japan replied that she had already severed diplomatic relations before taking action This controversy led to the provisions contained in The Hague Convention III, 1907, whereby hostilities must not commence without previous and explicit warning in the form either of a declaration of war, giving reasons, or of an ultimatum with a conditional declaration of war Further the existence of a state of war must be notified to the neutral Powers without delay, and does not take effect in regard to them until after the receipt of notification, which may be given by telegram Nevertheless, neutral Powers cannot rely on the absence of notification if it is clearly established that they were aware of the existence of a state of war In the World War, Austria-Hungary and Germany declared war by telegram. Great Britain verbally informed the German Government that unless it withdrew its troops from Belgium, she would take steps to secure its neutrality The German minister accepted this as a declaration of war. Italy verbally informed the Austro-Hungarian ambassador at Rome that she considered herself in a state of war, and telegraphed the Italian ambassador at Vienna to make a similar declaration. This declaration with a reasoned statement was dispatched to Italian representatives abroad and to foreign governments The United States declared a state of war with Germany by a resolution of Congress, approved by the President. The majority of other states at war with Germany made no formal declarations of war against her allies. Some merely broke off diplomatic relations. (H. H. L. B.)

ULTIMOGENITURE, the custom by which the youngest son inherits the homestead, is known in English law as Borough English. In England it obtained in parts from Gloucester to Cambridgeshire Under the name of Mainète and Jungerrecht it was known in northern France and northern Germany. In Assam it is found among the matrilineal Garos who possess the dual organization and speak a Tibeto-Chinese language, among the matrilineal Khasias who speak an Austric language, among patrilineal Lusheis, Meitheis, Nagas and Kachins, speakers of Tibeto-Chinese languages Cases are known in Africa.

This custom has been regarded as derived from the *jus primae noctis*, the youngest son being of undoubted paternity. This view has been successfully traversed by Blackstone, Westermarck and Frazer. It has been ascribed among settled peoples, such as Nagas and Meitheis, to the custom of making provision for the elder sons as they marry and set up house independently. The rule requiring elders to marry before juniors is found among communities which do not now practise ultimogeniture Among people like the Lusheis, who practise shifting cultivation, it is due to the custom by which the sons of chiefs, on marrying, swarmed off to found new villages. The view that it is connected with domestic worship—proffered by Elton and accepted by Gounne—is supported by the Khasi evidence, where the youngest daughter "inherits the religion"—in organic association with the homestead. With the Garos it is inseparably connected with the general system of marriage.

See Blackstone's *Commentaries on the Laws of England*, vol. ii; O. Elton, *Origins of English History*, 1st ed. (1888); E Westermarck, *History of Human Marriage*, 5th ed., Sir J. Frazer, *Folklore in the Old Testament* (1918).

ULTRAMARINE occurs in nature as the colouring principle of *lapis lazuli*, from which it was originally obtained by crushing the stone and separating the pure material by levigation. The scarcity of the mineral, which is a double silicate of sodium and aluminium with some combined sulphur, and the low yield obtainable rendered genuine ultramarine extremely costly and the pigment to-day is manufactured solely by artificial means The raw materials used consist, briefly, of (1) kaolin (China clay) free from iron and manganese, (2) soda ash, (3) anhydrous sodium sulphate, (4) finely powdered sulphur, (5) charcoal, ash-free coal or colophony, and (6) silica or quartz. In the "indirect process" these materials are intimately mixed and ground and heated in a furnace at a bright red heat for 7–10 hours with exclusion of air, then allowed to cool slowly Sulphur is added to the green ultramarine so formed and the mixture is converted into blue ultramarine by further heating at a low temperature In the "direct process" the raw materials, as above, after mixing and grinding are roasted in an oven with access to air

Artificial ultramarines are divided into three classes distinguished as the lighter "sulphate ultramarine," "ultramarine poor in silica" (dark blue) and the "ultramarine rich in silica", the last, which is made by the direct process, is darkest in colour with a reddish tinge and, unlike the first two, made by the indirect process, is very resistant to alum solutions (hence is largely used in the paper trades) Ultramarine is fast to light and alkalis but is readily destroyed by mineral acids Owing to the beauty of its colour, its cheapness and permanence, it is extensively used as a water, size, lime, oil and varnish colour, in printing inks; as a corrective for whites; for colouring paper; and in the ceramic industry. As it is liable to contain free sulphur, it is incompatible with lead pigments. The sodium in ultramarine may be replaced by lithium, potassium and silver, and the sulphur by selenium or tellurium Ultramarine violet is obtained by heating ultramarine blue in a furnace with ammonium chloride. Ultramarine red is prepared by the action of hydrochloric acid on ultramarine violet at a high temperature These colours are rarely met with in commerce. *See* PAINTS, CHEMISTRY OF (R S M)

ULTRAMONTANISM, the name given to a certain school of opinion in the Roman Catholic Church (Lat. *ultra*, beyond, *montes*, the mountains). The expression *ultramontane* was originally no more than a term of locality, characterizing the persons so described as living—or derived from—"beyond the mountains", but from the very beginning we find it used as a party appellation to describe those who looked "beyond the mountains" in order to obtain a lead from Rome, who represented the papal point of view and supported the papal policy. Thus, as early as the 11th century, the partisans of Gregory VII were styled ultramontanes, and from the 15th century onwards the same name was given to the opponents of the Gallican movement in France.

It was not until the 19th century that "ultramontane" and "ultramontanism" came into general use as broad designations covering the characteristics of particular personalities, measures and phenomena within the Roman Catholic Church. At the present time they are applied to a tendency representing a definite form of Catholicism within that Church, and this tendency, in spite of the individual forms it has assumed in different countries, everywhere displays the same essential features and pursues the same ends. It follows, from the very nature of Ultramontanism, and from the important position to which it has attained, that the official organs of the Church and all the people interested in the continuance of the actual state of affairs deny that it exists at all as an independent tendency. It is indisputably legitimate to speak of Ultramontanism as a distinct policy, but it is very difficult to define its essential character.

(i.) The first and fundamental characteristic of Ultramontanism is its carrying to a logical issue the concentration of all ecclesiastical power in the person of the Roman Pontiff. (*See* PAPACY.) To the *curial system*, so evolved, continually fortifying its position in the domains of theology, ecclesiastical law, and politics, the *episcopal system* stands in opposition. The system admits that the pope represents the unity of the Church, and acknowledges his primacy, while at the same time it claims on behalf of the bishops that, in virtue of the divine ordinance, they possess an inalienable right to a share in the government of the Church (*see* CHURCH HISTORY; FEBRONIANISM). The struggle between these two systems continued well into the 19th century; and, though episcopalism was not infrequently proscribed by the Curia, it still survived, and till the year 1870 could boast that no oecumenical council had ventured to condemn it. This was done for the first time, in 1870, at the Vatican Council (*q.v.*), whose decrees, recognizing the universal episcopate and the infallibility of the pope, marked the triumph of that doctrine by which they had been long anticipated. The Catholic Church, in all countries, has become more and more dependent on the Curia: the bishops have lost their autonomous standing, and their position is little more than that of papal delegates, while all important questions are referred to Rome or settled by the nuncios.

(ii.) A second peculiarity of Ultramontanism is that it claims for the Catholic Church the functions of a political power, and asserts that it is the duty of the secular state to carry out its instructions and wishes. Since the conditions of the age no longer allow the pope to depose a temporal sovereign, the practical application of this conception of the relationship between the spiritual and temporal powers has taken other forms, all of which, however, clearly show that the superiority of the Church over the State is assumed. This may be seen in the attitude of Ultramontanism towards secular law. It assumes that God has conferred on the individual and on society certain rights and competences as inalienable possessions. This "natural law" ranks above all secular law, and all state legislation is binding only in so far as it is in harmony with that law. As to the provisions of this natural law, and the consequences they entail in individual cases, these can be decided only by the Church, *i.e.*, in the last resort, by the pope. Thus, even at the present time, the opinion is very clearly expressed in Ultramontane quarters that, in the event of the state issuing laws contravening those of nature or of the Church, obedience must be refused. The attitude of Ultramontanism, for instance, towards the right claimed and exercised by the state to make laws concerning marriage is wholly negative; it recognizes no marriage laws except those of the Church, the Church alone being regarded as competent to decide what impediments are a bar to marriage, and to exercise jurisdiction over such cases.

(iii.) Since Ultramontanism cannot hope to realize its political ambitions unless it succeeds in controlling the intellectual and religious life of Catholic Christendom, it naturally attempts to extend its sphere of influence in all directions over culture, science, education, literature and the forms taken by devotion. The development of these efforts may be easily traced from decisions of the Congregation of the Index and the Holy Office in Rome. Ultramontanism, too, labours systematically to bring the whole organization of education under ecclesiastical supervision and guidance.

(iv.) In the fourth place, Ultramontanism is the embodiment of that intolerance towards other creeds which is the logical consequence of the authoritarian claims of the Catholic Church. The general presupposition involved is that a man cannot be saved except within the Catholic Church. Since, however, on the one hand—in virtue of a theory advanced by Pius IX. against the emperor William I. of Germany, in a letter which has since become famous—every Christian, whether he will or no, belongs to that Church by baptism, and is consequently pledged to obey her, and, on the other hand, since the state lies under the obligation to place the "secular arm" at her disposal whenever one of her members wishes to secede, the most far-reaching consequences result. In the past this principle led to the erection of the Inquisition (*q.v.*) and, even at the present day, there exists in the Curia a special congregation charged with its application. The gradual separation of State and Church, a process traceable in its various degrees in all countries of Europe, has resulted in rendering impossible the strict application of system to which human nature itself has, rightly or wrongly, taken exception. As a result of this situation, the Catholic condemnation of heresy—though as stringent as ever in principle—has assumed forms less physically dangerous for the heretic.

(v.) Lastly, Ultramontanism opposes the nationalization of Catholicism. This peculiarity is connected, though not identical, with the above-mentioned tendency towards the Romanization of the Church. Just as in Protestant countries there has often been an amalgamation of evangelical belief with national feeling, so many Catholics desire that Catholicism shall enter into the sphere of their national interests, and that the activities of the Catholic Church should rest on a national basis. These aspirations have been proclaimed with especial emphasis in France, in Germany (*Reformkatholizismus*) and in the United States (*Americanism; see* HECKER, I. T.); but they are everywhere met with a blank refusal from the Ultramontane side. Ultramontanism fears that any infusion of a national element into ecclesiastical life would entail the eventual separation of the people in question from papal control, and would lead to developments fraught with danger to the supremacy of the Papacy.

A MUCH DISPUTED PROBLEM

The relationship of Ultramontanism to Catholicism is a much-disputed problem. The Ultramontane maintains that there is no justification for distinguishing between the two; but, even within the pale of the Roman Church, the identification provokes dissent, and is repudiated by all who are shocked by the effects on the life of the Church of an over-centralized political Catholicism. It was on these grounds that in Jan. 1904, it was proposed in the chamber of the Bavarian Reichsrath that the clergy should be deprived of the suffrage. The years between the Treaty of Frankfurt (1871) and the outbreak of the World War witnessed a growing difficulty on the part of Catholic Germans to reconcile Ultramontane doctrine with the political and industrial development of united Germany. This was the real background of what is known as the *Kulturkampf* (*see* GERMANY, *History*).

The collapse of Germany after the World War (1914–18) tended, on the whole, to stimulate Ultramontanism (*e.g.*, in Bavaria), but the republican elements which combined in 1919 to uphold the Constitution of Weimar, proved strong enough to resist the more extreme manifestations of this tendency.

It may be admitted that for all the principal contentions of Ultramontanism, analogies may be found in the past history of the Catholic Church. Thus, in the middle ages, we find extremely bold pronouncements with respect to the position of the papacy in the universal Church; while political Catholicism had its beginnings in antiquity and found very definite expression, for instance, in the bull *Unam sanctam* of Boniface VIII. Again, the attempt to subordinate all intellectual life to ecclesiastical control was a feature of the mediaeval Church, and the fundamental attitude of that Church towards heresy was fixed during the same period. But since then much has been altered both in the Church and her secular environment. The State has become independent of the Church, legislates on its own sole authority, and has recognized as falling within its own proper sphere the civilizing agencies and social questions formerly reserved for the Church. Again, education, science, art and literature have been secularized; the printing-press carries knowledge into every house, the number of illiterates diminishes from year to year in every civilized country, and the clergy are no longer the exclusive propagators of culture, but merely one factor among a hundred others.

The origin of modern Ultramontanism is preceded and conditioned by the collapse of Catholicism in the period of the French Revolution. Pius VI. and Pius VII. were expelled from Rome, deprived of the papal States, and banished to France. In that country the Church almost completely lost her possessions; in Germany they were at least considerably curtailed; in both the hierarchical organization was shattered, while the Catholic laity

surveyed the catastrophe in complete passivity But from this severe fall the Church recovered with comparative readiness, and the upward movement is contemporaneous with the rise of Ultramontanism. The birth of that system, however, cannot be fixed as a definite event by the day and the hour; nor was it created by any single personality. Rather it was the product of the first post-revolutionary generation. Neither is it merely fortuitous that the reaction proceeded from France itself For in no other country had hostility to religion attained such a pitch or assumed such grotesque forms, and consequently in no other country did the yearning for religion manifest itself so unequivocally, when experience had demonstrated the necessity of a return to law and order. And in the other States of Europe there existed, more or less, a similar desire for peace and an equal dread of a fresh outbreak of revolutionary violence. In contrast to the struggle for an ideal freedom, which was at first hailed with tempestuous delight only to reveal itself as a dangerous tyranny, men became conscious of the need for a firmly established authority in the reconstruction of society At the same time, the repression of idealism and sentiment during the period of "illumination" was amply revenged, and the barren age of reason gave place to Romanticism These tendencies in contemporary opinion favoured the renovation of the Catholic Church

The papacy signalized its reinstatement by restoring the Society of Jesus (1814) and re-establishing the Index In Germany Ultramontanism had to contend with great difficulties; for here ecclesiastical affairs were not in so desperate a case that the most drastic remedies possessed the most powerful attraction; while, in addition, the clergy were unwilling to renounce all scientific work. The result was that a series of struggles took place between the old Catholicism and the new Ultramontanism But even here Ultramontanism gained ground and derived inestimable assistance from the blunders of government after government The growth of Jesuitical influence at Rome—more especially after the return of Pius IX from exile—implied a more definite protection of Ultramontanism by the papacy. The proclamation of the dogma of the Immaculate Conception in 1854 was more than the decision of an old and vexed theological problem, it was an act of conformity with a pietistic type especially represented by the Jesuits The Syllabus of 1864, however, carried with it a recognition of the Ultramontane condemnation of some aspects of modern culture (*see* the articles PIUS IX and SYLLABUS) Finally, in the Vatican Council, the Jesuits saw another of their favourite theories—that of papal infallibility—elevated to the status of a dogma of the Church (*see* VATICAN COUNCIL and INFALLIBILITY)

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ULTRA-VIOLET RADIATION: *see* LIGHT AND RADIATION.

ULUNDI (Zulu for "high place"), the royal kraal of Cetywayo, situated in the Mahlabatini district of Zululand, about 3 m. N. of the White Umfolosi river, and 115 m. N.N.E. of Durban. The valley of the White Umfolosi here forms an extensive basin called the Emhlabatini, and from the time of Chaka to the overthrow of Cetywayo in 1883 was the exclusive place of residence of the Zulu kings. The basin on the south side of the river is regarded as the cradle of the Zulu race; here all their early chiefs are buried, hence the term Emakosini (*i.e.*, at the grave of the chiefs) applied to the district (*see* Blue Book C 5143). During Cetywayo's reign a garrison of 3,000 was kept at Ulundi. About a mile from the kraal on July 4, 1879, a Zulu army some 20,000 strong was totally defeated by Lord Chelmsford. The British loss was about 100, the Zulu 1,500. After the fight the royal kraal was burned On Sept 1, at the site of the kraal, Sir Garnet (afterwards Lord) Wolseley announced the partition of Zululand into thirteen petty chieftainships; but on Jan 29, 1883, Cetywayo was reinstalled by the British at Ulundi as chief over two-thirds of his old dominions. Attacked at Ulundi in July 1883 by the rival chief Usibepu, Cetywayo and his 5,000 followers fled to the Nkandhla bush The royal kraal was again destroyed and Ulundi ceased to be a rallying point The magistracy for the district is situated 5 m N. of the site of Ulundi (*See* ZULULAND)

ULVERSTON, market town, urban district, Lonsdale parliamentary division, Lancashire, England, in the Furness district, 8 m N E from Barrow-in-Furness, and 256 m. from London by the L M S railway. Pop (1921) 10,121 The church of St. Mary, founded in 1111, retains the original (Transitional) south door, but is mainly Perpendicular in style with an altar-tomb of 1588 Ulverston is second in importance to Barrow in the Furness district. Conishead Priory, 2 m S E., a mansion on the site of a priory founded in the reign of Henry II, is now a hydropathic establishment Formerly Ulverston had a considerable trade in linens, checks and ginghams, but is now dependent on iron and steel works, chemical works, breweries, tan-yards, and hardware, paper, and wooden hoop factories Through its connection with Morecambe bay by a ship canal, 1 m in length, it has a shipping trade in iron and slates

Ulverston, otherwise Vlureston, Olvestonum, occurs in Domesday Book, where Vlurestun is named as a manor in possession of Turulf, who was probably the original Saxon owner Early in the 12th century the manor passed to Stephen, count of Boulogne, who gave it to Furness Abbey In 1196 the abbot granted the vill of Ulverstone with the inhabitants to Gilbert Fitz-Reinfred, who granted it a charter and made it a free borough The lordship became divided One part passed to the Harringtons and finally to Henry Grey, duke of Suffolk, on whose attainder in 1553 it was forfeited to the Crown, the other, returned to the abbey at the dissolution, was surrendered to the Crown. Early in the 17th century the Crown alienated the manor, now in the family of Buccleuch The yearly court-leet and court-baron are still held in October In 1280 Roger de Lancaster obtained a charter from Edward I for a weekly market on Thursday and an annual fair of three days on the eve of the Nativity (Sept. 7)

ULYSSES: *see* ODYSSEUS

UMBALLA or AMBALA, a city and district of British India, in the Punjab The city is 3 m E. of the river Ghaggar, 902 ft. above the sea Pop (1921), 76,326 It has a station on the North-Western railway, with a branch line to Kalka at the foot of the hills (39 m), which was continued up to Simla in 1903 Umballa owes its importance to a large military cantonment which was first established in 1843 The cantonment, which lies 4 m south-east of the native town, is well laid out with broad roads

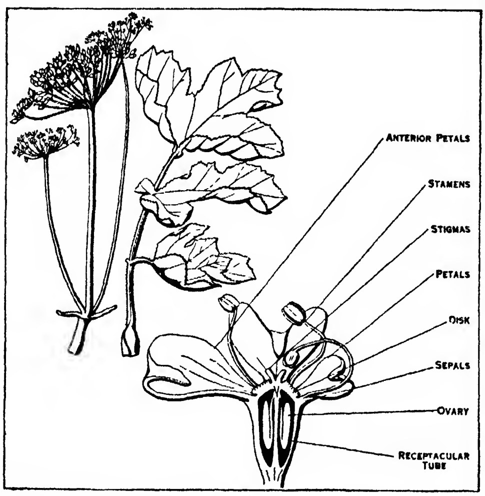
The DISTRICT OF UMBALLA has an area of 1 882 sq m With one small exception it consists of a level alluvial plain, sloping away gradually from the foot of the Himalayas, and lying between the rivers Jumna and Sutlej. These rivers do not materially affect the district, which has a drainage system consisting of the numerous torrents which pour down from the hills The principal of the northern streams is the Ghaggar, into which the minor streams empty themselves, some within and some beyond the limits of the district The Ghaggar is the only perennial stream within the district, but dwindles to a tiny rivulet in the dry season, and disappears altogether beyond the border of the district In 1901 the population was 681,477 The principal crops are wheat, maize, pulse, millets, rice, cotton and some sugar-cane. There are factories for ginning and pressing cotton, and also for grinding wheat Two opposite corners of the district are watered by the Sirhind and the Western Jumna canals. Umballa is one of the territories previously held by numerous Sikh sirdars, which were attacked by Ranjit Singh. This caused the movement of British troops in 1809 which resulted in the treaty with Ranjit Singh, by which he was required to withdraw his army from the left bank of the Sutlej In June 1849, after the second Sikh War had brought the

Punjab under British rule, the chiefs were deprived of all sovereign power. In March 1869 a grand durbar was held at Umballa on the occasion of the visit of the amir Shere Ali.

UMBEL, in botany, an inflorescence in which the stalks of the flowers all spring from the top of the main stalk, thus usually producing a flat-topped flower head, as in the carrot, parsnip and fennel (*See* FLOWER.)

UMBELLIFERAE, in botany, a family of polypetalous dicotyledons belonging to the order Umbelliflorae, which includes also the families Araliaceae (ivy family) and Cornaceae (dogwood family). It contains 200 genera with about 2,700 species, occurring in all parts of the world but chiefly in north temperate regions. It is well represented in the British flora by 35 genera. The plants are annual or perennial herbs, rarely shrubby as sometimes in *Bupleurum*, with generally a very characteristic habit, namely stout erect stems with hollow internodes, alternate pinnately compound exstipulate sheathing leaves and compound umbels of small, generally white, flowers.

An example of an annual is the common fool's parsley, *Aethusa Cynapium;* carrot (*Daucus Carota*) is a biennial; others are perennial, persisting by means of tubers or rhizomes—such are hogweed (*Heracleum*), *Angelica, Peucedanum,* and others. Some genera have a creeping stem as in *Hydrocotyle* (pennywort), a small herb with a creeping filiform stem and, in the British species, entire leaves. *Bupleurum* has simple, entire, often perfoliate leaves. *Azorella,* a large genus in south temperate regions, has a peculiar caespitose habit, forming dense cushions often several feet in diameter and persisting for many years; they resemble those of the Australian *Raoulia* (vegetable sheep). *Eryngium,* represented in Britain by sea-holly (*E. maritimum*), is a large genus of rigid often glaucous herbs with spiny-toothed leaves, which in some South American species with narrow parallel-



FROM GROOM, "ELEMENTARY BOTANY" (BELL & SONS)

LEAF AND INFLORESCENCE (COMPOUND UMBEL) OF COW PARSNIP (HERACLEUM DUBIUM), ALSO CROSS-SECTION OF MARGINAL ZYGOMORPHIC FLOWER

veined blade and broadly sheathing base recall those of a monocotyledon such as *Agave* or *Bromelia.* In sanicle (*Sanicula*), *Astrantia* and others the leaves are palmately divided.

There is also considerable variety in the development of the umbel, which is usually compound but sometimes simple, as generally in *Hydrocotyle* and *Astrantia,* rarely reduced to a single flower as in species of *Hydrocotyle.* In *Eryngium* the flowers are crowded into dense heads subtended by a whorl of rigid bracts. A terminal flower, distinguished by its form and dark colour, is sometimes present as in carrot (*Daucus*). The presence or absence of bracts and their form when present afford useful diagnostic characters. When present at the base of the primary rays of the umbel they form the *involucre,* and the *involucel* when at the base of a partial umbel. In *Astrantia* the simple umbel is enveloped by a large, often coloured, involucre.

The small epigynous flowers are usually hermaphrodite and regular, with parts in fives. The sepals are usually very small, often represented only by teeth on the upper edge of the ovary; the petals are usually obovate or obcordate in shape, often with the tip inflexed; the stamens have long slender filaments bent inwards in the bud but ultimately spreading; the two carpels are in the median plane; the two-celled ovary is surmounted by an epigynous glandular disk, which bears the two styles. Each ovary-cell contains a single pendulous anatropous ovule with a ventral raphe and a single integument. The flowers are rendered conspicuous by being massed into more or less dense flat-topped inflorescences (umbels). A resemblance to the rayed heads of Compositae is suggested in the frequently larger size of the flowers on the circumference of the umbel which are often sterile and zygomorphic from the larger size of the outer petals. This arrangement allows a large number of flowers to be visited by insects in a short time. The flowers are generally white, sometimes pink or yellow, very rarely blue, they are generally scented, but the whole plant has an odour from the general presence in the tissues of an ethereal oil or resin. The flower is widely open, the petals and stamens radiating from the central disk, on which honey is secreted, and is thus accessible to quite short-tongued flies. Cross-pollination is rendered necessary by the flowers being generally markedly protandrous.

The fruit is very characteristic, a schizocarp which splits down the septum to form two dry one-seeded mericarps which are at first attached to, or pendulous from, an entire or split central axis or *carpophore.* The form of the mericarp affords valuable characters for distinguishing genera. On the outer surface of each are generally five ridges (primary ridges), between which are sometimes four secondary ridges, oil-cavities, *vittae,* are often present in the intervening furrows.

The family is divided according to the nature of the flower and fruit (presence or absence of a free carpophore, and of vittae; the nature of the endocarp, whether soft or woody). Engler divides the family into three main classes, *Hydrocotyloideae, Saniculoideae, Apioideae.* The first two with two subfamilies each and the last with eight subfamilies. The 35 British genera represent seven of the twelve subfamilies. The following may be mentioned. *Hydrocotyle* (pennywort), *Eryngium* (sea-holly), *Sanicula* (sanicle), *Conium* (hemlock, *q.v.*), *Smyrnium* (Alexanders), *Bupleurum* (hare's-ear), *Apium* (celery, *q.v.*), *Carum* (caraway, *q.v.*), *Conopodium* or *Bunium* (earth-nut, *q.v.*), *Myrrhis* (Cicely), *Chaerophyllum* (chervil), *Foeniculum* (fennel, *q.v.*), *Crithmum* (samphire), *Oenanthe* (water dropwort), *Aethusa* (fool's parsley, *q.v.*), *Angelica* (*q.v.*), *Peucedanum* (hog's fennel), *Pastinaca sativa* (parsnip, *q.v.*), *Heracleum* (hogweed), *Daucus* (carrot). *Petroselinum sativum* is common parsley (*q.v.*).

It is represented in North America by about 70 genera. The more common ones are *Eryngium* (snakeroot), *Sanicula* (black snakeroot), *Hydrocotyle* (pennywort), *Osmorrhiza* (sweet cicely), *Conium* (poison hemlock), *Cicuta* (water hemlock), *Sium* (water parsnip), *Thaspium* (meadow parsnip), *Heracleum* (cow parsnip), and *Angelica*.

For further details *see* Engler & Prantl, *Die Naturlichen Pflanzenfamilien* (Leipzig, 1887–1908); J. C. Willis, *Flowering Plants and Ferns* (Cambridge, 1925); A. B. Rendle, *The Classification of Flowering Plants* (Cambridge, 1925).

UMBER: *see* MANGANESE; PAINTS, CHEMISTRY OF.

UMBRELLA ANTENNA, a radio antenna, the conductors of which form elements of a cone with the apex at the top to which the lead-in (*q.v.*) is connected.

UMBRELLA-BIRD, the name for a species of the genus *Cephalopterus,* belonging to the American family Cotingidae. The males are black and bear a peculiar umbrella-like crest from which characteristic the name is derived. They also have long, plumed wattle depending from the throat.

UMBRIA ('Ομβρική), the name of an ancient and a modern district of Italy.

1. The ancient district was bounded in the period of the Roman supremacy by the Ager Gallicus (in a line with Ravenna) on the north, by Etruria (the Tiber) on the west, by the Sabine territory on the south and by Picenum on the east The Via Flaminia passed up through it from Ocriculum to Ariminum; along it lay the important towns of Narnia (Narni), Carsulae, Mevania (Bevagna), Forum Flaminii, Nuceria Camellaria (Nocera) and Forum Sempronii; and on the Adriatic coast Fanum Fortunae (Fano) and Pisaurum (Pesaro) To the east lay Interamna (Terni), Spoletium (Spoleto), Fulginium (Foligno—on a branch of the Via Flaminia which left the main road at Narnia and rejoined it at Forum Flaminii) and the important town of Camerinum on the side of the Apennines towards Picenum. On the side towards Etruria lay Ameria (Amelia) and Tuder (Todi), both on the direct road from Rome to Perusia, Iguvium, which occupied a very advantageous position close to the main pass through the Apennines, and Hispellum (Spello) Not far off was Assisium (Assisi), whilst far to the north in the mountains lay Sarsina Under the empire it formed the sixth region of Italy

The name Umbria is derived from the Umbri, one of the chief constituent stocks of the Italian nation The origin and ethnic affinities of the Umbrians are still, like their geographical location in early times (1200–1000 B C), quite unknown (Randall MacIver, *Iron Age in Italy* [Oxford, 1927], 140), but their language proves them to have been an Aryan people closely allied with the Oscans and in a remoter degree with the Latins

The process by which the Umbrians were deprived of their traditional predominance in upper and central Italy and restricted to their confines of historic times cannot be traced in detail Their easternmost territory in the region of Ancona was perhaps wrested from them by the Picenes, a branch of the Sabine stock and it is probable that they were partly displaced in the valley of the Po by the Gaulish tribes which began to pour across the Alps from about 500 B C But their chief enemies were undoubtedly the Etruscans (*q v*), who eventually drove them into that upland tract athwart the Apennines to which the name of Umbria belonged in historical times without eradicating the Umbrian element of population in the conquered districts In Etruria proper the persistence of the Umbrian stock is indicated by the survival of numerous Umbrian place-names, and by the record of Umbrian soldiers taking part in Etruscan enterprises, *e g* , the attack on Cumae in 524 B C Indeed it is not unlikely that the bulk of the population in Etruria continued to be of Umbrian origin, and that the Romanization of this country was facilitated by the partial absorption of the Etruscan conquerors into the Umbrian multitude

Against the Romans the Umbrians never fought any wars of importance After the downfall of the Etruscan power they made a belated attempt to aid their Samnite kinsmen in their decisive struggle against Rome (308 B C); but their communications with Samnium were impeded by the foundation of a Roman fortress at Narnia (298 B C), and at the great battle of Sentinum (295 B.C), which was fought in their own territory, the Umbrians did not lend the Samnites any substantial help. It is perhaps on account of this defection that in 200 B C. they received from the Romans a portion of the Ager Gallicus reconquered from the Senonian Gauls. They offered no opposition to the construction of the Via Flaminia through the heart of their country, and in the Second Punic War withheld all assistance from Hannibal In the Social War (90–89 B C), they joined the rebels tardily and were among the first to make their peace with Rome. Henceforth they no longer played an independent part in Italian history.

The material prosperity of Umbria, in spite of its unfavourable position for commercial intercourse, was relatively great, owing to the fertility of the numerous small valleys which intersect the Apennine system in this region The chief products of the soil were olives, vines and spelt; the uplands harboured the choicest boars of Italy. The abundance of inscriptions and the high proportion of recruits furnished to the army attest its continued populousness. Among its most famous natives were the poets Plautus (b at Sarsina) and Propertius (b at Assisi).

The Umbrians in addition to the city (*tota*) had a larger territorial division in the *tribus* (*trifu,* acc) as we gather from Livy (xxxi. 2, "per Umbriam quam tribum Sapiniam vocant"; *cf.* xxxiii. 37) and from the Eugubine Tables ("trifor Tarsinates," vi. B 54). Ancient authors describe the Umbrians as leading effeminate lives, and as closely resembling their Etruscan enemies in their habits There is conclusive proof of strong Etruscan influences in Umbria, and their alphabet is undoubtedly of Chalcid-Etruscan origin, while the language, which we know from one or two inscriptions from Fulginium and Tuder, and from the so-called Eugubine Tables, the earliest parts of which may go back to the 5th cent B C. (*see* GUBBIO) is a dialect which sprang from the Oscan, but is marked by some phonetic changes Etruria also taught the towns near it, *e g* , Tuder and Iguvium the art of minting, for they alone had a coinage The Umbrians counted their day from noon to noon But whether they borrowed this likewise from the Etruscans we do not know. In their measuring of land they employed the *vorsus,* a measure common to them and the Oscans, 3½ of which went to the Roman *jugerum*

2 The modern territorial division is situated in the middle of the peninsula, between Tuscany and the Marches on the north and east, and Rome and the Abruzzi on the south and west, and comprising the two provinces of Perugia and Terni with an area of 3,366 sq m ; pop (1921), 638,991. Umbria and the provinces of Ancona and Pesaro and Urbino taken together form an area slightly more extensive than that of the sixth region of Augustus The surface is mountainous, but affords good pasture, and there are numerous fertile valleys Many treasures of art and architecture are preserved, and Umbria is in this respect one of the most interesting regions of Italy (*See* PERUGIA) Modern Umbria formed down to 1860 a part of the States of the Church

Two main lines of railway run through the territory That from Florence to Rome skirts the borders of the province on the west, running north and south, while the Rome-Ancona runs across the province from north-east to south-west The cross communication is given by three branch lines In the north a narrow gauge line from Arezzo to Fossato passes through Gubbio Perugia, the capital of the province, stands on the line from Terontola to Foligno, while on the extreme south a line passing through Rieti and Aquila, and ultimately reaching Sulmona, starts from Terni on the Rome-Ancona line There is also an electric railway from Terni via Perugia to Umbertide, on the line between Arezzo and Fossato

The great steelworks of Terni (*q v*), the chloride factory at Nera Montoro near Narni, the chemical manure works at Narni, Foligno and Assisi, the wool and jute works of Terni and Foligno, the cotton spinnery of Spoleto may all be mentioned; while the hydro-electric plants of Umbria, which are concentrated at Terni, are of great importance, and are able to help out those of Lazio and Tuscany. In 1926, 334,873 tons of lignite were mined in the province of Perugia (T. A)

UMBRIAN LANGUAGE. The dialect in which the *Iguvine Tables* (*see* IGUVIUM) are written is usually known as Umbrian, as it is the only monument we possess of any length of the tongue spoken in the Umbrian district before it was Latinized The language is that of a certain limited area, which cannot yet be shown to have extended very far beyond the eastern half of the Tiber valley (from Interamna Nahartium to Urvinum Mataurense).

Umbrian has diverged from Oscan in the following matters:

(1) The palatalization of *k* and *g* before a following *i* or *e*, or consonant *i* as in *tiçit* (i e , *diçit*)=Lat *decet; muieto* past part. passive (pronounced as though the *i* were an English or French *j*) beside Umb imperative *mugatu,* Lat. *mugire*

(2) The loss of final *-d, e.g.,* in the abl sing fem. Umb *tōtā*=Osc. *toutād.*

(3) The change of *d* between vowels to a sound akin to *r*, written by a special symbol ꟼ (*d*) in Umbrian alphabet and by RS in Latin alphabet, e g., *teḍa,* in Umbrian alphabet=*dirsa*

in Latin alphabet, "let him give," exactly equivalent to Paelignian *dida*.

(4) The change of *-s-* to *-r-* between vowels as in *erom*, "esse"=Osc. *ezum*, and the gen. plur. fem. ending in *-aru*=Lat. *-arum*, Osc. *-azum*.

To this there are exceptions, *e.g.*, *asa*= Lat. *ara*, which are generally regarded as mere archaisms. Unfortunately the majority of them are in words of whose origin and meaning very little is known, so that (for all we can tell) in many the *-s-* may represent *-ss-* or *-ps-* as in *osatu*=Lat *operato*, *cf*. Osc. *opsaom*.

(5) The change of final *-ns* to *-f* as in the acc. plur. masc. *vitluf*=Lat *vitulōs*

(6) In the latest stage of the dialect the change of final *-s* to *-r*, as in abl. plur *arver, arvиs*, *i.e*, "arvorum frugibus"

(7) The decay of all diphthongs

(8) The change of initial *l* to *v*, as in *vutu*=Lat. *lavito*.

Save for the consequences of these phonetic changes, Umbrian morphology and syntax exhibit no divergence from Oscan that need be mentioned here, save perhaps two peculiar perfect-formations with *-l-* and *-nçi-*; as in *ampelust*, tut perf "impenderit," *combifiançiust*, "nuntiaverit" (or the like).

See C. D. Buck, *Oscan and Umbrian Grammar* (Boston, 1904), R. von Planta, *Oskischumbrische Grammatik* (Strassburg, 1892–97), R. S. Conway, *The Italic Dialects*, vol ii p 495 *seq*

UNAMUNO, MIGEL DE (1864–), Spanish scholar and man of letters, was born at Bilbao on September 29, 1864. He was educated in Madrid, receiving a doctor's degree in philosophy and letters, and in 1892 was appointed to the chair of Greek language and literature at Salamanca University. In 1900 he became rector of the university He was always vitally interested in practical affairs and later in a campaign by means of newspaper articles and addresses against governmental corruption and abuses he was so outspoken that he was removed from the rectorship of the university. The *coup d' etat* of Primo d' Rivera in 1923, which established a military directorate, aroused him to such vehement denunciation that in February, 1924, he was exiled to one of the more remote of the Canary Islands The sentence aroused much criticism and the government granted amnesty in July, 1924, but Unamuno refused to return to Spain and took up his residence in Paris In letters Unamuno is a man of wide culture and of great influence in Spanish-speaking countries In his poems there is vigorous thought and lofty passion which strains at the bonds of rhyme, while his blank verse is weighted with mysticism. There are many excellent sonnets in the collection *Rosario de Sonetos liricos* (1911) His most remarkable poem is *El Cristo de Velazquez* (1920), a long series of mystic meditations, which is often compared by critics to the work of Blake His novels are made impressive by their philosophical quality Superfluous details and descriptive writing are suppressed and the stage is stripped for the interaction of passions and ideas *Niebla* (1914), *Abel Sanchez* (1917), *La Tia Tula* (1921) and *Tres Novelas Ejemplares* (1921) are all important, but his masterpiece is generally acceded to be *Del Sentimiento Tragico de la Vida* (1913, trans into English, 1921) Much of his thought, as well as more colourful descriptive writing, is to be found in the *Ensayos* (7 vols, 1916–19), while warmth of feeling for the people and countryside of Spain are shown in *De mi pais* (1903), *Por tierras de Portugal y de Espana* (1911) and *Andanzas y Visiones* (1922). In the *Vida de Don Quijote y Sancho* (1914; trans. into Eng. 1927) he preaches the cult of quixotism as an ideal

A number of selections and extracts from his essays are translated in *Essays and Soliloquies* (1925), other translations are *The Agony of Christianity* (1928) and the novel, *Mist* (1929)

UNAO, a town and district of British India, in the Lucknow division of the United Provinces The town is 10 m. N E. of Cawnpore Pop. (1921), 11,147

The DISTRICT OF UNAO has an area of 1,787 sq.m. It consists of a flat alluvial plain, lying north of the Ganges. Rich and fertile tracts, studded with groves, alternate with stretches of waste land and plains of barren *usar*, the whole being intersected by small streams, used for irrigation. The Ganges is the only navigable river in the district, while the Sai forms its north-eastern boundary. Pop. (1921), 819,128.

UNDEN, OSTEN (1886–), Swedish politician, became professor of civil law at the University of Uppsala in 1917. Unden, who was a Social Democrat, became a minister without portfolio in the Eden Cabinet from 1917 until 1920, and minister of justice in the first Branting Cabinet in 1920. From 1920 to 1924 he was the expert on international law to the Swedish Foreign Office; and a member of the Swedish delegation at the Assembly of the League of Nations from 1921 and also at the Genoa and Hague Conferences, 1922. He became foreign minister in Branting's third Ministry in 1924 and after the latter's death in 1925 Unden succeeded him on the Council of the League of Nations He was especially prominent at the special session of the Assembly held in March 1926, when he opposed the election of any other country than Germany to a permanent seat on the council He was one of the committee of three appointed by the council to consider the Laidoner report on the Mosul boundary, and only agreed to it after much persuasion, holding that a settlement conciliatory to Turkey was essential.

UNDERGROUND ELECTRIC RAILWAYS COMPANY OF LONDON LIMITED. This company was incorporated in April 1902, and had for its object the construction of new Underground Railways in London and the electrification of the Metropolitan District Railway In 1914, the Underground Company changed its constitution and became a share and securities holding company, mainly in companies concerned in London passenger transport The transport operating companies which it controls by its holdings of companies' stocks and shares are (1) the Metropolitan District Railway Company; (2) the London Electric Railway Company (comprising the Great Northern, Piccadilly and Brompton; the Baker Street and Waterloo, and the Hampstead and Highgate Railways), (3) the City and South London Railway Company; and (4) the London General Omnibus Company Limited. It also controls the Central London Railway Company in consideration of its dividend guarantee These five companies are under one control with a common management, and in pursuance of an Act of Parliament secured in 1915 they participate in a Common Fund and are collectively described as the Common Fund Companies This Common Fund consists of the balance of the revenue of the several companies after providing for their revenue liabilities, viz, working expenses, rent, rent charges, interest on loans, debenture, guaranteed and preference stocks and reserves for depreciation and obsolescence The balance is applied half yearly, first in meeting the deficiency of any of the constituent companies which may have been unable to discharge its revenue liabilities, and then in distribution among the constituent companies in agreed proportions The common fund and common management secure (1) that the several undertakings are treated as one traffic unit, and clearance of traffic between them is avoided; (2) increased through-booking facilities; (3) standardization of fares; (4) the elimination of wasteful competition as between the companies involved; (5) stabilization of financial results, (6) the pooling of resources for improvement and extension of the system of transport in London These advantages are further enhanced by the fact that the Underground Company by its holding of shares has a substantial interest in the London and Suburban Traction Company Limited, which in turn controls (1) the Metropolitan Electric Tramways Limited, (2) the London United Tramways Limited; (3) the South Metropolitan Electric Tramways and Lighting Company Limited; and (4) the Tramways (M E.T.) Omnibus Company Limited

The capital of the Underground Electric Railways Company of London Limited issued and outstanding at December 31st, 1928, was £16,574,510. The capital outstanding of the Common Fund Companies at that date was £62,622,013 of which £54,241,-364 was attributable to the railways. The railway system, entirely electrified, covered 114 route miles, including the lines of other companies over which it had running powers. In 1928, over 81 million car miles were operated and over 368 million passengers were carried by these railways.

The London General Omnibus Company in 1928 covered 1,029

road miles with its omnibuses, of which the average number worked daily was 4,328. During that year over 205 million service car miles were operated and over 1,834 million passengers carried.

The three Tramways undertakings named above owned, in 1928, 68·63 miles of track, and leased from the Middlesex and Hertfordshire County Councils a further 44·28 miles—a total of 112·91 track miles With an aggregate fleet of 553 tramcars, over 20 million car miles were worked and over 192 million passengers were carried. (J. C. Mi.)

UNDERGROUND RAILROAD, a term used popularly to designate an organized system existing in the Northern States of the United States prior to the Civil War by which slaves were secretly helped by sympathetic northerners and in defiance of the Fugitive Slave Laws (*q v*), to make their way to Canada, and thus to freedom The name arose from the exaggerated use of railway terms in reference to the conduct of the system Levi Coffin and Robert Purvis were the "presidents" of the road Various routes were known as "lines," stopping places were called "stations," those who aided along the stages of the route were "conductors" and their charges were referred to as "packages" or "freight." The system reached from Kentucky and Virginia across Ohio, and from Maryland across Pennsylvania and New York or New England The Quakers of Pennsylvania perhaps initiated the system; the best known of them Thomas Garrett (1789–1871) is said to have helped 2,700 slaves to freedom One of the most picturesque conductors was Harriet Tubman, a negro woman called "General" Tubman by John Brown, and "Moses" by her fellow negroes, who made about a score of trips into the South, bringing out with her perhaps 300 negroes altogether Levi Coffin, a native of North Carolina, in 1826 settled at New Garden (now Fountain City), Ohio, where his home was the meeting point of three "lines" from Kentucky In 1847 he removed to Cincinnati, where he was even more successful in bringing out slaves Estimates of the number of slaves who reached freedom through the system vary from 40,000 to 100,000

See W H Siebert, *The Underground Railroad* (1898), a scholarly study containing maps of routes and bibliography. W Still, *The Underground Railroad* (1872), R C Smedley, *History of the Underground Railroad* (1883), and *Reminiscences of Levi Coffin* (1880) are personal records of participants

UNDERWOOD, OSCAR WILDER (1862–1929), American politician, was born at Louisville, Ky , on May 6, 1862 He studied at the University of Virginia (1881–84), was admitted to the bar in 1884, and practised law thereafter in Birmingham, Ala From 1895 to 1915 he was a member from Alabama of the National House of Representatives, and during his last two years chairman of the committee on ways and means After the Democrats came into power in 1913 he had a large share in framing the tariff bill passed the same year In 1914 he opposed the Panama Canal Tolls Repeal bill, but supported the resolution authorising the President to use armed force in Mexico. He was opposed to the woman suffrage amendment to the Federal Constitution, holding that the question was a state issue. He also opposed the national prohibition amendment In 1914 he was elected to the U S Senate, and in 1920 re-elected In 1919 he favoured the anti-strike clause of the Cummins railway bill. A strong supporter of the Peace Treaty of Versailles, in Dec. 1919 he offered a resolution in the Senate providing that the president of the Senate should appoint a committee of 10 senators to work out some acceptable plan for adopting the Peace Treaty; but this was blocked by Senator Lodge In April 1920 he was chosen Democratic leader in the Senate He was a U S delegate at the Washington Conference on the Limitation of Armaments which assembled in Nov 1921 At the Democratic National Convention held in New York city, June 1924, Senator Underwood was an unsuccessful candidate for the presidential nomination. In 1927 he was made a member of the American delegation to the Pan-American Congress. He published *Changing Sands of Party Politics* (1927). He died at Woodlawn, Va., on Jan. 25, 1929.

UNDERWRITING: *see* INSURANCE ARTICLES.

UNDSET, SIGRID (1882–), Norwegian author, was born at Kallundborg, Denmark, on May 20, 1882. After completing her studies at the Christiania Mercantile college, Mme Undset entered a city office in 1899 and remained a clerk until 1909 She thus gained an intimate acquaintance with the empty and unenlivened existence of the girls with whom she came into contact, and utilized her experience in her first literary works, initiated in 1907 by *Fru Marta Oulie* In 1912 she achieved fame by the great Christiania novel, *Jenny* (Eng trans , 1920), remarkable for its courageous treatment of the erotic problem. After revealing in one of her minor works (1919) the religious crisis in her mind which in 1925 caused her to join the Roman Catholic Church, Mme Undset published *Kristin Lavransdatter* (1920–22); Eng trans , Pt I *The Garland* (1922), Pt II *The Mistress of Husaby* (1925), Pt III *The Cross* (1927), a remarkable novel of the 14th century, by which she became known to the English-speaking world Mme Undset's work shows psychological depth and an ability to appraise the mind and temper of bygone ages, but these qualities are nowhere enlivened by a sense of humour. Her work, *Olav Audunsson*, a 13th century novel (1925), Eng trans , *The Axe* (1928), is stamped by the same qualities Another work *The Snake-Pit* was published in Jan 1929 She was awarded the Nobel prize in 1928

See J. Bing, *Sigrid Undset* (1924).

UNEARNED INCREMENT, in economics, a term frequently applied to that part of the value of land which is due to the growth and development of the community using it, to the construction of buildings, roads, railways, canals, docks, harbours, upon it, or to the working of minerals beneath it Thus a piece of land in one part of a country, although beautiful or fertile, may be worth very little, while in another part of the same country a piece of land of similar area required for a railway, or by a railway made accessible for residential purposes, may rise in value by a hundredfold or a thousandfold The gains thus made by some landowners are so obvious and so great that the specific taxation of the unearned increment has been often proposed and in some countries carried into effect (*see* article on LAND TAXES) Amongst others John Stuart Mill favoured a progressive tax on land. Henry George's tax amounted to a proposal to absorb the whole of the surplus value (*see* SINGLE TAX)

UNEMPLOYMENT. If every able-bodied man and woman were regarded as an actual or potential worker, the term unemployment would have a larger meaning than is commonly accorded to it For it would include the withheld productive time and energy of those who figure in censuses as "unoccupied," the upper and the lower leisured classes, all who manage to live without doing work But though such a connotation might be sound and serviceable in a general assessment of national economic waste, it would carry us too far away from the set of actual problems conventionally and conveniently grouped under the term "Unemployment" That term covers the idleness of those willing and able to work which is attributable to the conditions of the trade or occupation in which they are ordinarily engaged

Thus defined, unemployment, however, may not be equivalent to waste of productive time on the part of all "unemployed." For there are occupations that are essentially or "naturally" irregular in the volume of work they require Such are those dependent upon climatic conditions, or seasonal requirements. Agriculture, building, fishing, dock labour, are important examples Most of the slackness in such trades is in winter, though there are trades, mining for instance, where employment is slacker in summer Fluctuations, as with some other trades, for instance printing and dressmaking, where seasonal activities are less directly traceable to climatic causes, run a fairly regular and calculable course This regularity, indeed, permits of a certain amount of inter-trade adjustment which lessens the amount of wasted time. In some countries, as in Belgium and Russia, where the ties between country and town life are closer than in England, agricultural work sensibly relieves the unemployment in town industries In a highly specialized industrial system, however, the possibilities of such adjustments are severely limited, and trade union discipline raises obstacles

Reasons for Unemployment.—There are two other important sources of unemployment in particular trades, that cause trouble by their irregularity and incalculability They are changes

of fashion or taste in the consumer, and inventions or new processes on the productive side of industry. The dressmaking and to a less extent the textile trades are peculiarly prone to sudden violent changes of fashion, while in most luxury trades considerable fluctuations of employment occur from the freaks of taste, often stimulated from the selling side. New materials, new combinations, shapes and colours, rapidly acquire prestige and shift the currents of employment It may, of course, be urged that no net increase of unemployment is thus caused, for the new fashion yields as much employment as the old But from the social standpoint considerable net waste ensues from such violent fluctuations

Inventions, involving important changes of technique, especially in labour-saving machinery, are liable to cancel much manual skill, though they may indirectly increase employment by reducing costs and prices, so stimulating demand. If industry is in general active, workers thus displaced may not remain long unemployed, but in normal times, still more in depressed, they will encounter much difficulty in fitting themselves into a new post.

It is true, as Mr. Charles Booth stated, that "our modern system of industry will not work without some unemployed margin, some reserve of labour" But this margin need not be as wide as it is More mobility of occupation, inter-local and inter-occupational, should be practicable. Better information through employment bureaux and trade union organizations can speed up adjustments, and so help to reduce the percentage of the population at any moment unemployed. But the efficacy of such measures depends largely upon those wider conditions of general trade, which are commonly brought together under the term cyclical fluctuations

I. CYCLICAL FLUCTUATIONS

The Measure of Unemployment.—It will be convenient, first, to consider briefly how far we are able to measure unemployment. There are two sources of information in Britain, the trade union returns of members out of employment (whether in receipt of unemployed benefit or not) and the returns covered by the Unemployment Insurance acts Up to 1920 the trade union returns were the largest statistical basis. They were, and are, a very incomplete index of the total volume of unemployment For the trade unionists included in the returns are usually less than half of the trade unionists in the country, and the latter are only from a third to a half of the wage-earning classes. Although it is part of the policy of trade unions to secure for their members a preference in employment, it is likely that the proportion of unemployed among industrial workers who are non-unionists is rather less than among unionists. For the trade unions are strongly represented in certain trades which are exceedingly liable to trade fluctuations, such as the building, mining, engineering, metal and ship-building trades Moreover, a trade unionist is far less likely to seek employment in some other trade than his own, or to accept lower wages in his own trade. On the other hand, the great mass of casual labour will bring up the volume of unemployment in the low-organized trades

These considerations serve to indicate that the returns under the Unemployment Insurance act of 1911, extended in 1922 to cover some 11,500,000 manual workers, form a better index of the total amount of unemployment. The only large classes excluded are domestic servants, farm labourers and government employees These classes, however, are so large and, with the exception of sections of farm labourers, so much more regular in their employment, as to cause some exaggeration to appear, if the insurance statistics are taken as a measure of the unemployment of the working population in the aggregate When the official figure for unemployment is 10%, the average unemployment for the workers as an aggregate might perhaps be put at 9% or even less. As an offset, however, against such a tendency to overestimate, the habit of resorting to short time to meet trade slackness must be taken into account. In coal-mining and the textile trades, especially cotton, this practice must considerably reduce the amount of reputed unemployment. At the lowest depth of the depression in Britain, in June 1921, when 2,171,288 workers were applicants for benefit in respect of total unemployment, 832,340 workers claimed benefit for short time.

Cyclical Unemployment.—The minor leakages and fluctuations due chiefly to natural causes, or to alterations in methods of work, or of consumption, are so various and so numerous that they may be held to require a certain small percentage of "waiters" as representing the wholesome elasticity of a free progressive economic system. But can the same be said of the larger periodic movements known as trade depressions, which doom a large percentage of the available productive capital and labour to stand idle for a couple of years or more? Are we to regard these large fluctuations as inevitable, or possibly desirable? First, a word as to the size of these fluctuations. Before the World War the annual averages in Great Britain swung between about 2½% and 7½%, leaving an implication that our system, for its free-working, requires an average unemployed margin of some 5%, half of it representing the minor trade changes and leakages to which we have referred, half forming a reserve of labour to enable expansion to take place in good times. But war and post-war experience shows a far more violent fluctuation. For, whereas the figure for 1918 was 0 8 and for 1919 2·4, the depression which set in at the close of 1920 reached by June 1921 the extraordinary figure of 23·1%, and the trade union average for 1921 was 15·3, for 1922, 15 4%

Two other general tendencies may be noted The larger intercourse between industrially developed countries since 1875 has made these ebbs and flows of trade more simultaneous The "boom" years 1873, 1874, 1900, were common to all industrial nations, so was the collapse of later 1907 The other tendency is the shortening of the cycle. Before the seventies of last century there was something like a 10 years' rhythm Since then the periods have shortened, the years of maximum trade activity being 1873, 1882, 1890, 1900, 1907 and 1913 The post-war situation caused some disturbance of both these tendencies "Japan began to feel the effect of trade depression in 1919 when trade in Great Britain was in full swing In 1921 Germany was expanding her industries rapidly, while Great Britain was in the throes of the depression Again, in 1923 economic conditions in the United States showed a very striking recovery, and indeed she attained in the spring a condition of record trade activity." (Hon. J. J. Astor, *Is Unemployment Inevitable?*, p. 11)

The Post-war Depression.—Before discussing the causes and remedies of normal cyclical unemployment, it will be well to deal briefly with the peculiarities of the post-war depression, which alike in its causation and its character is abnormal Without prejudging the question of the part played by finance in ordinary cycles, it is evident that the World War and post-war inflation, practised in different forms and measures by almost all European governments, and the consequent collapse of exchange and internal monetary values, were disturbing factors of prime importance. While inflation exercised an immediately stimulating influence on internal trade by encouraging expenditure, and upon export trade by means of an artificial cheapening of production, the consequent damages to confidence and credit, the ruin of large sections of the middle-classes, the difficulty of the import trade and the scarcity and dearness of working capital, were main contributions to the long depression Closely connected with this financial disease was the sabotage of commercial relations, accompanied by high tariffs and embargoes upon the movement of goods and investments, and the breaking up of the economic unity of the Austro-Hungarian empire. The virtual isolation of Russia from free economic intercourse with the outside world brought a serious curtailment of foods and raw materials for other countries, and a corresponding reduction of manufacturing exports.

New difficulties arose between town and country, due to bad money, creating food shortages, depressed wages and efficiency among industrial workers. Political disturbances, accompanied by strikes and labour difficulties in most countries, were a factor in low production. More important in Britain and other ex-belligerent industrial countries was the collapse of industries over-stimulated for war-production whose excessive plant and labour could not be adapted readily to useful work in the post-war world. The huge depression in the iron and steel, engineering and ship-building

trades, as in the mining, was largely attributable to this cause.

Monetary disturbances, commercial obstacles, industrial dislocation, revolutions and sporadic warfare thus contributed towards a trade depression unique in its character and distribution as well as unprecedented in its magnitude and duration. These different causes operated at different times and with different stresses in the various countries. In every country there was a striking coincidence between the fluctuations of prices and of employment. When prices fell unemployment rose, and vice versa The countries not directly implicated in the war suffered as violent fluctuations as the ex-belligerent countries. The unemployment figure in each of the Scandinavian countries (with the exception of Finland) was higher in the later part of 1921 and the opening of 1922 than the British highest figure Switzerland touched 25% in Jan 1922 and Belgium 32 3% in May 1921. In Germany and Austria inflation postponed the trouble until monetary reform was carried out; then came reaction and widespread unemployment. In general the internal monetary policy played a more determinant part than the restriction of the export trade, re-absorption of the fighting forces, political animosities, tariffs or any of the other disturbing factors of the post-war world This would seem to apply even to Great Britain, where certain of the principal export trades have been the heaviest sufferers For "most of the trades in question are also essentially producers of capital goods which invariably suffer worst during depression, even though they produce for home consumption only They are also the trades which were over-expanded during the war and for the production of which there is now neither home nor foreign demand on the same scale as before" (*Unemployment*, 1920, 1923, p 113. International Labour Office).

But though fresh light has thus been shed upon some aspects of our more normal economic life, especially upon its financial side, the war-origin of these phenomena disqualifies this depression from figuring as a safe study for those who seek to understand the more regular cyclical movements of industry.

II. THEORIES OF CYCLICAL UNEMPLOYMENT

The Physical Theory.—For convenience the explanations of the origin and causation of cyclical unemployment may be placed in five classes, not indeed mutually exclusive but presenting different aspects and starting points

The first may be termed the physical theory, dealing with the meteorological factor in trade fluctuation, which first came to the attention of economists in the work of W. S Jevons, who claimed to establish a connection of the appearance of sun spots with climatic conditions affecting harvests, and thereby the productivity and purchasing power of the world Though later astronomical records give no support to the sun-spot theory, attempts have been made by H S Jevons and Sir W. H Beveridge to relate climatic variations with food supplies and general trade But though there is nothing inherently improbable in such correlations, the case presented in statistics is not convincing, even if allowance is made for what may be called accidental lags The restricted scale of the crop-records, both as to areas and kinds, the dubious reliability of the earlier records, the combination of various minor and major waves, the overlapping of supplies from year to year, especially in modern times, the limited effect which such crop variations as are shown could exercise upon the total industrial activity, deprive this class of explanation of any claim to more than a minor speculative interest.

That variations in harvests, if they are considerable and widespread, will exercise some influence upon industrial output, transport and employment, is undeniable. If foodstuffs and raw materials are produced in diminished quantities at higher selling prices, the processes which work them up, carry and distribute them, will be reduced in the employment they afford, not, however, necessarily to an extent corresponding with the crop-shortage. The effect will be greater when trade is very active than when sluggish and over-stocked. The argument, often stressed, that in bad seasons the agricultural classes, having less spending power, will reduce their purchases of other goods and services, and so spread depression, cannot be accepted without qualifications. If it were true, as is sometimes held (*e g.*, Hull, *Industrial Depressions*, p. 45, etc.) that small crops often bring in as much money as big crops, the argument would of course collapse. But the varying elasticity of demand for different articles makes it pretty certain that a widespread bad harvest has some effect in reducing the purchasing power of the rural population. Moreover, the rise in food-prices will reduce the expenditure of the industrial classes upon other goods, causing a total shrinkage of demand that must affect employment But having regard to better crop information, quicker and more reliable transport over wide areas, improved finance for stimulating, moving and marketing raw products, better instruments for storage and preservation, climatic causes ought to play a constantly diminishing part in cyclical fluctuations

The Accidental Theory.—Under this head may be placed those who, discarding all general views of causation, impute trade depressions to a variety of unconnected occurrences, sometimes political, such as wars and revolutions, or natural, such as droughts or floods; or business, such as the collapse of active railroad enterprise; or financial, such as a banking crisis Local troubles, thus brought about, spread by contagion or infection, until they have depressed the entire industry and commerce of large sections of the world It is undeniable that one or more of such injurious occurrences, a bad monsoon, a war or revolution, a "Black Friday" or an Australian bank collapse, may play quite a distinguishable part in precipitating a crisis of trade and ushering in a period of depression. But most of these events belong to human conduct and are due to economic forces wider and longer in their operation than the catastrophic acts which figure as immediate causes of financial or industrial trouble. There is sufficient regularity in these cyclical fluctuations to enable us to dismiss as inadequate the view that regards them as pure accidents

The Psychological Factor.—Business action is so dependent upon beliefs and feelings that some economists use language implying that industrial prosperity and depression are little else than reflections of a rhythmic movement of confidence and dejection in the minds of men. This psychological rhythm, operating upon industry through credit (the financial index of confidence) they regard not merely as an accompaniment and agent, but as the chief efficient cause of industrial fluctuations. Starting with the assumption that the business mind is by nature prone to these alternating elations and depressions, and that they are quickly and easily communicated by business leaders to the rank and file, the theory of independent psychological causation becomes plausible In times of rising confidence business men seek to borrow freely from the banks, and the investing public to extend their profitable business operations Bankers, sharing the confidence of their customers, make large advances upon reasonable terms at such times, and new capital is forthcoming to extend existing businesses and open new ones. This wave of confidence having spent its force in thus stimulating credit and industrial activity, begins to subside; credits are restricted or called in, because of a belief that trade is going down, and this belief and restriction are the means of reducing the volume of commerce and contracting business operations This separate presentation of the psychological movement, however, is uncommon. The connection of these fears, hopes and illusions with "credit" is so close and obvious that it is here we must seek for the connection between the moral and material aspects of a cyclical fluctuation If everyone bought with his own money alone, business operations, though more restricted and less productive, would be subject to smaller variations in volume and value. The worth of the credit and investment systems is that they permit the rapid seizure of opportunities for profitable expansion of industrial activity. The concrete productive forces of land, capital and labour are thus handled to greater advantage.

Courses of the Cycle.—How credit actually operates in the cyclical movement is best seen by following the general course which such a cycle takes. In tracing this course it is well to begin from the start of a trade revival. When a depression with low production, low prices, profits and employment, has continued for some time, the excessive stocks which, because they could not get sold fast enough, congested the wholesale markets at the

beginning of the depression and brought prices down, show signs of approaching depletion. It becomes evident that the current rate of production will soon be inadequate to meet the effective demand at the present low level of prices, and that, to stimulate production, prices are going to rise. Merchants handling wholesale trade are usually most sensitive to the situation, and are the first to take action. Anticipating an early expansion of sales at higher prices, they seek to make contracts with manufacturers and other producers for future delivery of materials and goods upon a larger scale. These producing firms seek to replenish their lowered stocks of raw materials, fuel, etc, to improve and enlarge their plant and to take on more labour The fundamental and instrumental industries such as mining, iron and steel, engineering and shipbuilding, where depression and unemployment have been deepest, must set to work at once in order to make timely provision for the renewed activity in the later stages of production Merchants, manufacturers and makers of instrumental capital must all seek the assistance of banks for the means of making these expansions Since bank customers during a depression find a difficulty in getting safe or lucrative investments for their savings, bank deposits are swollen, and partly from this source, partly from the banks' own resources, the credit required, both for increased working capital by short loans, and for more permanent investment, is obtainable from the banks and the investing public

The limits set upon such expansion are slow to appear. For, in the earlier stages of the process, the well-founded conviction of bankers that there is a genuine revival of trade which permits them with safety and profit to make advances to customers, and the possession of large unused cash reserves, seem to make liberal credits a good banking policy Thus business men are able to go ahead with increased production, absorbing the capital and labour that had lain unemployed, and enlarging the volume of output and sales at prices which yield an increasing margin of profit But, when the movement has gone a certain way, two things happen As soon as the productive power of industry, especially in the great machine trades, has been in full play for a little time, merchants begin to realize that they can get quicker deliveries on easier terms than when the revival began, and as prices are still high and profits large, they become speculative holders of large supplies, applying to their banks for credit to assist them in this policy The confidence which a genuine revival has inspired, and the belief that prices will go higher still, induce the banks to aid and abet what is in reality a speculative boom in which prices for a time may rise higher than the level to which the industrial boom has brought them It is now generally recognized by financial experts that insufficient knowledge of actual trade conditions is largely responsible for carrying the cyclical wave of prices to an excessive height by this undue use of credit

The other thing that happens is even more crucial in its consequences In the revival of trade the rise of wages continually lags behind the rise of prices This means high profits for traders, and no considerable risk for bankers with their large cash reserves. But when the revival has reached its height and prices remain fairly stable at a high level, wages creep up and the workers demand their share of the prosperity This brings simultaneously a cut in profits, that in some measure weakens the borrowing power of the business man, and a reduction of the bank reserves of currency to meet the weekly demands of the higher wage-bills As cash reserves are reduced, the banker takes alarm, and, following his customary policy, raises his rates, restricts further credit and calls in loans This forces weaker business men to realize on their stocks, prices hurtle down, orders fall off, production slackens and unemployment sets in The fall of prices, accompanied by a fall in profits and later on in wages, does not stimulate enough increase of demand to check the process of depression. So the circle comes round.

This presentation of the cycle tends to support the view that trade fluctuations are pre-eminently credit cycles, the efficient causation of the movement coming from the money side There are those who hold that a stronger, clearer-sighted and more disinterested banking policy could stop altogether great trade fluctuations, except so far as they might be due to great natural or political interferences. If bankers, they argue, would rigorously check further emissions of credit to traders when industry had reached its full activity with capital and labour fully employed, the speculative part of the boom with its rocketing of prices would be stopped. Or if, again, they were more cautious in restricting credit later on when the tide was beginning to turn, the collapse of prices and restriction of output which ensued might be avoided A more judicious and public-spirited bank policy might, at any rate, cut off the peak of the trade curve and maintain a large degree of stability of prices and production. The prime cause of unemployment, according to this diagnosis, is the inelasticity of the modern monetary system.

The Under-consumption Theory.—A fourth school of thought fastens upon under-consumption, or the failure of consumption to keep full pace with the swelling current of production, as the main efficient cause of unemployment Their argument runs thus: In any economic society, the current condition of the arts of production and standards of consumption will determine, not only how much productive power of capital and labour can be economically employed in the several processes of industry and commerce required for turning out the different sorts of consumable goods in their due proportions, but also how much of the current income should be applied to taking out consumable goods for consumption, and how much to stimulating the increase of productive capital in the various processes of industry. If too little is expended in the latter way, *i e*, if savings are small, then there will be an insufficient provision for a rising standard of living for a larger population in the future. If too much is "saved" and too little "spent," there will come into being a larger amount of productive capital in plant, tools, materials, etc, than is required to turn out the consumable goods that get bought and consumed Though any individual, or group of people, may save as large a proportion of their income as they like without inconveniencing the economic system, economic society as a whole is restricted in the proportion of the general income that can usefully be saved by the condition of the arts of industry

In a primitive society very little industrial capital can be utilized. a modern industrial society affords a great scope for saving and investment But there is always a limit in the proportion of income that can be economically utilized as new capital If that limit were passed, too much capital being created for the supply of the quantity of consumables that were purchased for consumption, a stoppage of industry would take place, some of the industrial plants standing idle or half-used, with a congestion of unsaleable goods accumulated either earlier or later in the processes of production. The actual over-production of consumables, or even capital goods, need not go far; the real mischief will consist in the slowing down of the entire process of production with a stoppage of the worse-equipped or worse-placed plants As this productive plant slows down or stops, a corresponding body of unemployment is created Real and money incomes are thus reduced: profits, the main source of industrial savings, shrink, most other business incomes fall, so that the proportion of savings is let down for a time far below the true normal. Spending does not fall proportionately, so that gradually the congestion of the economic machine is released, goods being taken out faster than they are being replaced. Weaker firms, during the depression, have gone out of business, and little new plant has been created.

When this double process of depleting stocks and letting down plant has gone so far that irreducible consumption is tending to exceed current production, prices begin to turn upwards; the indication of an approaching revival of trade stimulates merchants and manufacturers to prepare for the revival. That preparation involves primarily a renewed activity in the fundamental and instrumental industries, in order that more manufacturing plant and larger supplies of raw materials may be ready for the expansion in the later processes. The mining, metal, engineering and transport trades, which depression had hit hardest, revive earliest and fastest, for their increased output is a prior condition to full activity in the manufacturing processes. For this process of revival an expansion of bank credit and of currency is a necessary

instrument and adjunct, but the efficient causation of the movement does not proceed therefrom

A variant of this under-consumption theory attributes depression to an over-investment in the instrumental and constructional industries, due to an over-estimation of the intensity of future wants which, operating in the immediate interests of the business classes, restricts consumption by putting an excessive proportion of productive power into industries the consumable fruits of which are long delayed and cannot in fact justify the amount of productive energy directed into them. The position is thus stated by Mr. Denis Robertson —

Since each new investment, once it is made, will be capable of functioning for a considerable period, the rise in the utility of new constructive goods will often in any case only be temporary, a point will be reached beyond which any further investment would involve a sacrifice of present enjoyment disproportionate to the enjoyment which will be afforded by the new consumable goods which it is proposed to create. In fact, however, owing to the stress of competition, aggravated by the length of time which must elapse before the new instruments projected can be brought into working order, investment is likely to be carried beyond this point (*Study of Industrial Fluctuations*, p. 240–1.)

This view, that an opposition of interests exists between the investing classes on the one hand and the working-class consumers on the other, is reinforced by the writings of Mr Veblen (*see* especially *The Engineers and the Price System*), who charges the former with practising a sabotage of industry, by chronic restriction of productivity and output in order to make larger profits out of regulated prices

Over-population Theory.—Neo-Malthusians often explain unemployment as a necessary implication of the tendency of population in certain countries, or in the world, to increase faster than the means of subsistence, or the growth of the fund of capital required for their employment under modern industry From the assumption that a given area can only support a limited population in employment upon such a standard of living as is required to sustain a family, they argue that in many countries the limit has been passed, and that though there may be other areas capable of bearing larger populations than exist at present, the transfer from over-peopled to under-peopled areas is so much impeded as to leave in the former a considerable surplus over the normal economic requirements of the labour market Though for a time, in certain favoured lands, the pressure of the law of diminishing returns to agriculture may be offset by high productivity of manufacture, the surplus of which may be used to purchase increasing supplies of foods and raw materials from newly developed lands, the difficulties of this economy increase as the more fruitful of the backward countries advance in population and in the development of their own industries

Moreover, the restrictions of tariffs on the one hand, and free migration on the other, make the natural adjustments more difficult The World War not only stopped the normal emigration by which congested European countries relieved themselves, but stimulated the erection of new barriers, especially by checking the flow of European labour into the United States On the other hand, the losses of the war and the lower birth-rate and reduced growth of population signify a considerable reduction in the numbers entering the labour-market in these countries, especially later on when the full force of the lower birth-rate is represented in adult numbers So far as a reduced population carries with it a better distribution of income, through higher wages, it may, in accordance with the under-consumption theory, stimulate a larger volume of demand and more employment But statistics do not sustain the view that comparatively sparsely peopled countries like the United States, Canada and Australia, escape periods of unemployment as large proportionately as those of thickly peopled Europe. While, therefore, the world volume of employment is evidently increased by mobility of labour, as of capital, from one country to another, retardation of migration cannot be regarded as a major cause of cyclical depressions and unemployment.

III. REMEDIAL MEASURES

Commercial Organization.—The remedies for unemployment, of course, vary with the different theories of the causation of the trouble. Orthodox economists, attributing it to a combination of unpredictable natural causes and business miscalculations, chiefly rely upon improved organization of markets, communications and finance, to reduce and alleviate the fluctuations. Even the natural causes can be considerably abated by increasing the dispersed sources of supply, and by better crop hygiene But their main remedies are fuller and more reliable statistics, better business education, publicity of trade information, sound banking, with its steadying effect upon the minds and methods of business men, and, finally, the more controversial proposition of a willingness of organized labour to assist the recovery of trade by accepting lower wages when prices and profits have fallen. Misapplications of productive power, with their attendant losses and stoppages, could thus be averted Business men, investors and workers would have the fuller confidence and security which better understanding of all factors in the business situation gives Planning would be improved, speculation would be more enlightened and greater stability of industry, prices and credit would exist This view is stated in the following terms by Sir W H Beveridge (*Unemployment*, p 193).—

Unemployment is a question not of the scale of industry but of its organization, not of the volume of the demand for labour but of its changes and fluctuations The changes are of several types Trades decay or are revolutionized by new machines Through these changes particular parts of the labour supply get displaced Unemployment arises through their difficulty in getting re-absorbed The fluctuations, also, are of several types, some co-extensive with the economic life of the nation, some peculiar to certain trades, some purely local or individual To meet these fluctuations—cyclical, seasonal and casual—there are required reserves of labour power. Unemployment arises as the idleness of these reserves between the epochs when they are called into action. The solution of the problem of unemployment must consist, therefore, partly in smoothing individual transitions, partly in diminishing the extent of the reserves required for fluctuation or their intervals of idleness, partly, when this plan can go no further, in seeing that the men of the reserve are properly maintained both in action and out of it The problem is essentially one of business organization, of meeting without distress the changes and fluctuations without which industry is not and probably could not be carried on It is not a problem of increasing the mere scale of industry. It is not a problem of securing a general balance between the growth of the demand for labour and the growth of the supply—for this general balance is already secured by economic forces—but one of perfecting the adjustment in detail.

Banking and Currency Control.—Those who hold trade cycles to be pre-eminently credit cycles seek remedies for depressions and unemployment in a more intelligent control of banking and currency Since these fluctuations are brought about by price changes, the aim should be to stabilize prices, or at any rate to keep the fluctuations within narrow limits If any economic events, affecting the supply of goods, tend to raise or lower prices, the supply of money should be increased or diminished so as to compensate for such disturbance A depression in which capital and labour lay unemployed because prices were too low to cover costs of production should be met by emissions of credit which by raising prices would stimulate industry These small doses of inflation would, it is contended, enable industry to absorb the unemployed capital and labour, by raising prices to a level which sufficed to yield reasonable rates of wages and profits. Then, when industry was brought into full activity, prices should be stabilized at that level, and a monetary policy devised to keep them stable Some financial purists, objecting to the inflationary method, would wait for general trade causes to produce a revival and would then apply the stabilizing policy

There are various methods advocated for stabilization Some are based on the retention of the gold standard The volume of currency could be expanded or contracted by increasing or reducing the quantity of gold in the unit of account This is the essence of Professor Irving Fisher's proposal of a "compensated dollar" Others would follow an elastic policy of expansion or contraction, operated by a central bank in conjunction with the Government, whereby alterations in the discount rate should be fortified by a selling or purchase of public securities Others, again, regarding a gold standard as a hampering factor in the situation, would regulate the quantity of credit and currency by exclusive attention to the demands of trade, at any rate for pur-

poses of intranational payments, gold being retained exclusively for purposes of international exchange pending the possible future development of a reliable federation of national banks pursuing an agreed international policy for the regulation of credit and currency. (*See* MONEY.)

Various critics of established monetary systems in recent years attribute depressions to the failure of the volume of purchasing power to correspond with the actual or potential volume of goods All that could be produced could not get sold, because of the lack of money in the hands of would-be purchasers This is sometimes attributed to the credit system, operated by the "money power," which by financing trade raises costs of production and selling prices to a height greater than the purchasing power distributed among the owners of the factors of production at the various stages. In this view, it is necessary for the State bank, or other money-makers, to provide a supplementary supply of purchasing power in order to furnish adequate markets for all the goods which the economic system could produce.

Taxation and Income.—Between the financial doctors and the under-consumptionists there is this common ground, that both find that the reason why goods cannot get produced in bad times is that there is an insufficiency of purchasing power in the hands of the consuming public to buy them at a price covering their costs. But most under-consumptionists attribute this insufficiency to a maldistribution of income An insufficient proportion of the actual or possible income passes to the classes who would spend most, an excessive proportion to those who would save most This, as we saw, leads to an attempt to put into concrete shape and activity a larger quantity of capital than can function productively in turning out the volume of consumable goods which can be taken out of the productive system to be consumed Those who accept this diagnosis find the only valid remedy in measures for a better, or more equal, distribution of income Measures of taxation, devised so as to take rents, excess profits, windfalls and other elements of income that are "surplus," in the sense that they do not evoke productive efforts from the recipient, and apply them economically to sound purposes of current public expenditure, make for this better distribution So do political or non-political actions that raise the proportion which workers take in wages out of the general income of the country Economists favourable to a socialist or labour policy generally hold that a sound test alike for preventives and remedies for unemployment is the absorption of "surplus" income in wages or in public revenue

Palliative Measures.—The different views of the origin of unemployment affect the attitude of business men, politicians, workers and economists, towards the measures adopted in various countries for the alleviation of the burdens of actual unemployment upon the working classes and the community. Leakage between jobs and other minor wastes may be repaired by employment exchanges where out-of-works may apply for vacant posts Quick, full and reliable information may here greatly help the mobility of labour Trade unions, either working with employment exchanges, or on their own account, make it their business to find vacant jobs for their unemployed members. In Great Britain there existed at the close of 1924. 382 employment exchanges, 772 branch employment offices and 324 local employment committees, representing employers, workers and certain other bodies. Where trade conditions are largely of local determination, it may be possible for displaced workers to find a job in some other town or district, or even in some other country. Travelling money is provided by many unions, and in certain continental countries, as in pre-war Germany, relief stations are provided in order to enable unemployed workers to move about in search of work.

Another mode of stopping leakages is a decasualization policy, applied chiefly to certain classes of dock labour where the inherent irregularities of the trade are intensified by keeping an excessive reserve instead of tightening up the organization of the trade. Seasonal fluctuations may be similarly remedied by transference from one seasonal trade to another This is probably applicable only to low-skilled work. "Building, with all the country occupations—harvesting, fruit picking, hopping—on the one hand and the gas-works, the docks and all the Christmas demand in the post office and in shops on the other, offer ample material for a start" (Beveridge, p. 210). Schools and juvenile employment exchanges can do much to help a better apportionment of young labour among the occupations. At the end of 1924 there were in Britain 140 juvenile advisory committees attached to employment committees and 145 choice-of-employment committees under local education authorities. Continued education for unemployed boys and girls has made some progress since the war in England, and a beginning has been made in technical or vocational training as a contribution towards improved efficiency of labour and enlarged supply of skilled workers. In Germany vocational guidance has taken on great activity, the number of offices in 1924 being 597, of which two-thirds were working with the employment exchanges

The Ministry of Labour of Great Britain co-operates with Dominion Governments in finding employment overseas for willing emigrants, though the numbers thus placed are small. There are difficulties on both sides, unemployed workers preferring to await the chance of work at home, and the Dominions exercising a rigorous choice in the personnel of those they admit Publicly organized relief works are a device for dealing with unemployment widely adopted in Britain and other countries In England the unemployment grants committee was established in Dec. 1920, to give financial aid to local authorities in executing "works of public utility designed to secure some measure of relief in districts or in trades suffering from unemployment" The committee operates partly by loans of public money, varying from 50 to 75% of the capital costs of the undertaking, partly by grants amounting to 75% of the wage-bill for unemployed men taken on Most of the works thus encouraged were dock and harbour extensions, gas, water and electric supply, roadmaking, sewerage works, parks and recreation grounds, construction of public ferries. In addition to the employment directly afforded by these works, an almost equal amount is provided in factories, etc, for the production of the materials required During the four and a half years' working to June 1925 the estimated capital cost of the approved works was £85,123 371, and the total grants were £68,434,280 The amount of employment thus provided was estimated at 3,181,270 man-months This policy has conformed to the recommendations of the Minority Report of the Poor Law Commission of 1907 in seeking to even out the total volume of employment by allocating public expenditure as far as possible to periods of depression and unemployment.

Insurance Against Unemployment.—By far the most effective provision for the unemployed is by insurance This began when certain trade unions in Britain and Belgium, about the middle of the 19th century, arranged to pay regular allowances to members out of work. This method of provision has grown in various countries, and has been built into the public insurance schemes of more recent times (*see* SOCIAL INSURANCE) There are various outstanding problems in the development of unemployment insurance policy. The widest is concerned with the question whether the basis of insurance should be general or industrial. The latter view is supported on the grounds that each industry is best qualified to deal with its own risks, which, alike in size and origin, differ from those of other industries. The former view stresses the common needs of the unemployed, the difficulty the more fluctuating trades would find in making adequate provision, and the advantages of one instead of many administrative bodies So far, in countries where compulsory insurance prevails, the general tendency has been towards a single uniform administration, though in the British case certain exceptions are admitted in the 1920 act. Other difficulties arise as to the interpretation of the "suitable employment" which an unemployed person may not refuse, and of the term "involuntary unemployment" when a strike or lock-out throws out of work members of other trades than that directly affected. The Unemployment Insurance Act of 1927 provides that claimants to benefit may be asked to accept work in occupations other than their own, under certain approved conditions. Other questions remain. How far should insurance cover seasonal and short-time unemployment? A large issue remains,

that of the linking up or unification of unemployment with other working class risks in a joint insurance policy. (*See* TRADE CYCLE)

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UNEMPLOYMENT INSURANCE. The National Unemployment Insurance scheme of Great Britain was instituted in 1912 under the National Insurance Act of 1911 Its main object is to provide assistance during unemployment to contributors insured under the scheme.

Prior to 1912 there was no national or other system of compulsory insurance against unemployment The need for providing against the risk had, however, been recognised for some time previously, and from the middle of the 19th century a number of trade unions and friendly societies granted assistance from their funds to their unemployed members This was not, however, by any means a general practice of the unions, for as recently as 1904, the numbers of workers covered by voluntary schemes barely exceeded one million

While British trade unions were among the first to pay allowances to members out of work, the use of public funds for this purpose appears to have been first applied in Switzerland, where, from 1893 onwards, a number of towns and cantons established voluntary funds. In 1895 the first attempt to institute a compulsory system of insurance against unemployment was made at St. Gall, in Switzerland, but this scheme ceased operation after two years A more general and successful method was that known as the "Ghent system," under which municipalities and other local authorities supplemented from their local revenues the benefits paid by trade unions or voluntary unemployment funds to their members. This system of co-operation between the local authorities and the trade unions received most support in Belgium, Holland and France The Poor Law commission recommended in 1909 the encouragement of the voluntary methods of the trade unions and other societies by the addition to the benefits which they paid of a fixed amount from the State or municipality Very shortly after this recommendation was made, however, the first instalment of the present national system of insurance against unemployment came into being Part II of the National Insurance Act 1911, for the first time in any country, provided for a compulsory scheme of unemployment insurance on a national basis.

The 1911 Scheme.—This was admittedly experimental and was applied to certain trades which were regarded as particularly subject to unemployment, viz, building, construction of works, shipbuilding, mechanical engineering, iron founding, construction of vehicles and sawmilling The number of workers in these trades covered by the scheme was rather over 2¼ millions. All workers of the age of 16 and upwards were insured

The broad lines of the scheme of 1911 were that a fund called the Unemployment fund should be created from contributions by employers and employed in the insured trades and by the Exchequer. Out of this fund a worker would be entitled, subject to fulfilling stated conditions, to receive benefit in proportion to the contributions he had paid, subject to a maximum period in each year

Under the act of 1911 the contribution of employers and workers respectively was 2½d each The joint contribution of 5d was paid in the first instance by the employer who was required to affix a special stamp to an unemployment book and was then entitled to deduct 2½d from the worker's wages Reduced rates were payable for workers below 18 years of age. The Exchequer contributed a sum equal to one-third of the total receipts from employers and employed. The total income from contributions for the year 1913–14, the only typical complete year before the war, was about £2,400,000, of which employers and employed contributed about £900,000 each and the Exchequer about £600,000.

The rate of benefit in 1911 was 7s a week (with half-rate between 17 and 18 and nothing between 16 and 17). No distinction was made between men and women as regards rates of contributions or benefit There were in fact very few females in the trades then insured. Benefit was not payable for the first week of unemployment, which was termed a waiting week After that it might be drawn to the extent of one week of benefit for every five contributions paid and for a maximum of 15 weeks in a year.

The main conditions which an insured person had to fulfil before he could obtain benefit were that he should prove that he had worked in an insured trade in 26 weeks during the preceding five years; that he had applied for benefit in the prescribed manner and had since been continuously unemployed, that he was capable of work and unable to obtain suitable employment and that he had not exhausted his right to benefit. In addition to satisfying these conditions the applicant for benefit had to show that he was free from disqualifications—the chief of which were the loss of employment through a stoppage of work due to a trade dispute at his place of employment or through misconduct or voluntarily leaving work The only material alteration made prior to 1920 in the statutory conditions for the receipt of benefit was that instead of having to prove employment in an insured trade for 26 weeks during the preceding five years, an applicant had to show that he had had ten contributions to the scheme paid in respect of him.

The question whether or not benefit was payable to an insured person was decided under a special machinery set up to deal with applications expeditiously The decision was given in the first instance by an officer called an insurance officer, and if adverse to the claimant was subject to appeal by him, or by an association of which he was a member, to a court of referees consisting of an employer, a workman and an impartial chairman Beyond this tribunal there was the possibility of further reference to an umpire appointed by the crown This machinery maintains to-day, although for a time it was supplemented by another procedure which is mentioned later

There were two provisions in the act of 1911 which may be described as encouragements to voluntary systems of unemployment assistance The first permitted an association of workers in the insured trades which paid allowances to its members when unemployed to administer for those members the benefits payable under the act from the State scheme The other provided for the repayment to associations of workpeople, whether in the insured trades or not, of a proportion (one-sixth) of their expenditure on out of work allowances to their members

Two other supplementary provisions of the 1911 act may be mentioned One was intended as an encouragement of regularity of employment If an employer kept a workman in his employ continuously during a year and paid at least 45 contributions in respect of him, he might obtain a refund of one-third of his own share of the contributions The other provision enabled a refund of contributions to be made with compound interest, to a workman who had attained the age of 60 and had paid 500 contributions, subject to the deduction of any benefit he had received since his entry into insurance.

These were the main lines of the scheme embodied in the act of 1911. Benefit could not be drawn as soon as work was lost, there must be a waiting period, it could only be drawn for a limited time and it was not at a subsistence level—it was, and was intended to be, an aid to the insured contributor's own thrift by supplementing his savings or voluntary insurance. In these matters the compulsory national scheme followed the voluntary methods of the trade unions and also avoided many of the dangers inherent in a more generous scheme.

Contributions first became payable in July 1912 and benefit became payable as from January 1913. Very little experience, therefore, had been gained of the working of the scheme before the World War put an entirely different complexion on the industrial situation and the need for a scheme of the kind The two

years from July 1912 to July 1914 were years of good trade, and there was no opportunity to test the soundness of the assumptions and calculations upon which the scheme had been based

The scheme was in the beginning administered by the Board of Trade and later by the Ministry of Labour through the machinery of what were first called the labour exchanges and later the employment exchanges This was a natural, indeed an essential arrangement since it is of the utmost importance that the administration should be in a position to test the genuineness of claims by the offer of suitable employment whenever possible A system of employment agencies was therefore a vital part of the scheme of unemployment insurance

A proportion, one-tenth, of the income of the fund was to be applied to the cost of administering the scheme. While the rates of contribution were low a part of this cost fell upon the Exchequer, but when, under later acts, the rates increased considerably the appropriation thus made from the fund was sufficient to meet the cost of administration in most years

During the World War, employment in the insured trades was good, and while the collection of contributions went on, very little benefit was paid under the scheme The result was a succession of surpluses of income over expenditure down to the end of the war. In 1916 an act was passed which brought into insurance for a period of five years or until three years after the end of the war, whichever was longer, certain additional trades and all munition workers not already insured The chief trades brought in were the metal, chemical, rubber, leather and ammunition trades Thus the total number covered by the insurance scheme at the end of 1916 was about 3¾ millions, of whom about 1 million were females These workers were brought into the scheme because it was anticipated that there would be considerable unemployment amongst them on the cessation of hostilities No changes were made in the rates of contributions or benefit or in the general conditions.

The Out of Work Donation.—It is necessary to mention here as a step towards the development of the national system of unemployment insurance, the scheme of "out-of-work donation" which was instituted to cope with the serious unemployment which ensued on the termination of hostilities in Nov. 1918 both amongst ex-service men and women returning to civil life and the non-service population who had to turn over from war-time to peace occupations This was, however, no part of the then existent unemployment insurance scheme—indeed it took the place of that scheme for some time

The rate of donation payable under this scheme varied from 29s to 20s a week for men, and from 25s to 15s a week for women with supplementary donation of 6s a week for the first dependent child and 3s a week for each additional child. Civilians were allowed up to 26 weeks of donation during the twelve months for which the scheme applied to them, while ex-service men and women were allowed up to 89 weeks of donation if unemployed for so long, within the period from Nov. 1918 to March 1921, for which their policies were available. Upwards of £40,000,000 was paid under the scheme to ex-service men and women and upwards of £21,000,000 to civilians *No part of this money came from the unemployment insurance scheme.* It was all provided by vote of parliament.

During and immediately after the war the subject of unemployment insurance was examined by a number of committees, all of which reported in favour of the extension of the scheme. The institution of the out-of-work donation scheme and the need for awaiting the resettlement of industry into its peace time occupations postponed for a time the extension that was generally anticipated and desired, but in Dec 1919 a bill for this purpose was introduced and was passed into law in Aug. 1920.

The Act of 1920.—The Unemployment Insurance Act, 1920, repealed all earlier enactments and is still (1929) the principal act under which the scheme operates. It came into force on Nov. 8, 1920 and brought into insurance an additional eight million persons, making with those insured under the earlier acts, a total of about 11¾ million persons insured against the risk of unemployment. The scheme as extended by the act of 1920 applies to all persons of 16 years of age and upward employed under a contract of service or apprenticeship (except apprentices without a money payment), save those in certain excepted employments, the chief of which are agriculture and private domestic service. The permanent employees of Government departments, local authorities, railways and general utility companies may also be excepted. Non-manual workers in receipt of remuneration exceeding £250 a year are also excepted. Contributions cease to be payable by the employed person, and he ceases to be entitled to benefit, on reaching the age of 65, but the employer remains liable for his share of the contributions. No material change has been made in the scope of the scheme since 1920, save that workers in the Irish Free State and in Northern Ireland are now covered by schemes of their own

Exemption from the scheme may be obtained by persons in receipt of any pension or independent income of £26 a year or more and by persons ordinarily and mainly dependent for their livelihood on some other person or in an uninsurable occupation. An exempt person is not himself liable to contribute to the scheme but his employer remains liable for the employer's share. Both in this case and in that of the person over 65 the reason for requiring payment of the employer's share of the contribution is that there shall not be any premium or inducement to employ an exempt rather than an insurable person. The number of exemptions current is rather under 30,000.

The main features of the scheme as launched in 1911 were retained in the greatly extended scheme of 1920. Contributions were levied on the same three parties, viz, employer, employed and the Exchequer, and, as the scheme was introduced to parliament, the shares of each party were to be in the same proportion as in 1911. Owing, however, to changes made during the passage of the bill, changes which increased the cost of the scheme, the contributions of employer and employed were increased and, instead of being, as intended, in the case of adult male contributors, 3d from employer, 3d from employed, and 2d from the Exchequer, the amounts became 4d, 4d and 2d respectively. Thus, instead of paying one-fourth of the total contribution, the Exchequer paid one-fifth. Benefit was payable in proportion to the number of contributions previously made and subject to a maximum of 15 weeks in a year—again as in 1911, but instead of one week of benefit for every five contributions, the rule was one week's benefit for six contributions, hence the "1 in 6 rule" The weekly rate of benefit was increased. In 1911 it was 7s a week for men and women alike. This had been raised in Dec. 1919 to 11s a week The act of 1920, following the precedent of the out-of-work donation scheme, prescribed different rates for men and women respectively, the former being entitled to 15s and the latter to 12s. Boys of 16 to 18 received 7s 6d. and girls of the same age 6s a week

The "waiting period," for which benefit is not paid at the beginning of a spell of unemployment, was retained, but it was reduced from six days to three days This was the most costly alteration made during the passage of the bill through parliament, and was largely responsible for the increase in the contributions. The earlier days of unemployment are necessarily the most expensive in any scheme of unemployment insurance, since many more people are unemployed for one day than for two, for two days than for three, and so on Therefore, not only would many more persons become entitled to benefit although they were unemployed for only four, five or six days than would be entitled to it if the minimum period to qualify were seven days, but those who were unemployed for more than six days would become entitled to three days more

Statistical Basis of the Scheme.—Upon the data available when the act was being framed it was assumed that over a period or cycle of good, bad and average years of trade the rate of unemployment among workers in the trades to be insured would be 4%. The act of 1920 contained, as explained later, provisions enabling industries to contract out of the general scheme. It was estimated that after allowing for the withdrawal of those industries that might be expected to contract out the industries that remained in the general scheme would have an unemploy-

ment experience of 5·32% over a cycle. It was upon this basis that the finance of the scheme was founded. As will appear, there has so far (1928) been no opportunity to test the soundness of the assumptions as to the rates of unemployment or of the financial basis of the scheme as passed, and having regard to the very material alterations in the contributions and benefits which have since been made no test is now practicable. The conditions and disqualifications for benefit were almost identical with those under the act of 1911 and need not, therefore, be repeated The machinery of adjudication upon claims, viz., the insurance officer, court of referees, and the umpire, was maintained.

The act of 1920 contained two provisions for enabling persons who would not otherwise have been qualified to draw benefit under the scheme The first was of a permanent character and was to the effect that men discharged from the Forces should be given a free credit of contributions to enable them to receive up to the maximum period payable during twelve months; this was at first 15 weeks, and later 26 weeks in a year. The other special qualifying condition was temporary It was, that during the first twelve months of the scheme benefit might be paid up to a maximum of eight weeks as soon as an insured person had paid four contributions This was to provide for the unemployment of new entrants who would have had no opportunity to satisfy the normal first statutory condition, viz., the payment of twelve contributions. Even this relaxation of the normal condition did not prove adequate to meet the situation which arose The act of 1920 began to operate just when the severe industrial depression which has since continued first began to affect employment. Many persons who normally would have been at work and paying contributions found themselves unemployed without having paid the necessary qualifying number of contributions To meet this position a short act was passed enabling eight weeks of benefit to be paid to persons who had been engaged in insurable employment during ten weeks since Dec. 1919 or during four weeks since July 1920. Even this proved insufficient, as will be shown

The right of employers to receive a refund of a part of the contributions paid in respect of workmen in their regular employment was not continued, but the practice of refunding to workmen their share of the contributions paid in respect of them less any benefit they had received, was retained This right of the workmen was, however, abolished in 1924

An important new feature was included in the extended scheme of 1920. Power was given to an industry to set up a special scheme of unemployment insurance for itself and so contract out of the general scheme. Such a scheme when approved had statutory force and effect and was binding on all employers and workers in the industry. The chief conditions which applied to a special scheme, were that it must cover all persons employed in the industry, the benefits must be, on the whole, not less favourable than those provided under the general scheme; the State contribution would be on a reduced scale; and the scheme would be administered, not by a government department, but by a joint body of employers and employed in the industry. The object of this provision was, no doubt, to sweeten the pill of compulsion and to allow those industries which had low rates of unemployment to set up schemes of their own, which they could administer on lines which would be more suited to their particular needs than those of the general scheme, framed as it necessarily was, to meet the general requirements and conditions of industry as a whole.

It was expected that several industries with low rates of employment would contract out of the general scheme and a number prepared to do so. The severe trade depression which began in the autumn of 1920, however, changed the position so materially that special schemes became financially impracticable for most of the industries. In the result only two industries succeeded in forming special schemes, viz, the insurance and banking industries. The power of contracting out was suspended as from July 1921 and was abolished by the act of 1927. The present position, therefore, is that no further contracting out by industries is possible. The State contribution to special schemes was abolished by the act of 1924; the two existing schemes are therefore entirely dependent on contributions paid by the industries themselves.

Another new feature of the extended scheme of 1920 was the power given to an industry to set up a supplementary scheme for the benefit of workers in the industry, instead of contracting out of the general scheme. Such a supplementary scheme might provide for higher rates of benefit, for benefit during partial employment as well as unemployment and for benefit during periods when it was not payable under the general scheme, *e g*, during the waiting period. Advantage has not been taken of this provision by any industry.

Put shortly, the scheme as extended by the act of 1920 covered practically the whole of the working population which was subject to any considerable risk of unemployment. It brought into partnership in the scheme the employer, the employed and the State, and by means of a moderate contribution from each of them created a fund from which reasonable benefits would be paid to unemployed insured persons in proportion to the contributions they had made when in employment. While there were what may be called trimmings, this was the effect of the main provisions of the act of 1920.

Fourteen Acts (1920–1927).—Since the principal act of 1920, no less than 14 acts of parliament were passed down to the end of 1927 dealing with unemployment insurance, while contributions under the scheme were dealt with in two other measures. The need for this mass of legislation lies in the wholly exceptional trade depression which began in the autumn of 1920, just when the scheme commenced, and has continued ever since (1928) These several acts have had one main purpose, viz., to enable benefit to be paid to those persons normally employed in the insured trades who were unable to satisfy the usual requirement of the prior payment of contributions

Under the act of 1920 an insured person who satisfied the conditions and was free from disqualification, was entitled as of right to receive benefit in proportion to his contributions. This may be described as the covenant between himself and the scheme The legislation which followed the principal act brought into existence a system of additional benefit which was first called "uncovenanted" and later "extended" benefit which, except for the period from Aug. 1924 to Aug 1925, was not drawn as of right, but only if, in the opinion of the Minister of Labour, as the minister responsible for the administration of the scheme, it was expedient in the public interest to allow benefit in any individual case.

Uncovenanted Benefit.—Persons who desired to obtain the advantage of this extended system of benefits although they had exhausted all their contributory rights, or even although they had paid no contributions at all, were required not only to fulfil all the usual conditions for covenanted benefit (except those relating to contributions), but also to satisfy certain additional conditions These extra conditions varied somewhat from time to time, but in the main they required the claimant to show that he was normally employed in an insured trade, that he had done what, in the circumstances of his case, could be regarded as a reasonable amount of work in a recent period, and that he was making every reasonable effort to obtain work suited to his capacities

The various measures dealing with uncovenanted benefit proceeded for some time on the basis of allowing it to be drawn for a stated number of weeks during certain periods which were termed "special periods" It was found that the provision so made did not meet the needs of the case and that many insured persons who were genuinely unemployed were obliged to apply to the poor law authorities for relief, during the intervals, or "gaps" as they were termed, between the periods for which benefit was payable. From time to time the number of weeks for which benefit might be drawn during the "special periods" was extended and increased and the "gaps" were reduced in length and finally abolished

The additional conditions which had to be fulfilled by recipients of extended benefit were in general of such a character that they did not readily lend themselves to precise adjudication or determination by the authorities set up to give decisions on the normal conditions Partly for this reason, partly in order to ease the burden which would otherwise have fallen on the ordinary machin-

ery, the work of advising whether or not extended benefit should be allowed in individual cases was given to the local employment committees, bodies which had been appointed by the Ministry of Labour to advise him on the employment position in the areas of the employment exchanges and generally on the work of the exchanges

These committees were representative of the employers and employed in each district and had additional members nominated by other bodies such as boards of guardians and ex-service men's associations The committees, in view of the magnitude of their task, co-opted a number of local persons to act as rota committees for the purpose of dealing only with claimants to extended benefit. These committees over the period from 1921 to April 1928, when their functions in regard to extended benefit ceased, have rendered a great service to the community.

As a further means of meeting the need for exceptional assistance to the unemployed a measure which, in its title, was described as a "temporary provision," was passed in Nov 1921, by which an insured person in receipt of unemployment benefit became entitled to receive in addition 5s. a week for his dependent wife and 1s a week for each dependent child This act was intended to operate for six months only, but the provision made under it for adult and juvenile dependants was made part of the general unemployment insurance scheme early in 1922 The classes of persons in respect of whom the 5s allowance might be paid were also extended and the rate for children was increased to 2s a week.

Cost of the Depression.—In order to meet the increased expenditure due to the long continued depression and to the grant of extended and dependants' benefit the contributions of all three parties—employers, employed and the Exchequer—were raised and power was given to borrow up to £30,000,000 The contribution in respect of a man became 2s 1½d, borne as to 10d by the employer, as to 9d by the employed and as to 6½d by the Exchequer This was, later, reduced to 1s. 9d, the three parties paying 8d, 7d, and 6d respectively. There have been variations also in the rates of benefit. Starting in 1920 with 15s for men and 12s for women these rates were raised to 20s and 16s respectively in March 1921, but were reduced to 15s and 12s again from the end of June 1921 As from Aug 1924 they were again increased to 18s for men and 15s for women The changes in rates under the act of 1927 are mentioned later

It is right to say that the various acts of parliament passed from the end of 1920 to 1926 inclusive were all regarded as emergency measures and that the extended benefit paid under them has been regarded as paid in advance of future contributions. No separate account has been kept of the cost of extended benefit but for some time before April 1928 probably more than half the persons in receipt of benefit were drawing extended benefit The amount of the debt has varied considerably. The borrowing power was first exercised in July 1921. By the end of the year the debt was £7,000,000 It reached £17,060,000 in March 1923, but fell to £5,000,000 in 1924 It rose again to nearly £25,000,000 in March 1927 largely in consequence of the severe unemployment due to the coal dispute which lasted for six months or more in 1926.

During 1925 and 1926 the whole subject of unemployment insurance was examined by a committee under the chairmanship of Lord Blanesburgh They made a number of important recommendations for the amendment of the scheme with a view to putting it on a sound and permanent basis In particular they advised the abolition of the dual benefit system, *i.e.*, the concurrent existence of standard and extended benefit. The recommendations of the committee were accepted in principle by the Government, and with one main exception were passed into law by the Unemployment Insurance Act of 1927. That act made a number of changes in the scheme, dealing amongst other matters with the rates and conditions of benefit, the creation of a class of young persons between 18 and 21 years of age, the abolition of extended benefit and of contracting out. The present position is that from April 1928 there has been only one kind of benefit, the grant of which has not been subject to ministerial discretion based upon recommendation of local rota committees, but to determination by the normal machinery of insurance officer, courts of referees and umpire.

The governing condition of the scheme as amended by the act of 1927 is the payment by the claimant for benefit of 30 contributions during the two years preceding the claim. During a transitional period which will end in individual cases between April 1929 and April 1930 this condition is relaxed in favour of claimants who can prove that they satisfy an easier contribution test, that they normally work in an insured trade and that they have done such an amount of work in the last two years as is reasonable in the circumstances of the case

The Scheme in 1928.—As a result of this legislation and subject to the relaxation mentioned above during the transitional period, the broad outlines of the scheme as it was in 1928 may be stated as follows

(1) With certain exceptions, the scheme applies to workers over 16 years of age in all industries save agriculture and private domestic service, the insurance and banking industries have separate special schemes of their own.

(2) Contributions are payable by employers, employed and the Exchequer, the rates for an adult male being at present 8d, 7d and 6d respectively, lower rates apply to women and young persons.

(3) Benefit is payable at the following weekly rates.

Unemployment Insurance Benefits

	Males	Females
Persons of 21 years and over	17s	15s
,, ,, 20 ,, of age	14s	12s
,, ,, 19 ,, ,, ,,	12s	10s
,, ,, 18 ,, ,, ,,	10s	8s.
,, ,, 16 and 17 years of age	6s	5s

(4) Benefit is payable in respect of an adult dependant at the rate of 7s a week and for dependent children up to 14 years of age (and exceptionally up to 16 years of age) at the rate of 2s. a week.

(5) No benefit is paid for the first week of unemployment.

(6) The principal conditions for the receipt of benefit are

(a) The payment of 30 contributions during the last two years,

(b) Making a claim for benefit and proving continuous unemployment,

(c) Being capable of and available for work,

(d) Genuinely seeking work and being unable to obtain suitable employment

(7) Benefit is not limited in proportion to the number of contributions previously paid, nor is it restricted to a given number of weeks in a period, but after thirteen weeks have been drawn in a period of six months the claim is referred to a court of referees for review; moreover the "30 contributions rule" has to be satisfied at the commencement of each quarter

(8) A claimant is disqualified for benefit if he loses his employment by reason of a stoppage of work due to a trade dispute at his place of employment or if he has left his employment voluntarily without just cause or been dismissed for misconduct

(9) Benefits may be administered by Associations on behalf of their members

(10) Industries may set up supplementary schemes, but may not contract out

The principal matter on which the act of 1927 did not follow the recommendations of Lord Blanesburgh's committee was in regard to the proportions in which contributions should be made by the three contributing parties. The committee urged that both benefits and contributions under the scheme should be moderate in amount, and upon the advice they received as to the degree of unemployment which might be anticipated over a period of years, viz, six %, they stated that the total contribution required to be levied in the case of a man in order to provide the benefits they recommended was 1s 3d a week. This, the committee said, should be paid in equal shares by employer, employed and the State, and in order to liquidate the debt with which they anticipated their new scheme would start, they suggested an extra 1d. a week from each of the three parties, the extra 3d. thus raised being earmarked for debt extinction. Instead, however, the act of 1927 fixed the contribution for a man at 1s. 9d. instead of 1s. 6d without any part of it being specifically set aside for debt repayment. It is, however, provided that when the scheme achieves a condition of solvency the contributions of the three parties shall be approximately equal

The reception which was given to the report of Lord Blanesburgh's committee and the legislation which followed it may fairly be said to give a clear indication that a national compulsory scheme of unemployment insurance on a contributory basis is now generally accepted as part of the social code of Great Britain This acceptance is, however, no doubt conditioned in several ways. In particular it may probably be asserted with confidence that public opinion would not tolerate a scheme which was so generous in its cash benefits as to constitute a real incentive to idleness and so be a serious menace to the basis of society, nor, probably, would a scheme to which insured persons did not contribute find general acceptance

The general feeling in favour of a national scheme is no doubt largely due to the realisation that the scheme, as it has existed since 1920, has enabled the country to surmount many and serious post-war difficulties with a minimum of economic disturbance and an undoubted relief to national and local taxation which can, to some extent at least be measured by the cost to the Exchequer of the out-of-work donation scheme

Receipts and Payments.—The following table gives in a summarised form the receipts and payments of the scheme from its general extension in Nov 1920 to Dec 31, 1927 —

Receipts

Balance of 1911 and 1916 schemes		£22,210,000
Contributions		
Employers	120,475,000	
Employed	107,934,000	
Exchequer	81,158,000	
		£309,567,000
Miscellaneous		646,000
Deficiency (Approximate)		23,771,000
		£356,194,000

Payments

Benefits to insured contributors	£317,908,000
Expenses of administration	30,833,000
Interest on loans	3,005,000
Refunds of contributions	2,880,000
Miscellaneous	1,568,000
	£356,194,000

These figures show—if the evidence were required—the need which has existed since 1920 for a scheme of the kind. In order to complete the picture the following table of the average numbers of persons registered at the Employment Exchanges as unemployed from January 1921 to December 1927 may be given

1921	2,130,000*	1925	1,228,000
1922	1,606,000	1926	1,385,000*
1923	1,284,000	1927	1,121,000
1924	1,138,000		

*Dispute in the coal trade in both of these years.

The financial position of the British scheme is that there was still in 1928 a debt of upwards of £20,000,000 outstanding. Income and expenditure balance when the numbers of unemployed claimants is slightly over one million Debt repayment was making good progress until 1926 when at about the same moment the contributions were reduced and the national coal dispute threw large numbers of workers in other trades on to the scheme. From slightly over £7,000,000 the debt rose in six months to £22,000,000. Until the debt has been paid off and the unemployment situation has so far improved that the scheme is not only paying its way but there is a reasonable prospect that it will continue to do so, the reduction of the contributions to the level suggested by Lord Blanesburgh's committee cannot be effected

Such opposition as exists to a national scheme of unemployment insurance probably arises from the fear that social dangers must inevitably exist in such a scheme But that fear, so far as it existed, must have been considerably allayed by the finding of Lord Blanesburgh's committee that the cases where benefit had been drawn by persons who had no title to it were relatively few and that that result was "due to the vigilance with which the administration, while dealing fairly with the genuine claimant, guards against abuse." The committee also quoted in their report, in addition to their own view, the conclusion of the secretary of the Charity Organisation society who said that "he began by thinking the abuses (of the scheme) serious, but on enquiry, he had been unable to find them"

Other Schemes.—At the first International Labour Conference held in accordance with the provisions of the treaty of peace it was recommended by the delegates from the nations represented at the conference: "that each member of the International Labour Organisation establish an effective system of unemployment insurance, either through a Government system or through a system of government subventions to associations whose rules provide for the payment of benefits to their unemployed members"

Compulsory schemes exist in eight States, viz, Great Britain and Northern Ireland, Russia, Italy, Austria, Queensland, Poland, Irish Free State and Germany, while voluntary systems aided by the State are in operation in nine other States, viz, Denmark, France, Norway, the Netherlands, Finland, Spain, Belgium, Czechoslovakia and Switzerland

The scope of the several schemes naturally varies in the different countries since the need of insurance against the unemployment of classes of the population varies widely. Even where the system is compulsory it does not extend to everybody subject to the risk On the other hand, where the system is on the voluntary basis with a government subvention it may be applied to classes or persons not covered under the compulsory systems The upper and lower age limits for insurance also vary Again, the conditions to be satisfied under the various national systems differ in points of detail, but there are broad lines of resemblance in most of them For instance the unemployment against which the worker is insured is involuntary unemployment Nor will he be paid benefits under the schemes if there is suitable employment which he can take up In this connection it is worthy of note that in countries which have instituted compulsory systems the example of Great Britain has been followed by setting up systems of employment exchanges by means of which the existence of suitable employment may be known and jobs offered to the unemployed

The loss of work through a trade dispute in which the worker is involved is commonly a reason for disqualification although there are various refinements on this point, *e g*, the duration of the disqualification may be for the period of the dispute or for any period after it has ended until the worker is again employed Voluntarily leaving work without good cause and dismissal for misconduct are also generally grounds for refusal of benefit.

The British requirements of an initial qualifying period during which contributions shall have been paid is a usual condition as is also a waiting period, during which benefit is not payable, at the beginning of a spell of unemployment The British system of fixed rates of benefits is not however by any means universal Several systems provide that benefit shall bear a relation to earnings of the worker when in employment Under the compulsory systems contributions are usually made by employers, employed and the State, although the proportion in which they share may vary. In the case of voluntary schemes administered as they generally are by the trade unions, the employers do not contribute The payments by the workers vary according to the rules of the associations, and the State adds a proportionate contribution

While there are still a few European countries with no national or state-aided scheme of insurance against unemployment it may be said that in Europe generally the ground is fairly well covered In the British Dominions, however, with the exception of Queensland, very little has been done (J. F. G. P.)

UNITED STATES

Although there has been considerable discussion of the English and European experience with public, compulsory unemployment insurance, no such provisions exist in the United States After the great waves of general unemployment in 1914, 1920, and 1921, state insurance received serious consideration, but the prevailing sentiment against it, shared by trade unions and employers alike, prevented action President Harding's National Unemployment Conference, held Sept 1921, provided for an exhaustive study of the various types of unemployment insurance but refrained from recommending State insurance. Such opinion

as there is on the subject appears to be concerned more with the devices of business regularization and stabilization than with unemployment relief

American experiments with unemployment insurance, the bulk of which came into existence after 1920, are all of voluntary origin, are limited either to single plants or portions of an industry, and cover probably less than 150,000 persons (1929). They are schemes either initiated by employers or created by joint agreement between trade unions and employers Systems of trade union benefits against unemployment, in which the benefit funds are raised and administered by the unions themselves, are not very extensive in the United States and have much the same features as European plans of trade union unemployment relief.

In 1929 unemployment compensation plans initiated by the employers were limited to a few plants, employing altogether probably less than 15,000 workers The highly diverse provisions of these schemes are difficult to summarize In general they may be divided into the plans that are designed to guarantee employment and those that are created to furnish unemployment relief In no case, however, is the distinction clear and permanent One plan, for example, guarantees 48 weeks of employment a year to those of its employees who have been employed by the company a specified period of time The length of service criterion appears to be generally in use

Unemployment funds arising out of joint agreement between employers and trade unions covered in early 1929 about 80,000 workers, limited wholly to the needle trades The first of these was established May 1921 in the cloak and suit industry of Cleveland by agreement between the International Ladies' Garment Workers and the employers and affected some 3,000 members of the union By the terms of this arrangement, the employers guaranteed their employees a specified number of weeks of employment in a year. They at the same time established unemployment funds to be used in compensating workers for part of the difference between the period actually worked and the period guaranteed This plan was clearly designed to encourage the regularization of employment and to a very slight degree has had this effect

In 1924 the same union demanded of the cloak and suit manufacturers in New York City the adoption of a similar plan of employment guarantee and unemployment insurance This demand was not granted, but an agreement was made for the creation of an unemployment fund of 3% of the weekly payroll of the industry, with contributions of 2% from the employers and of 1% from the members of the union. Under this unemployment insurance agreement benefits were paid at the rate of $10 a week for a maximum period of 12 weeks in a year Because of internal dissension in the union the operations of this fund were suspended in 1927

The Cloth, Hat and Cap Makers' Union, beginning in 1923, established unemployment funds throughout the industry with contributions of 3% of the weekly payroll by the employer and no contribution from the members of the union The rate of benefits, in this arrangement, is $13 a week for men and $9 a week for women, for a maximum period of 7 weeks in a year Local funds in the lace industry, made up of equal contributions from employers and employees, cover only 300 workers

The most extensive system of unemployment insurance of this type is that now in operation in the men's clothing industry in Chicago, New York and Rochester The plan was first introduced in Chicago in May 1923, by agreement between the clothing manufacturers and the Amalgamated Clothing Workers of America Each employer was required to contribute 1½% of his weekly payroll and each of the 25,000 members 1½% of their weekly earnings, thus creating an unemployment fund of 3% of the weekly payroll. Benefits were paid at the rate of 40% of the full-time weekly earnings of each worker for a maximum period of five weeks in the year; later this rate was reduced to 30% In May 1928 the employers' contribution was raised to 3%, the total therefore being equivalent to 4½% of the payroll, and the maximum period of benefit to 7½ weeks Eligibility to benefit depends on membership in the union for a specified period and in the computation of the period of unemployment both short-time and total lay-off are counted By March 1929 the total contributions to this fund had amounted to $5,200,000 and the total benefits to slightly more than $4,000,000. The cost of administering the fund has averaged 6% of its income.

In the summer of 1928 similar agreements were made between the Amalgamated Clothing Workers of America and the clothing manufacturers of New York City and Rochester. In each case the fund is equivalent to 1½% of the payroll, contributed entirely by the employer The rules for the payment of benefits have not yet been made Altogether these three funds provide unemployment insurance for 60,000 members of the union in the men's clothing industry

Attempts to introduce state unemployment insurance in Massachusetts, New York, Wisconsin, Pennsylvania, Minnesota and Connecticut, all failed of enactment Some of these measures were modelled on the English system and provided for contributions from employer, employee and the state. The Huber bill in Wisconsin, which for a time won considerable public support, adopted the principles of American workmen's compensation legislation by imposing the total cost of the insurance on the employer, by providing that the employer's insurance premium should vary with his unemployment risk, and by permitting the establishment of employer mutual insurance companies to perform the function of insurance carriers

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UNEMPLOYMENT STATISTICS. The following article deals merely with unemployment figures and their interpretation, and as far as possible refrains from drawing deductions from them

I. UNITED KINGDOM

Prior to the year 1912 almost the only statistics of unemployment in the United Kingdom were those relating to unemployment among the members of certain trade unions paying unemployment benefits These statistics go back over a considerable period From 1888 onward returns were regularly obtained by the Board of Trade from a number of such trade unions, and for a number of unions figures were computed for earlier years and carried back to 1851 The statistics for the earlier years, however, rest on a very slender basis Until 1872 the total membership covered does not reach 100,000 In 1893, when the figures were first regularly published in the *Labour Gazette* 23 unions, with a total membership of nearly 300,000, contributed returns The membership rose to 1,603,000 in 1920, but had fallen again to 833,000 in 1926, when the series was discontinued in view of the immensely greater range and value of the statistics derived from the working of the Unemployment Insurance Acts. The annual percentages of unemployed among members of these trade unions from 1881 to 1926 are shown in Table I on page 693

The percentage of these trade union members unemployed at the end of each month from 1888 to 1928 is shown in Table V. on page 694

These percentages of unemployment were never regarded as providing a trustworthy measure of the actual intensity of unemployment among workpeople generally They cover a relatively small portion of the industrial population; they wholly exclude some of the industries, *e g*, agriculture and railway service, in which unemployment is comparatively stable, and they include in undue proportion such fluctuating industries as engineering and shipbuilding On the other hand, the trade unions included are of rather special character in that they are all unions paying unemployment benefit and they are mainly (though not entirely) composed of the more skilled classes of workers. Taken by and large these factors tend to cancel out and close examination of the figures during the years of overlap when the old trade union and the new insurance statistics were running together leads to the view that by happy accident the trade union percentages reflected not too badly the general rate of unemployment Be that

Table I

Year	Membership at end of June of unions reporting	Yearly average of percentages unemployed at the end of each month				
		All unions included in returns	Engineering, shipbuilding and metal	Carpenters and joiners	Other woodworking and finishing	Printing and bookbinding
1881	140,000	3.5	3.8	5.2	2.7	2.8
1882	151,000	2.3	2.3	3.5	2.5	2.4
1883	160,000	2.6	2.7	3.6	2.5	2.2
1884	167,000	8.1	10.8	4.7	3.0	2.1
1885	169,000	9.3	12.9	7.1	4.1	2.5
1886	168,000	10.2	13.5	8.2	4.7	2.6
1887	164,000	7.6	10.4	6.5	5.6	2.2
1888	168,000	4.0	6.0	5.7	3.1	2.4
1889	188,000	2.1	2.3	3.0	2.4	2.5
1890	213,000	2.1	2.2	2.2	2.5	2.2
1891	220,000	3.5	4.1	1.9	2.1	4.0
1892	234,000	6.3	7.7	3.1	2.8	4.3
1893	320,000	7.5	11.4	3.1	4.1	4.1
1894	368,000	6.9	11.[illegible]	4.3	4.4	5.7
1895	391,000	5.8	8.2	4.4	3.6	4.9
1896	423,000	3.3	4.2	1.3	2.0	4.3
1897	458,000	3.3	4.8	1.2	2.2	3.9
1898	458,000	2.8	4.0	0.9	2.3	3.7
1899	494,000	2.0	2.4	1.2	2.1	3.9
1900	525,000	2.5	2.6	[illegible]	2.8	4.2
1901	531,000	3.3	3.8	3.9	3.7	4.5
1902	538,000	4.0	5.5	4.0	4.1	4.6
1903	550,000	4.7	6.6	4.4	4.7	4.4
1904	567,000	6.0	8.4	7.5	6.8	4.7
1905	569,000	5.0	6.6	8.0	5.8	5.1
1906	586,000	3.6	4.1	6.9	4.8	4.5
1907	661,000	3.7	4.9	7.3	4.6	4.3
1908	689,000	7.8	12.5	11.6	8.3	5.5
1909	698,000	7.7	13.0	11.7	7.6	5.6
1910	703,000	4.7	6.8	8.3	5.4	4.9
1911	759,000	3.0	3.4	4.2	3.3	5.1
1912	834,000	3.2	3.6	3.7	3.1	5.2
1913	922,000	2.1	[illegible]	3.3	2.4	4.0
1914	993,000	3.3	3.3	3.3	4.1	4.5
1915	922,000	1.1	0.6	2.2	2.1	3.1
1916	939,000	0.4	0.3	0.9	1.0	1.3
1917	950,000	0.7	0.[illegible]	0.5	0.6	0.6
1918	1,117,000	0.8	0.2	0.2	0.5	0.3
1919	1,334,000	2.4	3.2	1.2	1.3	1.6
1920	1,603,000	2.4	3.2	0.3	1.4	1.6
1921	1,235,000	14.8	22.1	3.9	9.4	7.3
1922	1,360,000	15.2	27.0	7.5	7.6	6.6
1923	1,145,000	11.3	20.6	5.0	5.8	4.7
1924	1,084,000	8.1	13.8	1.9	4.5	3.3
1925	978,000	10.5	13.5	2.2	4.4	[illegible]
1926	833,000	12.2	18.2	5.[illegible]	8.2	4.3

as it may, the trade union percentages may safely be regarded as providing a valuable index to the *changes* in the state of employment from year to year and, more uncertainly, from month to month In this latter aspect they may be taken as giving a measure of the seasonal swing of unemployment before the war Since the war the sudden intrusion of high figures due to the reflex influence of large trade disputes, particularly in the coal industry, often masks the seasonal trend and even before the war this erratic element may, unless allowed for, lead to misleading conclusions Read with that qualification. Table II, showing the averages of the percentages returned for each month over the 20-year period 1894–1913 is informative

Table II

Jan	Feb	March	April	May	June
4.8	4.4	4.4	4.0	3.8	3.9
July	**Aug**	**Sept**	**Oct**	**Nov**	**Dec.**
4.0	4.2	4.4	4.4	4.2	4.7

The rate, as will be seen. falls to a minimum in May and rises to a maximum in January

Unemployment Insurance Statistics.—In the course of the year 1912 a new source of information concerning the amount and rate of unemployment opened out Part II. of the National Insurance Act passed in Dec 1911, provided for the institution of a system of compulsory unemployment insurance for workpeople employed in certain industries regarded as being more than commonly subject to unemployment, viz, building, public works, contracting, shipbuilding, engineering, construction of vehicles, ironfounding, and certain branches of saw-milling From the working of this measure came the first instalment of a new series of unemployment statistics The workpeople so insured numbered some 2,300,000, and from Sept 1912 onwards, information concerning the rate and volume of total unemployment among these persons became publicly available In July 1916 the scope of Unemployment Insurance was extended to include workpeople employed upon munitions work or in certain specified industries, and the numbers covered increased to approximately 3,700,000 By the acts of 1920 and 1921, the range of National Unemployment Insurance received its latest and greatest extension and with certain exceptions now covers all manual workers (and also non-manual workers earning at the rate of not more than £250 a year) of the age of 16 and upwards in all trades and industries except agriculture and domestic service, in 1928 about 11,784,000

In respect of this very large sample of the total of employed persons there have been available, since 1921, unemployment statistics of great and increasing trustworthiness Weekly throughout this period have been published the numbers of men, boys, women and girls "on the registers of employment exchanges" and monthly, in the *Ministry of Labour Gazette*, have been given the numbers of insured persons in the different industries and the numbers and percentages of such persons unemployed

Numbers Registered at Employment Exchanges.—The weekly figures represent the numbers of persons registered at employment exchanges as seeking employment on the first day of the week It should be understood that the figures include workpeople suspended or temporarily "stood-off" and persons working short time, provided they were unemployed and registered on the dates to which the returns relate The figures also include some persons who were in employment or otherwise occupied but had registered with a view to obtaining other work, but the number of these is not material except perhaps in the case of juveniles Table VII on p. 695 gives the Great Britain figures for dates from Jan 1921 to December 1928

The figures of persons registered for employment given in table VII are not limited to persons insured against unemployment. They include unemployed domestic servants, agricultural workers and juveniles under 16 years of age in so far as these were registered for employment The size of "field" from which they are drawn cannot be estimated, and consequently percentages of unemployment cannot be computed from them except for special and limited purposes

For trustworthy percentages one must turn to the unemployment insurance statistics published each month in the *Ministry of Labour Gazette*

Insured Workpeople Unemployed.—Every person insured under the Unemployment Insurance Acts is given an unemployment book, and the number of persons insured is estimated annually when old books are exchanged for new books in the summer of each year. When an insured person comes out of work and makes a claim to unemployment benefit the unemployment book must be "lodged" at an employment exchange. It is therefore possible to obtain from a count of the lodged books a record of unemployment among insured persons, and by relating this to the total of insured persons the percentage of unemployed among insured workpeople can be calculated Table III on p 694 gives the percentages for Great Britain for dates near the end of each month from Jan. 1921 to December 1928

It should be understood that the figures of "books lodged" are not confined to persons in receipt of unemployment benefit Over and above these. they include all persons, whether recipients of or claimants to benefit or not, whose books are lodged and who are known to be unemployed; and in the case of persons whose books remain lodged, indicating that they are not working in

Table III

Percentages unemployed among insured workpeople in Great Britain								
Date	1921	1922	1923	1924	1925	1926	1927	1928
January	10·9	17·5	13·1	11·8	11·1	10·7	11·8	10·6
February	12·8	16·9	12·2	10·5	11·1	10·1	10·7	10·4
March	15·0	15·8	11·5	9·7	10·8	9·5	9·7	9·5
April	19·8	15·6	11·3	9·5	10·6	8·8	9·3	9·5
May	23·0	14·4	11·1	9·2	10·6	14·1	8·6	9·7
June	21·9	13·5	11·2	9·2	11·6	14·3	8·8	10·6
July	17·4	12·9	11·4	9·6	10·8	14·2	9·1	11·5
August	15·1	12·6	11·7	10·3	11·9	13·8	9·2	11·7
September	13·9	12·5	11·6	10·5	11·7	13·5	9·2	11·5
October	14·3	12·4	11·6	10·8	11·0	13·4	9·5	11·8
November	16·9	12·8	11·4	10·7	10·7	13·3	9·9	12·2
December	17·7	12·6	10·5	10·6	10·1	11·7	9·8	11·2

an insured industry, but whose employment condition or continued existence is not known by reason of their having ceased to maintain registration, such persons are counted as unemployed for two months after their last attendance at the exchange Further, the statistics are not confined to persons definitely without a job Those who were not at work on the day of the count because they were "stood off" or on short time, and whose unemployment books are lodged at exchanges, are counted in the statistics as "unemployed" It should be noted that insured persons who are disqualified for the receipt of benefit under the trade dispute disqualification are not included among the numbers unemployed unless they have registered for other work

The official figures have from the beginning distinguished between men, boys, women and girls; and since the beginning of 1926 a distinction has also been made between persons wholly unemployed (in the sense that they are definitely without a job) and those who are temporarily stopped or suspended from the service of an employer The figures under the heading "temporary stoppages" include those persons recorded as unemployed on the date of the return who were either on short time or were otherwise stood off or suspended on the definite understanding that they were to return to their former employment within a period of six weeks from the date of suspension. In cases where there was no definite prospect of return within six weeks the individuals have been included in the statistics as "wholly unemployed" Table IV. gives in summary form the British figures (excluding Northern Ireland) for males and females separately and the figures for those wholly unemployed and those temporarily suspended from employment from 1926 to and inclusive of August, 1928.

Table IV

Date	Males	Females	Males and females		
			Wholly unemployed and casuals	Temporarily stopped	Total
1921 Average	16·8	15·9			16·6
1922 ,,	16·1	8·7			14·1
1923 ,,	12·4	9·0			11·6
1924 ,,	10·8	8·5			10·2
1925 ,,	12·0	8·1			11·0
1926 ,,	13·2	9·5	8·6	3·7	12·3
1927 ,,	10·9	6·2	7·3	2·3	9·6
Jan 1928	12·1	6·8	8·2	2·4	10·6
Feb 1928	11·9	6·3	8·1	2·3	10·4
March 1928	10·9	5·7	7·6	1·9	9·5
April 1928	10·9	5·6	7·5	2·0	9·5
May 1928	11·3	5·6	7·4	2·3	9·7
June 1928	12·2	6·5	7·6	3·0	10·6
July 1928	13·0	7·4	7·9	3·6	11·5
Aug 1928	12·9	7·1	8·1	3·4	11·5
1928 (mean of 8 months)	11·9	6·5	7·8	2·6	10·4

Table V Percentage of Trade Union Members unemployed at the end of each month (All Trade Unions Making Returns)

Year	Jan	Feb.	March	April	May	June	July	Aug	Sept.	Oct	Nov	Dec	Yearly average
1888	7·8	7·0	5·7	5·2	4·8	4·6	3·9	4·8	4·4	4·4	3·1	3·3	4·9
1889	3·1	2·8	2·2	2·0	2·0	1·8	1·7	2·5	2·1	1·8	1·5	1·7	2·1
1890	1·4	1·4	1·7	2·0	2·0	1·9	2·3	2·3	2·6	2·6	2·4	3·0	2·1
1891	3·4	2·6	2·8	2·7	3·0	2·0	3·3	4·2	4·5	4·4	3·8	4·4	3·5
1892	5·0	5·7	5·7	5·4	5·9	5·2	5·0	5·1	6·2	7·3	8·3	10·2	6·3
1893	10·0	9·5	8·7	6·9	6·2	5·8	6·2	7·1	7·3	7·3	7·2	7·9	7·5
1894	7·0	5·6	6·5	6·1	6·3	6·3	7·5	7·7	7·6	7·4	6·9	7·7	6·9
1895	8·1	7·9	6·5	6·5	6·0	5·5	5·2	5·2	4·9	4·8	4·[illegible]	4·8	5·8
1896	4·4	3·7	3·3	3·0	3·1	3·0	3·0	3·3	3·4	3·2	2·8	3·1	3·3
1897	3·1	2·7	2·2	2·2	2·0	2·5	2·5	3·4	4·2	4·5	4·6	5·1	3·3
1898	4·7	4·[illegible]	2·9	2·7	2·4	2·4	2·4	2·5	2·3	2·[illegible]	2·0	2·6	2·8
1899	2·7	2·1	2·0	1·7	2·0	1·8	1·8	2·1	2·0	1·9	1·8	2·3	2·0
1900	2·3	2·4	2·0	2·0	1·9	2·1	2·2	2·5	3·0	2·8	2·7	3·5	2·5
1901	3·5	3·4	3·1	3·4	3·0	3·0	2·9	3·4	3·2	3·2	3·3	4·2	3·3
1902	4·0	3·9	3·2	3·4	3·5	3·7	3·5	4·0	4·5	4·5	4·4	5·0	4·0
1903	4·9	4·3	3·9	3·6	3·5	3·9	4·4	5·0	5·2	5·6	5·5	6·3	4·7
1904	6·1	5·6	5·5	5·5	5·8	5·5	5·6	5·9	6·3	6·3	6·5	7·1	6·0
1905	6·3	5·7	5·2	5·2	4·7	4·8	4·7	4·9	4·8	4·6	4·3	4·5	5·0
1906	4·3	4·1	3·4	3·2	3·1	3·2	3·1	3·3	3·3	3·9	4·0	4·4	3·6
1907	3·9	3·5	3·2	2·8	3·0	3·1	3·2	3·6	4·1	4·2	4·5	5·6	3·7
1908	5·8	6·0	6·4	7·1	7·4	7·9	7·9	8·5	9·3	9·5	8·7	9·1	7·8
1909	8·7	8·4	8·2	8·2	7·9	7·9	7·9	7·7	7·4	7·1	6·5	6·6	7·7
1910	6·8	5·7	5·2	4·4	4·2	3·7	3·8	4·0	4·3	4·4	4·6	5·0	4·7
1911	3·9	3·3	3·0	2·8	2·5	3·0	2·9	3·3	2·9	2·8	2·6	3·1	3·0
1912	2·7	2·8	11·3*	3·6	2·7	2·5	2·6	2·2	2·1	2·0	1·8	2·3	3·2
1913	2·2	2·0	1·9	1·7	1·9	1·9	1·9	2·0	2·3	2·2	2·0	2·6	2·1
1914	2·5	2·3	2·1	2·1	2·3	2·4	2·8	7·1	5·9	4·4	2·9	2·5	3·3
1915	1·9	1·6	1·3	1·2	1·2	1·0	0·9	1·0	0·9	0·8	0·6	0·6	1·1
1916	0·6	0·5	0·5	0·5	0·5	0·5	0·4	0·4	0·4	0·3	0·3	0·3	0·4
1917	0·3	0·3	0·3	0·3	0·4	0·4	0·4	0·5	1·3	1·1	1·1	1·4	0·7
1918	1·0	0·9	1·2	0·9	0·9	0·7	0·6	0·5	0·5	0·4	0·5	1·2	0·8
1919	2·4	2·8	2·8	2·7	2·1	1·7	2·0	2·2	1·6	2·6	2·9	3·2	2·4
1920	2·9	1·6	1·1	0·9	1·1	1·2	1·4	1·6	2·2	5·3*	3·7	6·0	2·4
1921	7·1	8·7	10·2	15·1*	19·9*	20·6*	16·9*	16·6*	15·0	15·7	16·1	16·2	14·8*
1922	16·5	16·2	16·2	16·8	16·2	15·5	14·5	14·1	14·4	14·0	14·2	13·8	15·2
1923	13·6	12·9	12·2	11·2	11·2	11·0	10·9	11·1	10·9	10·5	10·2	9·3	11·3
1924	8·5	8·2	7·8	7·5	7·0	7·2	7·4	7·9	8·6	8·7	8·6	9·2	8·1
1925	9·0	9·4	9·0	9·4	10·1	12·3	11·2	11·4	11·4	11·3	11·0	11·0	10·5
1926	10·6	10·4	10·1	10·0	13·2*	12·9*	13·2*	13·3*	13·6*	13·6*	13·2*	12·2*	12·2*

*Affected by general Coal Mining stoppage.

Unemployment in Various Industries.—On every insured person's unemployment book is recorded the industry in which he is engaged The analysis by industries in the *Ministry of Labour Gazette* for Aug 1928 reveals wide differences in the intensity of unemployment in the various groups ranging from 30% in the linen industry, 28% in coal mining, and 23% in iron and steel, at the one extreme, down to less than 3% in commerce, in tramway and omnibus service, and scientific instrument making, and less than 5% in 13 of the 100 groups

The geographical distribution of unemployment in the United Kingdom shows wide differences in the intensity in various areas. Table VI. below shows these variations at July 23, 1928.

Table VI

Divisions	Estimated numbers insured aged 16 64 inclusive, at July 1927 (Totals)	Percentage unemployed at July 23, 1928		
		Males	Females	Total
London	2,091,260	6 3	3·2	5·3
South-eastern	849,410	4 9	3·5	4·6
South-western	807,100	8·3	4·7	7·5
Midlands	1,733,280	13·2	9·3	12 1
North-eastern	1,961,560	18 4	10·1	16 6
North-western	2,090,390	14·0	11·6	13 2
Scotland	1,268,170	13 8	6·4	11·7
Wales	607,580	26·7	5·1	24 6
Northern Ireland	249,000	20 6	23·7	21·9
Special schemes	126,250	1 9	0 4	1·5
Total	11,784,000	13 1	7 9	11 7

The local incidence of unemployment can be followed month by month in the local unemployment index prepared by the Ministry of Labour and issued as a subscription publication by the Stationery Office Here can be found the numbers of insured persons, and the percentage rate of unemployment for men, women and juveniles for 637 towns and for country areas in Great Britain The issue for Aug 13, 1928, shows towns in the Welsh coal areas and in the mining counties of Durham and Northumberland with rates of unemployment of 70, 60 and 50%, while at the other extreme are whole counties, such as Surrey, Sussex and Hertfordshire, with less than 3% of unemployment and individual towns in these counties with less than 2%. These detailed tabulations show the concentration of the most intense unemployment in certain industries and in certain districts where those industries are found, and the virtual absence of unemployment over large areas

Statistical information as to the personal circumstances and industrial history of unemployed persons in Great Britain has been greatly extended since 1923 as a result of the adoption, in that year, of a small-sample method of investigation The method consists of examining thoroughly, by reference to documents and by personal interview, the case of every hundredth person on the claims files of the employment exchanges, and preparing from the material so obtained a statistical picture of the whole body of unemployed persons Reports based on these enquiries analyse the results according to sex, age, degree of employability, early training, marital state, industry, date of entering insurance, contributions paid, benefit received, etc The impression most reasonably to be drawn from them is that the unemployed are not a particular class with personal characteristics which conduce to unemployment but are hardly distinguishable from any other assortment of working people. There is a preponderance, certainly, of older people. As a man or woman gets past 45 his or her liability to unemployment grows year by year Between the ages of 30 and 40 less than 10% of the men are unemployed, but after 45 the rate of unemployment increases steadily until as men approach 70 something like 20% are unemployed and much the same, on a lower scale, takes place with women These older people figure largely in the class described in the reports as "verging on the unemployable" Of the whole number interviewed in the 1927 enquiry only 2% were assigned by the interviewing officers to this class, and nearly three-quarters of the 2% were people over 60, many of them suffering from some physical impairment The reports afford little ground for supposing that either family responsibilities or war service rank prominently as influences determining who will or will not be employed It is also made quite clear in the reports that the unemployed are not a "standing army" consisting of the same people week after week and month after month At any given date there will be found some who have been on the fund for considerable periods, perhaps 10% will have been on benefit throughout the previous year, but these will on further investigation be found to live in one or other of those industrially afflicted areas to which reference has been made, and to have been dependent upon one or other of the depressed industries As for the rest there is a constant movement of individuals into and out of the "unemployed" group On any Monday, 17% of the persons registered at exchanges were not there on the previous Monday, they were new-comers who had lost, or had been stood-off from, their jobs a day or two before and were either seeking other jobs or waiting for the former ones to re-open The analyses reveal among the whole number a continuous gradation from persons who have never visited an exchange before, who will not remain on the register more than a few days, and who may never appear again, down to those who have drawn benefit every week in the previous year and have had little regular employment for several years; but this "hard core" of the unemployment problem is found to be associated with industry and locality and not with individual incompetence, laziness or depravity For the rest, the unemployed are demonstrated to be not a "standing army" but a melting crowd whose composition changed materially from week to week, a constantly changing body of workpeople who had lately lost one job and would presently get another

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II. UNITED STATES

The available statistics of unemployment in the United States are scanty and frequently unreliable Scattered data exist for or-

Table VII Numbers Recorded on the Registers of Employment Exchanges in Great Britain only

Date	1921	1922	1923	1924	1925	1926	1927	1928
January	1,276,577	1,036,081	1,463,612	1,320,518	1,240,922	1,200,827	1,348,719	1,168,941
February	1,465,316	1,859,137	1,353,173	1,154,504	1,236,065	1,125,760	1,196,059	1,108,676
March	1,697,938	1,736,457	1,266,997	1,063,519	1,201,315	1,013,609	1,081,720	1,033,845
April	2,246,082	1,712,051	1,263,665	1,047,780	1,187,068	981,877	1,044,757	1,136,003
May	2,558,190	1,565,429	1,237,716	1,015,626	1,186,522	1,614,212	985,513	1,101,026
June	2,438,125	1,436,100	1,223,152	1,013,782	1,304,243	1,639,776	1,004,613	1,192,564
July	1,905,196	1,389,257	1,221,554	1,048,261	1,197,631	1,605,420	1,026,902	1,304,971
August	1,656,452	1,359,376	1,268,828	1,149,078	1,343,738	1,549,759	1,049,261	1,367,000
September	1,470,388	1,342,503	1,275,770	1,180,290	1,336,155	1,527,751	1,050,117	1,384,000
October	1,639,545	1,348,060	1,293,317	1,203,229	1,232,396	1,516,171	1,074,032	1,421,000
November	1,849,069	1,401,003	1,261,838	1,190,592	1,174,545	1,496,067	1,145,230	1,430,000
December	1,885,478	1,381,612	1,285,623	1,169,227	1,102,400	1,351,045	1,100,052	1,312,000

ganized trades and surveys have been made of individual cities On the whole, however, most of the information bearing upon unemployment is in the nature of speculation

The data used in public discussion are for the most part the results of guesses This was particularly evident during the conference on unemployment called in 1921 by the late President Harding, when, despite the resources available to that body, no reliable estimate of the number of unemployed people in the United States could be secured. Estimates ranged from two million to six million During 1927 and 1928, when the problem of unemployment assumed considerable importance, estimates of the number of jobless workers, all emanating from responsible sources, ran from 1,700,000 to over seven millions The Secretary of Labor placed the number of unemployed at 1,874,050, but careful analysis revealed that this figure was a measure not of unemployment but rather of the *shrinkage of employment* which was assumed to have taken place in American industry between the average employment for the year 1925 and that for the month of January, 1928.

Trade Union Data.—Prior to 1922 current data were available which showed the extent of unemployment among trade union members in two important industrial States, namely, New York and Massachusetts. The New York figures, publication of which was begun in 1897, were discontinued in 1916 In the following table are presented the percentages of unemployment in the trade unions of the State of New York at the end of March and September for each year from 1897 to 1914:

Idleness of Members of All Labour Organizations in New York

Year	End of March		End of September	
	Membership included in reports	Percentage unemployed	Membership included in reports	Percentage unemployed
1897	142,570	30·6	168,454	13·8
1898	179,955	21·0	171,067	13·1
1899	173,516	18·3	201,904	4·7
1900	221,717	20·0	237,166	13·3
1901	228,327	18·5	268,635	6·9
1902	270,855	13·6	321,082	5·7
1903	347,492	12·1	383,971	9·0
1904	382,344	27·2	385,740	9·7
1905	363,155	15·1	370,301	4·9
1906	377,283	9·9	376,355	5·7
1907	404,028	19·1	404,814	10·5
1908	387,450	35·7	358,756	22·5
1909	353,035	21·1	359,787	10·3
1910	389,501	16·1	462,466	13·6
1911	475,890	20·3	467,825	10·3
1912	458,070	19·6	491,178	7·1
1913	578,796	15·9	627,094	16·1
1914	*	*	552,970	24·1

*No data.

The distribution of unemployment during the period from 1902 to 1916 as between the different industries in the State of New York is shown in the table at the bottom of this page

Non-Governmental Statistics.—Since no official data on unemployment for the entire country is collected by any Governmental agency such estimates as have been made in the United States have emanated for the most part from private sources. The first elaborate estimate, made in 1918, placed the average number of unemployed in occupations other than agriculture between 1902–1917 at 2,500,000 The maximum estimated number of jobless workers at any one time was 6,500,000 in January, 1915. During 1914 the number of unemployed in any one month was estimated never to have been below a minimum of four millions. The most acceptable figures showing the average number of unemployed in non-agricultural pursuits from 1902 to 1917 and the percentages which they bore to the total normally employed population is given below

Year	Average number unemployed	Per cent of labor supply	Year	Average number unemployed	Per cent of labor supply
1902	2,500,000	14·1	1910	1,700,000	6·5
1903	1,000,000	9·3	1911	2,800,000	10·8
1904	2,400,000	11·5	1912	2,600,000	9·6
1905	2,000,000	9·3	1913	2,600,000	9·3
1906	1,200,000	5·5	1914	4,500,000	15·8
1907	1,400,000	6·0	1915	4,600,000	16·0
1908	3,500,000	14·8	1916	2,100,000	7·1
1909	2,100,000	8·6	1917	1,400,000	4·7

Other private estimates were given wide currency in 1928 when the problem of unemployment was in the public eye One, made by a private labour research bureau, placed the average amount of unemployment in 1927 at approximately four millions

Another estimate, made in 1928, attempted to measure the extent of unemployment in the country from 1910 to 1928 The figures arrived at represent the difference between the probable maximum employment and the actual employment for each year As will be seen from the table which follows, the results are quite different from those arrived at in other estimates

Year	Maximum number of persons employed at one time	Average number actually employed	Number unemployed
1910	38,167,000	38,167,000	*
1911	38,856,000	38,360,000	496,000
1912	39,445,000	39,445,000	*
1913	40,149,000	39,882,000	267,000
1914	40,875,000	38,848,000	2,027,000
1915	41,585,000	40,106,000	1,479,000
1916	42,318,000	42,206,000	112,000
1917	43,016,000	43,016,000	*
1918	42,989,000	42,931,000	58,000
1919	42,841,000	42,766,000	75,000
1920	42,809,000	42,809,000	*
1921	43,161,000	39,508,000	3,653,000
1922	43,189,000	40,622,000	2,567,000
1923	43,284,000	43,284,000	*
1924	43,216,000	41,826,000	1,390,000
1925	42,805,000	42,418,000	387,000
1926	42,433,000	42,433,000	*
1927	42,943,000	41,477,000	1,466,000
1928 (March)	43,445,000	40,813,000	2,632,000

*Since 1900, 1912, 1917, 1920, 1923, and 1926 had been years of great business activity they were regarded as years of full employment

Mean Monthly Percentage of Idleness in Representative Trade Unions in New York State by Industries

Industry	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916†
Building, stoneworking, etc	18·1	24·4	18·1	15·3	10·1	25·0	42·3	26·7	24·1	30·7	21·2	25·2	38·9	36·9	32·1
Transportation	13·8	18·0	22·1	13·7	12·5	16·6	31·0	23·8	14·0	19·9	7·5	9·4	13·5	13·0	7·4
Clothing and textiles	22·5	24·5	26·0	11·0	8·5	16·4	34·3	18·8	34·1	22·8	28·8	40·9	38·9	32·4	21·7
Metals, machinery, etc.	4·6	9·6	11·9	5·2	5·4	10·4	29·0	13·7	7·7	24·0	11·4	10·5	20·2	15·1	7·8
Printing, binding, etc	12·4	12·4	16·2	9·9	16·4	11·9	18·7	9·4	5·0	5·2	5·7	7·1	10·4	9·5	6·7
Woodworking and furniture	18·5	26·9	28·4	15·5	11·6	17·9	33·2	13·3	10·5	19·4	17·8	21·7	32·4	24·6	18·4
Food and liquors	8·4	7·4	8·3	7·2	7·1	7·4	11·0	9·6	12·8	8·5	9·9	10·3	12·5	13·5	11·1
Theaters and music	11·2	14·7	13·2	12·1	7·8	6·6	16·1	4·9	13·4	18·7	15·7	13·1	20·2	25·1	5·8
Tobacco	5·1	5·8	6·9	5·8	4·9	11·0	15·4	12·4	11·1	12·8	7·7	10·0	25·9	13·0	7·3
Restaurants, trade, etc.	6·7	7·3	7·9	7·2	5·0	6·5	11·1	6·6	5·4	5·3	5·3	6·0	13·5	12·8	10·5
Public employment	3·9	7·1	8·0	5·1	2·4	1·4	1·1	1·2	1·3	1·2	1·0	0·5	0·9	*	*
Stationary engine tending	*	3·4	3·3	2·5	1·9	1·8	3·1	1·6	1·4	1·8	1·9	2·1	3·0	4·0	3·3
Miscellaneous	7·6	9·3	4·8	3·9	2·8	4·6	22·0	14·4	14·5	13·1	7·1	9·5	24·4	*	*

*Data not available †First six months of year.

Estimated Average Minimum Volume of Unemployment, 1920–27
(000's omitted)

	1920	1921	1922	1923	1924	1925	1926	1927
Total employees attached to non-agricultural pursuits	27,558	27,989	28,505	29,293	30,234	30,941	31,808	32,695
Minimum number unemployed								
Manufacturing	487	2,554	1,761	432	924	578	552	727
Construction	230	248	230	220	350	345	280	422
Transportation and communication	170	598	580	251	340	184	144	152
Mines, quarries, and oil wells	274	470	520	329	326	308	323	380
Public service, mercantile and miscellaneous	240	400	350	300	375	360	370	374
Minimum total unemployed	1,401	4,270	3,441	1,532	2,315	1,775	1,669	2,055

The latest and most reliable statistics of unemployment were compiled in conjunction with a survey of economic conditions in the United States made in the winter of 1928–29 In this survey the volume of unemployment was defined as the difference between the number of persons actually employed and the number desiring and habitually dependent upon employment The number of persons gainfully employed in or attached to the different occupational and industrial groups was estimated for each year and from these estimates were subtracted the average annual numbers actually employed in each group. The difference was assumed to represent the average annual unemployment. The results of this survey are presented above.

The figures presented in the above table, it should be borne in mind, are estimates of the average minimum of unemployment for each year The maximum figure for any given year cannot be estimated from the data presented It is highly probable, however, that the maximum exceeded the figures given above by a considerable amount The real significance of the preceding table lies in the fact that it indicates the trend of unemployment during the period covered.

Employment Data.—Beyond the material described above there are no data of reputable value presenting the volume of unemployment in the United States. The Bureau of Labor Statistics of the United States Department of Labor and many of the State labour departments publish monthly indexes of *employment,* but these, it should be noted, do not necessarily throw any light upon the course of *un*employment They depict the number of persons employed in industry and show which industries are growing and which are contracting But the fact that they show, for example, that employment is contracting does not necessarily mean that unemployment is increasing Nor does the fact that they show employment is increasing necessarily mean that unemployment is decreasing

Workers are constantly leaving industry and going into business for themselves Some are retiring and living on their past savings, or on the income of others Some leave industry and go to schools, colleges and universities. Theoretically, unless American employment figures cover every branch of production and distribution it would be quite possible for employment in the major industries of the country to be declining, and at the same time have the number of unemployed grow less On the other hand, with approximately one-third of a million immigrants entering the United States each year, with about 200,000 people coming into the cities from the farms, and with anywhere from 1,500,000 to 2,000,000 young people reaching the working age each year, a very marked growth in our employment may at the same time be accompanied by a serious increase in the number of people unemployed.

The most comprehensive employment reports are to be found in the monthly survey of employment for the United States as a whole which is published in the *Monthly Labor Review* of the United States Bureau of Labor Statistics These reports, based upon returns from 12,000 plants employing over 6,000,000 workers with a weekly payroll of over $170,000,000, present monthly changes in both employment and in payrolls for 12 groups of industries classified as follows:

I. Food and Kindred Products
II. Textiles and their Products
III Iron and Steel and their Products
IV Lumber and Its Products
V Leather and its Products
VI Paper and Printing
VII Chemicals and Allied Products
VIII Stone, Clay and Glass Products
IX Metal products other than Iron and Steel
X Tobacco products
XI Vehicles for Land Transportation
XII. Miscellaneous industries

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III. OTHER COUNTRIES

The statistics of unemployment compiled and issued by the different countries exhibit the widest variety in completeness and value. The only statistics yielding trustworthy *percentages* of unemployment are those concerning workers insured against unemployment, for only in such cases is the "field" of persons registered as unemployed accurately known and proof of unemployment rigorously required. Trade unions paying unemployment benefit to their members come within this category, and for these, more or less extensive and trustworthy statistics exist for many countries The numbers covered are, however, usually only a small proportion of the whole wage-earning population, and the data require very careful examination before the degree in which the percentages reflect unemployment among workers generally can be estimated In no country other than the United Kingdom and Germany does there exist a national system of unemployment insurance covering the bulk of wage-earners so organized and used as to produce unemployment statistics of national range and practical trustworthiness In some countries, notably the United States, statistics of unemployment are virtually non-existent, but in that country, as also in Canada, effort has been directed to statistics showing variations in the numbers employed from one date to another in representative establishments in certain industries These *employment* statistics have their own especial value, but it is not possible to deduce from them with any assurance, figures of unemployment In many countries there are national or local employment agencies, where workers desiring employment may register and the statistics of registrations and placings by these agencies give some indication of changes in intensity of unemployment in the areas where they operate but in no case, except where, as in the United Kingdom and Germany, the administration of an unemployment insurance fund is added to their employment-finding functions, do these administrative statistics give any measure of the gross volume or rate of unemployment. For these reasons the figures quoted below cannot, in any case, be taken as measures of the gross amount of unemployment in the country in question nor as reliable indications of the rate of unemployment throughout the country as a whole; and they should consequently on no account be used to compare

either the level or the rate of unemployment as between country and country.

Canada.—The official statistics compiled by the Canadian Department of Labour relate to trade union unemployment and to the state of employment based on returns from about 6,600 firms covering about a million workers Agriculture is included in the employment statistics. The number of persons employed is expressed as a percentage of the number on Jan. 17, 1920. The trade union statistics cover some 170.000 workers and include unions which do not pay unemployment benefit. The summary figures for the five years ended June 1928 are as follows.

Date (end of month)		Number unemployed	Percentage
1923	December	11,767	7·2
1924	March	10,051	6·7
	June	9,250	5·8
	September	9,156	5·9
	December	18,373	11·6
1925	March	13,159	8·5
	June	9,578	6·1
	September	8,374	5·7
	December	11,716	7·9
1926	March	11,069	7·3
	June	5,965	4·1
	September	4,837	3·3
	December	9,340	5·9
1927.	March	8,075	5·7
	June	5,410	3·2
	September	5,314	3·1
	December	11,893	6·6
1928.	January	12,082	6·8
	February	12,522	7·0
	March	11,965	6·5
	April	9,573	5·2
	May	6,657	3·7
	June	5,800	3·2

Australia.—The Australian official statistics relate to unemployment among trade unionists and to the operations of the public employment exchanges in the various States The trade union statistics cover more than 400,000 workers in the principal industries, and show for each quarter and each State the number (and percentage) of members who have been unemployed for at least three days during the course of a given week. The figures relate not only to workers unemployed on account of the state of the labour market but also those unemployed on account of sickness, accident and all other reasons with the exception of trade disputes

The statistics for the five-year period Dec. 1923 to Dec. 1927, inclusive, together with those for the quarter ending March 1928 (the latest date available) are as follows

Date		Number unemployed	Percentage
1923	4th quarter	24,521	6·6
1924.	1st „	29,417	7·6
	2nd „	32,708	8·3
	3rd „	38,482	9·5
	4th „	41,420	10·3
1925.	1st „	37,836	9·3
	2nd „	36,490	10·2
	3rd „	29,801	7·9
	4th „	34,287	8·1
1926	1st „	34,161	8·2
	2nd „	24,920	6·7
	3rd „	32,871	7·6
	4th „	25,351	5·7
1927.	1st „	26,280	5·9
	2nd „	29,217	6·4
	3rd „	29,991	6·7
	4th „	38,641	8·9
1928.	1st „	45,638	10·7

Germany.—Official unemployment statistics in Germany relate to the numbers in receipt of unemployment insurance benefit (published monthly for the whole of the Reich and for the different States); to applications for work, vacancies offered, and workpeople placed in the course of employment exchange administration; and to the records of trade unions with unemployment insurance funds. The latter statistics are compiled monthly and are published in the *Reichsarbeitsblatt.* They show the number of trade union members covered, over four millions in 1928, and the percentage of unemployed workers registered on the last Saturday of each month. There are also published monthly in the *Reichsarbeitsblatt* statistics of short-time employment among the bulk of the trade unionists reported upon. These show the percentage of short-time workers at the end of each month, distinguishing sex and industry; and the number of cases of short time, classified according to the extent of loss of work (1–8 hours, 9–16 hours, 17–24 hours, 25 hours and more lost per week) and the percentage which these various groups represent of the total number of cases of short-time employment recorded. The summary figures for the five years ending July 1928, are as follows

Date (end of month)	Wholly unemployed		Partially unemployed		Numbers of unemployed in receipt of benefit*	
	Number	Per cent	Number	Per cent	Ordinary unemployment benefit	Emergency benefit
1923						
December	1,304,073	28·2	1,691,309	42·0	1,533,489	
1924						
March	674,606	16·6	346,153	9·9	694,559	
June	340,774	10·5	610,840	10·4	426,420	
September	362,997	10·5	512,028	17·5	513,496	
December	282,645	8·1	193,280	6·5	535,529	
1925						
March	211,259	5·8	158,681	5·1	465,761	
June	130,249	3·5	163,461	5·2	195,099	
September	168,657	4·5	268,186	8·5	266,078	
December	706,253	19·4	695,949	19·8	1,498,681	
1926						
March	727,312	21·4	730,640	21·7	1,942,011	.
June	627,287	18·1	596,973	17·2	1,740,754	.
September	513,304	15·2	427,380	12·7	1,394,062	.
December	572,653	16·7	249,628	7·3	1,748,597	
1927						
March	420,550	11·5	160,080	4·4	1,121,150	223,357
June	239,597	6·3	101,378	2·7	540,703	208,426
September	178,016	4·6	93,113	2·4	355,462	136,576
December	510,573	12·9	123,207	3·1	1,188,274	211,472
1928						
January	464,454	11·2	146,516	3·5	1,333,115	214,829
February	431,765	10·4	151,646	3·6	1,237,504	214,912
March	383,224	9·2	155,797	3·7	1,010,763	197,643
April	295,135	6·9	180,712	4·2	729,329	162,403
May	270,103	6·3	215,759	5·0	629,470	132,449
June	268,443	6·2	255,090	5·9	610,687	113,595
July	273,696	6·3	283,562	6·5	564,064	82,934

*From Oct. 13, 1923 until Oct 1, 1927, when the Unemployment Insurance Act of July 16, 1927, came into force, the German system of relieving unemployment was a compromise between relief and insurance: both employers and workers were compulsorily required to contribute to the funds, but the workers were not unconditionally entitled to benefit. Since Oct. 1, 1927, unemployment insurance proper has been in force.

France.—French official statistics cover only the numbers of unemployed in receipt of State assistance, and the activities of employment exchanges The statistics of State relief cover only a limited number of workpeople, the municipal and departmental unemployment funds on which they are based having only a temporary and intermittent existence. The statistics of the activities of the employment exchanges set up in each department and open to all workers comprise, *inter alia,* the number of applications and vacancies outstanding and the number of placings during the month. Both these sets of figures are given weekly in the *Bulletin du Marché du Travail.* Owing mainly to the complementary character of agricultural and industrial employment, but also to a combination of other factors, unemployment is not usually a problem of any gravity in France; but the "live register" figures cannot be taken as more than a rough indication of ebb and flow of employment activity. In the five years end-

ing July 1928 they have varied between 6,883 at the end of Dec. 1923, and 96,591 at the end of Feb. 1927. In 1928 the number on the live register fell from 32,849 in January to 8,009 in July

Belgium.—The Belgian statistics of unemployment cover about 630,000 workers voluntarily affiliated to insurance funds and belonging to the chief industries and to transport. They are based on the reports of these funds, which are controlled and subsidized by the State. There are also compiled statistics of the activities of public employment exchanges, open to workers of all kinds and established since the war on a national scale These two series of statistics are published monthly in *La Revue du Travail.* The insurance figures which are given below, distinguish between those wholly unemployed and those intermittently unemployed on the last working day of each month

Date (end of month)	Wholly unemployed		Partially unemployed	
	Number	Per cent	Number	Per cent
1928				
January	13,730	2·2	33,242	5·3
February	7,480	1·2	24,902	4·0
March	5,294	0·8	17,108	2·7
April	4,922	0·8	17,769	2·8
May	4,062	0·7	22,574	3·6
June	3,708	0·6	19,115	3·0
July	4,147	0·7	23,136	3·7

Netherlands.—The Dutch official unemployment statistics cover some 310,000 workpeople voluntarily affiliated to unemployment funds in the principal industries, as well as in different branches of commerce, transport and agriculture They show, *inter alia,* the number of members covered, the number and percentage of unemployed registered during the course of a week (an average for four or five weeks for the month), the total number and the number of days of employment per unemployed worker during the week These figures are also combined with those obtained from a few trade unions which have no unemployment funds but are able to give information regarding the number of members unemployed The percentages resulting from this combination differ very slightly from the others, as the supplementary data cover only about 9,000 workers In addition to these relatively complete figures less detailed statistics of a provisional nature are compiled

The figures for the five months ending June 1928, given below, relate to members of unemployment funds, supplemented by additional information from trade unions without such funds

Date (end of month)	Number unemployed	Percentage
1928 January	40,424	16·1
February	27,505	9·0
March	19,740	6·3
April	15,620	5·0
May	14,083	4·4
June	14,302	4·4

Sweden.—Official Swedish statistics regarding employment and unemployment cover state relief, showing the number of persons engaged on State or communal relief works; the activities of employment exchanges; statistics of employment in the principal industries based on returns from about 2,000 employers employing some 270,000 workers indicating the number of workers engaged and the general state of activity in the undertaking; and unemployment among members of trade unions. The last statistics cover more than 260,000 trade union members in the principal industries and in certain branches of commerce and transport Figures for the seven months ending July 1928 follow.

Date (end of month)	Number unemployed	Percentage
1928. January	37,135	14·5
February	35,183	13·4
March	36,722	13·3
April	32,218	11·7
May	22,978	8·2
June	21,257	7·6
July	20,238	7·2

(J. H.)

UNGAVA, the northern portion of the Province of Quebec, bounded by Hudson bay on the west; Hudson strait and Ungava bay on the north; and the coast strip of Labrador belonging to Newfoundland on the east The area is estimated at more than 300,000 sq m and includes much of the lower portion of Labrador, with a rim of recent marine deposits along its western coast, but the interior has the usual character of low rocky hills of Archean rocks, especially granite and gneiss, with a long band of little disturbed iron-bearing rocks, resembling the Animikie, or Upper Huronian of the Lake Superior region, near its eastern side Along Hudson bay shore there is a strip of similar rocks, and a long row of small islands of the same age, with great sheets of trap or diabase forming the tops of the hills Ungava, like the rest of Labrador, has risen several hundred feet since the Ice age, marine beaches being found up to 700 ft. on the Hudson bay side; and it is interesting to find seals like those of the adjoining sea-coasts in the Seal lakes 100 m inland and 800 ft above the present sea-level. Owing to its northerly position a large part of Ungava is treeless, and belongs to the barren grounds where caribou roam and feed on the so-called caribou moss, a greyish lichen.

UNGER, FRANZ (1800–1870), Austrian physician and botanist, was born at Amthof in Steiermark on Nov. 30, 1800. He studied medicine in Graz, Vienna and Prague He practiced in Stockerau and Kitzhubel and in 1833 became professor of botany at the University of Graz In 1849 he went to Vienna to occupy the chair of plant physiology. In 1866 he retired to live in the country near Graz where he died on Feb 13, 1870 Unger made many contributions to the understanding of plant anatomy and physiology, and was also much interested in plant palaeontology He contributed numerous articles to such scientific reviews as *Neues Jahrbuch Miner*, *Steiermark Nat*, *Ver Mitth*, etc His more important published works were *Die Exantheme der Pflanzen* (1833); *Ueber den Einfluss des Waldbodens auf die Verteilung der Gewächse* (1836), *Ueber der Bau und das Wachstum des Dikotyledonenstammes* (1840); *Ueber Kristallbildungen in den Pflanzenzellen* (1840), *Anatomie und Physiologie der Pflanzen* (1855); *Synopsis plantarum fossilium* (1845), *Chloris protogaea, Beitrage zur Flora der Vorwelt* (1841–47); *Inconographia plantarum fossilium* (1852); *Sylloge plantarum fossilium* (1860); *Die Urwelt* (1851), *Versuch einer Geschichte der Pflanzenwelt* (1852), *Geologie der Europaischen Waldbaumen* (1870), *Botanische Streifzuge auf den Gebiet der Kulturgeschichte* (1857–67)

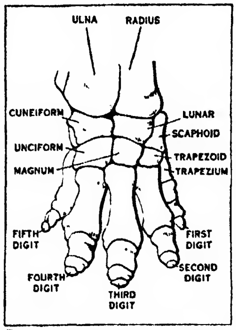
UNGER, RUDOLF (1872–), German writer and literary critic, was born in Hildburghausen in 1872 He studied in the universities of Heidelberg, Munich and Berlin, and in 1911 became professor in literature at Munich Since 1921 he has been professor of German literature at the university of Gottingen He is most noted for his studies in the period of Goethe He edited *Obras de Goethe* (1910) and *Briefe von Dorothea und Friedrich Schlegel* (1913), and wrote *Philosophische Probleme in die neueren Literaturwissenschaft* (1908); *Von Nathan zu Faust* (1916), and *Weltanschauung und Dichtung* (1917); and *Zur Geschichte des Palingenesisgedankens im 18 Jahrhundert* (1924).

UNGULATA, an order or super-order of placental mammals including the hoofed herbivorous quadrupeds Aristotle in his work on *The Parts of Animals,* in describing the extremities of the viviparous quadrupeds, says that " . . some are bifid and have hoofs instead of nails, as the sheep, the goat, the elephant, the hippopotamus, and some have undivided feet, as the solid-hoofed animals, the horse and the ass . ."

After the Renaissance Wotton (1552), following Aristotle, divided the viviparous quadrupeds into the many-toed, double-hoofed and single-hoofed. In 1693 John Ray divided the viviparous quadrupeds into two grand divisions, the Ungulata, or hoofed, and the Unguiculata, or clawed, forms. The former were subdivided into: (*a*) the Monochela, or Solidipeda, with solid hoofs, including the horse, the ass and the zebra, (*b*) the Dichela, or Bisulca, with cloven hoofs, and (*c*) the Tetrachela or Quadrisulca, including the rhinoceros and hippopotamus. The Dichela were again subdivided into the Ruminantia, or ruminants, and the Non-ruminantia, or swine; the Ruminantia were finally divided into

those with permanent horns, namely the cattle, sheep and goats, and those with deciduous horns, of the deer kind. Here then was a usable and nearly correct classification of the ungulates before the beginning of the 18th century.

Subsequent discoveries have added to the Ungulata a great many extinct and some recent groups which were wholly unknown to Ray. Thus in Osborn's *Age of Mammals* (1910) the "Cohort Ungulata" includes no less than 13 "orders" of hoofed mammals. While each of these is a more or less natural group of animals related by descent from a common ancestral stock, the derivation and interrelationships of the orders themselves are still far from clear. It is well established that the typical ungulates, namely the Perissodactyla (horses, tapirs, rhinoceroses, etc.) and the Artiodactyla (ruminants, swine, etc) were wholly distinct from each other in the Lower Eocene, some 50 to 60 million years ago It is indeed not improbable that the ungulate, or hoofed herbivorous type, was evolved several different times from different families of placental mammals of the Cretaceous period, or in other words, that many of the resemblances between ungulate orders are examples of either parallel or convergent evolution.



RIGHT FORE FOOT OF INDIAN ELEPHANT, SHOWING PARTS

Order Condylarthra.—In the Basal Eocene formations of New Mexico and in the Lower Eocene of Wyoming have been found the fragmentary jaws and teeth, and very rarely more or less entire skeletons, of small hoofed mammals which on the whole were *structurally* intermediate between the oldest creodonts or flesh-eaters, and the true ungulates Of these the most primitive was the genus *Mioclaenus,* known chiefly from the conical-cusped upper molars, which recall those of such primitive carnivores (creodonts) as *Tricentes* and *Claenodon* Somewhat higher in the scale was the group of species of the genus *Hyopsodus*; these little animals were about as large as a hedgehog, the skull being of remarkably generalized type The dental formula, (Incisors $\frac{3}{3}$ Canines $\frac{1}{1}$ Premolars $\frac{4}{4}$ Molars $\frac{3}{3}$)$\times 2=44$, was that of other very primitive placental mammals The crown-patterns of the molar teeth were advancing ever further away from the primitive tritubercular type toward the more typical condylarth types presently to be described

By far the most famous condylarth was the Lower Eocene *Phenacodus primaevus,* an animal about as large as a Newfoundland dog, which has figured in many textbooks as the "five-toed ancestor of the horse." But W. D Matthew has advanced decisive evidence against this view. For in *Phenacodus* (*q v.*) each quadrangular upper molar had four conical main cusps and two very small intermediate cusps or conules; whereas in the contemporary ancestors of the horse family the oblique crests of the molars were progressively developed. Even in the Lower Eocene genus *Ectocion,* which was related to *Phenacodus,* the detailed patterns of the upper and lower molars were not quite right to be structurally ancestral to the molars of the primitive horses. Another Eocene condylarth, the genus *Meniscotherium,* had more complex upper molar patterns of the type known as buno-lopho-selenodont (*i.e.,* with cones, ridges and crescents), which in some respects foreshadow the general molar types of such later ungulates as the hyracoids, the chalicotheres and the litopterns

The foot structure of the condylarths was likewise of interest. In the five-toed hind foot the ankle bones were much like those of a contemporary creodont, with a ball-and-socket joint at the lower end, an arrangement to which the name Condylarthra refers. In the fore foot of *Phenacodus* the two rows of carpal bones were placed directly above each other, "like unstruck bricks," whereas in typical ungulates a more displaced, or alternating arrangement, was the rule. E D Cope supposed that *Phenacodus* was in this respect also ancestral to later ungulates but Matthew showed that in both *Phenacodus* and the later ungulates the contrasting arrangements of the carpal elements above mentioned were probably both derived independently from the still older interlocking creodont type.

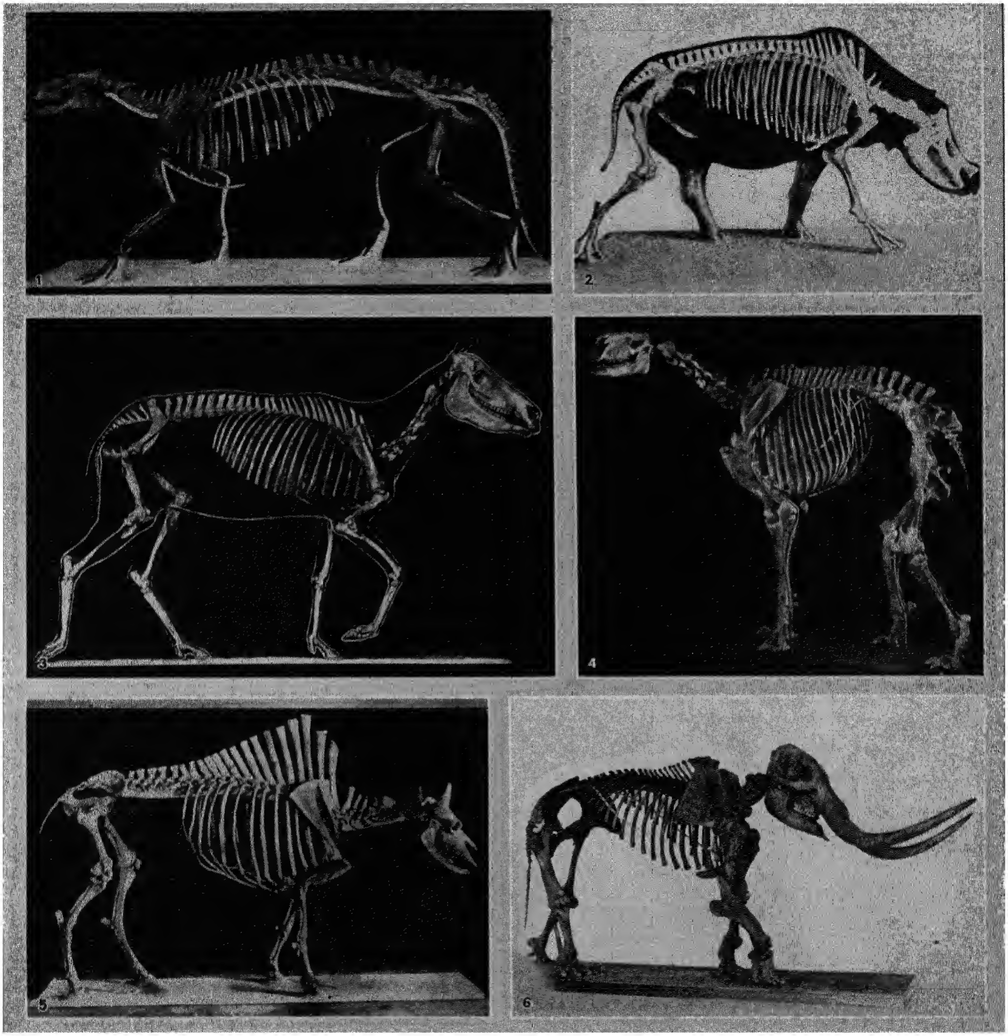
Amblypoda (*q.v.*).—In the basal Eocene of New Mexico occur the fragmentary remains of a diversified series of small hoofed mammals collectively known as Taligrada, or primitive Amblypoda Some of the smaller genera were hardly bigger than insectivores and with teeth suggestive of insectivore-creodont ancestry, while the larger taligrades (*Periptychus, Pantolambda*) were about the size and proportions of stocky badgers. The upper molar teeth in the smaller forms had three main cusps arranged in a triangle with the apex toward the inner side; the small intermediate cusps or conules were more or less circular; the main internal cusp was flanked by small cusps borne by the anterior and posterior ridges or cingula. In *Periptychus* the upper molar cusps were all subcircular and the enamel surface was pleated. The brain-cast indicates a brain of extremely primitive form with large olfactory lobes and a minimum development of the neopallium. In *Pantolambda* the upper molar crowns bore two sharp outer V's and a centrally placed conical internal cusp

In all the taligrades the feet were short, especially so in *Pantolambda* This feature becomes greatly emphasized in the later members of the order, the coryphodons and Dinocerata *Coryphodon* is characteristic of the Lower Eocene of Wyoming and England It was broad-headed and almost hippopotamus-like Related forms have recently been found in the Eocene of Mongolia *Uintatherium, Dinoceras* and their allies were characteristic of the later Eocene. Their bodies were gigantic, larger than modern rhinoceroses, with massive, post-like limbs and extremely short stubby toes They had sabre-like upper tusks, six or more horn-like bony outgrowths on top of the skull and a brain of low type

Notoungulata.—The condylarths and taligrades disappeared from the fossil record of the northern hemisphere in early Eocene, but there is some reason to believe that some of them reached South America and there gave rise to the amazingly varied series of herbivorous mammals which are often referred to collectively as notoungulates These flourished for millions of years in Patagonia and adjacent regions, while the perissodactyls, artiodactyls and other ungulates held sway in the northern world These notoungulates exemplified the law of adaptive radiation on a grand scale. Protected by geographical barriers from the deadly competition of their larger-brained northern analogues, they exploited all the economic possibilities for ungulates available in South America and gave rise to the wide diversity of forms that covered the ancient pampas Some (the protypotheres) were small and swift-running like rabbits, others (the smaller litopterns) were like slender-limbed three-toed horses, some (*Macrauchenia*) paralleled the llamas and camels, others closely paralleled the rhinoceroses, while a few almost rivalled the elephants in bulk (*Pyrotherium*).

Litopterna (*q v*).—Among the most primitive of the entire series of notoungulates is the genus *Didolodus,* a small forerunner of the litopterns known only from the upper cheek-teeth, which in some ways recall those of the smaller taligrades. In the swift-footed proterotheres of the Miocene of Patagonia both cheek-teeth and feet suggest those of the Oligocene three-toed horses of the northern world. But in the upper molars the main inner cusp is central rather than anterior in position and the posterior cross-crests fail to meet the middle point of junction of the two main outer cusps, as they do in the three-toed horses, while the feet, although superficially horse-like, differ profoundly from the horses in the detailed arrangements and contacts of the tarsal elements. The larger litopterns (*Theosodon, Macrauchenia*), while in general appearance paralleling llamas and camels, yet are more nearly related to the horse-like proterotheres in their deeper characters.

Entelonychia, or *Homalodontotheria.*—In the "*Notostylops* beds" of Lower Oligocene or Upper Eocene in Patagonia occur a strange group of ungulates, varying in size from a rabbit to a rhinoceros. Of these the most famous form, *Notostylops,* had a small skull in which the upper grinding teeth have oblique and flattened



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

EXTINCT MAMMALS OF TERTIARY AND QUATERNARY TIMES

1. Skeleton of Lower Eocene *Phenacodus primaevus*, believed to be a five-toed ancestor of the horse
2. Skeleton of Upper Oligocene *Diceratherium*, an extinct species of Rhinoceros
3. Skeleton of *Neohipparion whitneyi*, a horse of the Upper Miocene plains region of North America. The outline is restored
4. Skeleton of Lower Miocene *Moropus*. It stood about six feet high at the shoulders and resembled a large horse
5. Skeleton of *Bison occidentalis*, extinct North American mammal of the Quaternary period, inhabiting Kansas and Alaska. Closest species to the existing bison
6. Pleistocene North American *Mastodon americanus*, forerunner of the elephant

outer walls remotely suggesting those of recent rhinoceros. The lower molars bore long obliquely-placed blades on the hinder part or talonid. The skull as a whole suggests that of the recent *Hyrax*. In certain early members in which the feet are known there are five digits on the fore and hind feet, the terminal bones are cleft for the attachment of fairly large hoofs, the main ankle bone (astragalus) is more or less flattened. A single very small jaw, the genus *Arctostylops* of Matthew, found in the Lower Eocene of Wyoming, appears to be related to these South American Entelonychia. Another apparently related type is found in the Eocene of Mongolia. These small jaws seem to increase the probability that the South American Entelonychia, like other members of the notoungulate series, had been derived from some basal Eocene or Upper Cretaceous forerunners of the taligrades and condylarths of the northern world. Of the later Entelonychia the best known is the Santa Cruzian (Lower Miocene) genus *Homalodontotherium*, a larger form in which all the teeth had become high-crowned and all the incisors, canines, premolars and molars were pressed together in a continuous series without break or interval.

The *Astrapotheria*, gigantic Santa Cruzian (Lower Miocene) forms with long downwardly growing tusks, may be highly specialized derivatives of some early member of the Entelonychia.

Toxodontia (*q v*).—These were perhaps the most numerous in species of all the notoungulate series. The Santa Cruzian (Lower Miocene) *Nesodon* was about the size of a rhinoceros but with the back curved and the limbs shorter. The front teeth were enlarged and flattened for cropping vegetation, the upper molar teeth had extremely long oblique outer walls and folded wearing surfaces. The three-toed feet, although rhinoceros-like in appearance, agreed with those of the litopterns in their fundamental characters. The Pampaean (Pleistocene) *Toxodon* was still larger, with a gigantic head and a huge curved back. This was one of the famous fossil South American mammals studied by C. Darwin (see *Voyage of the Beagle*)

Typotheria.—The smaller genera of this group, named protypotheres, included some that broadly resembled *Hyrax* and others that were rabbit-like They were very abundant in the Lower Miocene of Patagonia. The extremely high-crowned molar teeth were much curved transversely, as in some rodents, and were adapted for grinding tough vegetation The later form, *Typotherium*, from the Pampaean or Pleistocene of Argentina, had rodent-like incisors. It was about as large as a brown bear. This group is rather closely related to the toxodonts

Pyrotheria.—In these curious animals the molars were bilophodont, that is they bore two cross-crests like those of tapirs and dinotheres The skull in some ways resembled those of the Proboscidea (*q.v*) and the same is true of the tusks, but on the whole it seems more likely that the pyrotheres are simply the South American analogues of the Proboscidea.

Hyracoidea (*q.v.*).—This characteristically African group is represented to-day by the "coneys" or dassies of southern and west Africa, Abyssinia, Arabia and Syria These furry little animals have but slight external resemblance to ungulates but their jaws and teeth abound in resemblances to ungulates of many groups The internal anatomy shows a curious mixture of resemblances to elephants and perissodactyls There is no satisfactory evidence, however, of the relationship of *Hyrax* to any of the groups so far named. The hyracoids as a group must have been in Africa for many millions of years, since various forms of fossil hyracoids have been found in the Lower Oligocene of the Fayûm district in Egypt. In some of these very ancient hyracoids (*Megalohyrax*) the molar teeth recall those of Eocene titanotheres or of *Meniscotherium* among the condylarths. In its skull *Megalohyrax* was more or less swine-like.

Embrithopoda.—While the hyracoids played the part of the small ruminants in the ancient fauna of the Fayûm, the economic rôles of the rhinoceroses and elephants were assumed by gigantic beasts named *Arsinoitherium* (*q.v.*) in honour of an Egyptian queen. In these very strange animals the whole fore-part of the skull was surmounted by an enormous pair of bony horns, which in the front view rose to a great height The folded surfaces of the molar teeth remotely recall those of the American Eocene amblypods, but the premolars rather suggest relationships with the hyracoids. The body was very massive and the skeleton shows a curious mingling of resemblances to elephants and amblypods, doubtless the results of similar adaptations to slow browsing movements and the support of the immense body weight. The existence of these highly specialized animals in Africa at such an early date as the Lower Oligocene and their apparent isolation, in spite of their adaptive resemblances to elephants and amblypods, all indicate a very long line of less and less specialized ancestors, traces of which may some day be discovered when still older fossil-bearing horizons are discovered elsewhere in Africa.

Barypoda.—Still another strange type of extinct ungulate (named *Barytherium grave* by C. W. Andrews) was discovered in the Fayûm district of Egypt along with the fossil hyracoids, arsinoitheres and ancestral elephants. The only parts of the animal found were a large lower jaw, a humerus and a radius, all of which show a curious mixture of resemblances on the one hand to the primitive proboscidean *Moeritherium* and on the other hand to *Dinoceras* of the Amblypoda. In a general way it also resembles the ancient South American *Pyrotherium*.

Proboscidea.—The evolution and structure of the elephants (*q v*) are considered in the article PROBOSCIDEA, and further information can be found in H. F. Osborn's *Monograph* of this group As to the remote origin of the Proboscidea, the fact that *Arsinoitherium*, in spite of its wholly different skull and dentition, shows so many curiously detailed resemblances to the Proboscidea in its limbs and backbone, lends some support to C. W Andrews' view that the group of "Subungulata," consisting of the Proboscidea, Hyracoidea, Embrithopoda, Amblypoda, may after all be a more or less natural assemblage of ungulates. In fact we may even advance the tentative hypothesis that some such small Lower Eocene condylarth as *Hyopsodus walcottianus* (described by Matthew and Granger), with short spreading feet, reduced canines, slightly procumbent incisors and bunodont molars, would have been an ideal starting-point for the entire subungulate series, including also the South American Pyrotheria and perhaps even the Sirenia

Sirenia (*q v*)—If "common sense" and superficial appearances were trustworthy, these surprisingly whale-like mammals would still be classified with the Cetacea (*q v*) as they were by all early naturalists But De Blainville as far back as 1816 classified them as *"ongulogrades anomaux pour nager"*—anomalous ungulates adapted for swimming; in his later classification he brigaded them with the Proboscidea under the term "Gravigrades" Andrews in his description of *Eosiren* (the oldest known sirenian, from the Upper Eocene of the Fayûm, Egypt) pointed out a number of significant features in which the skull of *Eosiren* resembled that of *Moeritherium*, the oldest and most primitive known proboscidean from the same formation. He also cited a number of curious anatomical details in which even the modern Sirenia agree with the elephants in spite of the enormous difference in their external appearance and mode of life On the other hand, R. Lydekker pointed out that the unworn molar teeth of certain extinct sirenians were curiously like those of certain extinct artiodactyls (*Merycopotamus*) and that this fact suggested the derivation of the Sirenia from very early Eocene artiodactyls; but one might equally say that the molar teeth of another extinct sirenian (*Miosiren*) suggest those of the Eocene rodent *Ischyromys* and that the order Sirenia had therefore been derived from primitive rodents. Either of these views would be hard, in the present meagre state of our knowledge of the subject, to disprove; but neither has nearly as much positive evidence in its favour as the view of De Blainville and Andrews that the Sirenia are an aquatic specialization from the Proboscidean stem.

Be that as it may, however, by the time of the Lower Oligocene *Eosiren* was already definitely a sirenian in its dentition, skull and locomotor skeleton. Thereafter during the Oligocene, Miocene, Pliocene and Pleistocene epochs the changes in the skull and skeleton were comparatively slight and unimportant. The middle and late Tertiary sirenians (such as *Halitherium* and *Metaxytherium*) were for the most part considerably larger than the modern manatees and dugongs (*qq.v*) and had a large vertically-

placed pair of upper tusks, which have been retained by the dugongs but lost by the manatees.

The Sirenia are whale-like in their torpedo-like bodies and horizontal tail flukes, in the complete absence of external hind limbs and in their flipper-like forelimbs, which however still retain external nails or vestigial hoofs They differ markedly from typical cetaceans in their relatively small heads, truncate flattened snouts with transversely expanded upper lips covered with very large bristles The molar teeth are two-ridged,—wholly unlike the conical teeth of toothed cetaceans. Their tusks when present are situated at the end of the muzzle and directed downward They differ profoundly from cetaceans in their food and feeding habits, being the herbivores of the coasts and estuaries, whereas at least the typical cetaceans are essentially carnivores of the open seas. In their internal anatomy the sirenians likewise differ widely from cetaceans· the musculature of the forelimbs is less profoundly modified for aquatic life, the brain has a much less complexly convoluted surface and the digestive tract recalls that of the ruminants The skeleton of sirenians is peculiarly massive and dense, the swollen, heavy ribs serving apparently as ballast to keep these voluminous, gas-filled bodies below the surface.

Most of the many known extinct types of sirenians conform in essentials to the dugong type, but one extinct family, the Miocene *Desmostylidae*, is widely different from the rest In these the large upper tusks almost suggest the earliest proboscidean types but the most remarkable peculiarity is found in the molar teeth, each of which consists of a closely packed cluster of cylindrical columns of circular cross-section

Perissodactyla.—For the origin and evolution of this order of ungulates *see* PERISSODACTYLA

Artiodactyla.—This order is chiefly dealt with in the article ARTIODACTYLA Here it may be noted that attempts, as by Cope and others, to brigade the artiodactyls with the perissodactyls under the terms Taxeopoda or Ungulata Vera have in the long run only served to bring out the entirely artificial nature of such an assemblage and to throw into relief the significant differences which widely separated these two orders from each other as far back as Lower Eocene times There is indeed more to be said in favour of the view that the Artiodactyla may be an offshoot of some forerunner of the mesonychid family of the creodonts, while the Perissodactyla may be related remotely to the Cretaceous ancestors of the condylarths Recent studies by Miss H S Pearson on the skull structure of the earliest artiodactyls have revealed that at a very early date the order was already subdivided into two series, one the amastoid series, in which the mastoid region of the periotic bone was completely covered by the squamosal and adjacent elements (as in the suillines and their extinct relatives) and the other, or mastoid series, in which the mastoid was well exposed on the outer side, as in the Eocene Dichobunidae and all the ruminant artiodactyls

In conclusion, much future palaeontologic exploration, in Africa, in Mongolia and many other parts of Asia, will doubtless be necessary before many of the problems touched upon in this article can be pushed forward nearer to solution

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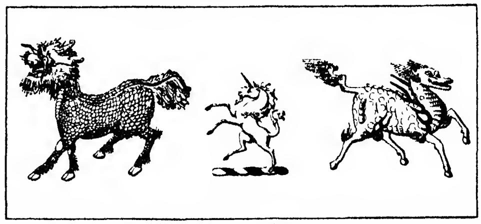
(W K. G.)

UNICORN, a fabulous beast, usually having the head and body of a horse, the hind legs of an antelope, the tail of a lion (sometimes horse's tail), sometimes the beard of a goat, and as its chief feature a long, sharp, twisted horn, similar to the narwhal's tusk, set in the middle of its forehead (Lat. *Unicornis*, single-horned, Gr. *μονόκερως*). The earliest description is that of Ctesias, who (*Indica opera*, ed. Baehr, p 254) states that there were in



FROM (LEFT AND RIGHT) GOULD, 'MYTHICAL MONSTERS' (ALLEN & CO), (CENTRAL) FAIRBAIRN, 'BOOK OF CRESTS' (T. C. & E. C. JACK)

THE UNICORN OF LEGEND AND HERALDRY

The centre illustration shows the heraldic unicorn, and those on the left and right, the Chinese and Japanese varieties respectively

India white wild asses celebrated for their fleetness of foot, having on the forehead a horn a cubit and a half in length, coloured white, red and black; from the horn were made drinking cups which were a preventive of poisoning. Aristotle mentions (*Hist. anim*, ii 1; *De part anim*, iii. 2) two one-horned animals, the oryx, a kind of antelope, and "the so-called Indian ass" In Roman times Pliny (*N H*, viii 30; xi 106) mentions the oryx, the Indian ass, and an Indian ox as one-horned, Aelian (*De nat anim*, iii 41; iv 52), quoting Ctesias, adds that India produces also a one-horned horse, and says (xvi 20) that the *Monoceros* was sometimes called *Carcazonon*, possibly a form of the Arabic *Carcadân*, rhinoceros

The mediaeval conception of the unicorn as possessing great strength and fierceness is perhaps due to the fact that in certain passages of the Old Testament (*e g*, Num xxiii 22, Deut xxxiii 17, Job xxxix 9–10) the Hebrew word *R'êm*, now translated in the Revised Version "wild ox," was translated in the Septuagint *μονόκερως*, in the Vulgate *unicornis* or *rhinoceros*, and in the Authorised Version "unicorn," though in Deut xxxiii 17 it obviously refers to a two-horned animal Isidore xii 2, 12 tells how the unicorn has been known to worst the elephant in combat

As a decoration on drinking-cups it symbolized the ancient belief in the efficacy of the unicorn's horn against poison, which in England remained, even in the time of Charles II, though Sir E Ray Lankester (*Science from an Easy Chair*, 1910, p 127) mentions that a cup made of rhinoceros horn was then handed over to the Royal Society for experiment, with the result of entirely disproving the superstition In the court ceremonial of France as late as 1789 instruments of "unicorn's" horn were still used for testing the royal food for poison

In heraldry the unicorn was sometimes used as a device (*see* HERALDRY), but oftener as a supporter, and subsists to the present day as the left-hand supporter of the royal arms This position it assumed at the Union, the Scottish royal arms having been supported by two unicorns. When the unicorn became a supporter of the royal arms both of England and Scotland, a royal crown was added on the head of the unicorn, in addition to the crown with chain and ring round its neck (*see* Great Seal of James I and VI in Anderson, Pl. xciii), but this crown was removed after the Hanoverian succession. In England after the Union the unicorn became the left-hand supporter, but in Scotland, as late as 1766, it was still put on the right (Seton, p. 442).

BIBLIOGRAPHY.—*See* Drexler *s.v. Monokeros*, in Roscher's *Lexicon;* and Rev. W. Haughton in *Annals and Magazine of Natural History* for 1862, p. 363, "On the Unicorn of the Ancients"

UNICORN-PLANT (*Martynia prosboscidea*), a North American plant of the family Martyniaceae, called also proboscis-flower and devil's-claw, native from Indiana to New Mexico and southward to Mexico, cultivated for its abundant foliage, peculiarly shaped flowers and oddly formed fruiting pods. It is a

coarse, sticky-hairy, half-prostrate annual, with thick, roundish leaves; larger violet or purple flowers, 1¾ in. long; and hanging, horn-like, woody pods, with a thick body, 3 in to 4 in long, ending in a curved beak of equal or greater length When dry, the beak splits into two opposed hook-like or claw-like appendages.

UNIDIRECTIONAL RADIO DIRECTION FINDER, a radio device which permits determination of the direction (without 180 deg. ambiguity) of waves as received from a transmitting station.

UNIFIED FIELD THEORY, a term widely applied, early in 1929, to represent the new theory which was then advanced by Dr. Albert Einstein, according to which there is but a single background to all material activity—one unified field A material object is commonly conceived of as existing in *space* and *time.* The scientist often adds that the object is in a *gravitational field* and in an *electro-magnetic field* These four terms seem to attribute four different backgrounds to the object But the special theory of relativity (*q v.*) has amalgamated space and time into space-time and the general theory of relativity, with its Riemannian geometry, has absorbed the gravitational field into space-time. Thus three of the four terms were already reduced to one. The unified field theory goes a step further by including the electro-magnetic field A survey of Dr Einstein's announced solution of the problem of unification has been written by Professor A S. Eddington, and will be found immediately after Dr. Einstein's own article on SPACE-TIME in vol. xxi, page 108.

UNIFORMS. The word "uniform" (Lat *unus*, one, and *forma*, form), meaning adjectively homogeneous, is specifically used as a substantive for the distinctive naval, military and air service dress, which serves, in its various styles, to give homogeneity to the several services, regiments and ranks. Although in ancient history we occasionally meet with uniformed soldiers, such as those of Rome and the white and crimson Spanish regiments of Hannibal, it was not until the establishment of standing armies that uniforms were introduced in modern times The absence of uniforms accounts very largely for the significance attached to the colours and standards, which alone formed rallying points. The beginnings of uniforms are therefore to be found in truly national armies, in the *Indelta* of Gustavus, and the English armies of the Great Rebellion In the earlier years of the latter, though the richer colonels uniformed their men (as, for instance, the marquess of Newcastle's "Whitecoats" and the king's own "Bluecoats"), the rustics and the citizens turned out for war in their ordinary rough clothes, donning armour and sword-belt But in 1645 the parliament raised an army "all its own" for permanent service, and the colonels became officials rather than proprietors. The "new model" was clothed in the civilian costume of the date —ample coat, waistcoat, breeches, stockings and shoes (in the case of cavalry, boots)—but with the distinctive colour throughout the army of red and with regimental facings of various colours. The regiments were known as the Blue, Orange, Yellow, etc. Regiments—according to the colour of these facings The breeches were grey. Soon afterwards the helmet disappeared, and its place was taken by a grey broad-brimmed hat From the coat was evolved the tunic of to-day, and the hat became the cocked hat of a later generation, which has never altogether disappeared, and has reverted to its original form in the familiar "slouch-hat."

For service in Ireland the red coat was exchanged for one of russet colour. The cavalry, however, wore buff leather coats and armour long after the infantry had abandoned them; the Austrians on account of their Turkish wars, retained them longer than any.

Thus the principle ever since followed—uniform coat and variegated facings—was established In France, as in England and Austria, the cavalry, as yet rather led by the wealthy classes than officered by the professional, was not uniformed upon an army system until after the infantry. But in 1688 six-sevenths of the French cavalry was uniformed in light grey with red facings; and about half the dragoon regiments had red uniforms and blue facings. Louvois, in creating a standing army, had introduced an infantry uniform as a necessary consequence. The native French regiments had light grey coats, the Swiss red, the German black and the Italian blue, with various facings.

The hat and the long coat and breeches remained the uniform of line infantry almost everywhere up to the advent of the shako and the coatee about 1790–1820 The gradual evolution of these two garments, from the comfortable civilian clothes of 1690 to the stiff, precise military garments of 1790, can be traced in a few words The brim of the felt hat was first looped up on one side for convenience, then, for appearance' sake, on the other, and so became the three-cornered cocked hat, fringed with feathers, lace or braid, of Marlborough's wars Then came the fashion of looping up before and behind, which produced the hat called the "Khevenhuller," or the broadside-on cocked hat Lastly, came the purely decorative, lace-looped "fore-and-aft" pattern Though the long skirts that rendered great coats unnecessary were looped back, and the ample cuffs of Marlborough's time were becoming narrower until they were at last sewn down to the sleeve, yet the military costume was in all essentials the civil costume of the time —long coat, hat, sleeved waistcoat, breeches and gaiters.

The introduction into armies of Slavonic irregulars, tended to restrict line infantry and cavalry to parade drill and to pitched battles in parade order This stiffened their costume until it became "soldierly" The flapped cuffs have become plain round cuffs, above which are embroidery stripes and buttons which at one time laced the flaps of the cuff together and now survive as the "guard-stripe." This may be called the first instance of the dummy adornments, which are so marked in modern full-dress uniforms Similarly the former cloth turnback on the front of the coat has even in 1756 been cut off, the buttons and embroidered loops that retained it being kept as decorations

Many of these specially military adornments were borrowed from the national costumes of the irregulars themselves Their head-gear in particular drove out the cocked hat. The grenadier cap, now a towering bearskin, was its first successful rival, the shako the next The grenadier cap was, in the first instance, a limp conical cap (identical with the hussar cap), edged with fur and having a tassel at the end Soon the fur became more prominent in the front, and the tail disappeared. Then the cloth mitre-cap appeared This was originally a field-service cap with ear-flaps and sunshade. From the narrow and forward-pointing bearskin of Peninsular days, it evolved into the great fur cap of grenadiers and fusiliers of the present time As early as 1755, a conical leather cap with a large brass plate in front had come into existence This held its ground for some time, and the grenadier cap of the modern Russian and German armies was a metal copy of the mitre field-service cap itself

The Hungarian hussars introduced the jacket and the busby The latter was originally a conical cap with fur edge, but the fur became higher until there was nothing left of the cap but the ornamental "busby-bag" of to-day The lancer cap, which, originally the Polish czapka, was a cylindrical cap with a square top, the upper part of which could be pushed up or down after the fashion of a bellows or accordion. The line infantry and cavalry coat, full-skirted in the first instance, retained its original length until about 1780, but from that time onwards it becomes, little by little, shorter and scantier until at last it is a "coatee," not as long as the present-day tunic or a swallow-tailed coat This did away with the protection afforded by the full skirt, and necessitated the introduction of the great coat The white breeches and gaiters, retained to the last, gradually gave way to trousers and ankle boots in 1800–1820

Meanwhile another form of head-dress came into vogue This was the helmet, which had disappeared from the infantry about 1650–1670, and the cavalry thirty years afterwards It took two forms, a small helmet with sausage-shaped ornament from front to back, worn chiefly by British light dragoons and artillery, and the towering crested helmet worn by the French, British and Austrians The French cuirassiers and dragoons had long horse-hair tails dependent from the crest

At the beginning of the 19th century gaitered breeches were replaced by trousers and cavalry uniforms were increasing in brilliance. After Waterloo, indeed, all traces of the old-fashioned coat disappeared, and, the soldier was more showy and worse off in comfort and convenience than previously The hussar furred pelisse, originally worn over a jacket had become a magnificently

embroidered and laced garment, always slung and never worn, and the old plain under-jacket had been loaded with buttons and lace, and differed from the pelisse only in the absence of fur The dress regulations of 1855 introduced the low "Albert" shako and the tunic, and abolished the epaulette

The tunic, accompanied by a spiked helmet of burgonet shape, had been introduced in Prussia and Russia about 1835 The French adopted the tunic in 1853, the Austrians in 1856, and in both countries the shako became smaller and lighter. From about 1880, when the spiked helmet replaced the low shako in England, no radical changes were made in full dress uniforms, except that the Russian army, abandoning the German pattern uniforms formerly in vogue, adopted a national uniform In 1906–1909, however, this attempt to combine handsomeness and comfort was given up, full dresses being made more decorative, and light green-grey service dresses being introduced Lastly, subsequent to the South African War and its revelation of the development of infantry fire, the attempt to wear full dress uniform on active service was practically given up Great Britain first of all adopted the Indian khaki, and then a drab mixture for "service dress" Germany, Italy, the United States and other countries followed suit, though each has chosen its own shade, and the shades vary from light grey blue in Italy to deep olive drab in the United States The details of the present-day uniforms in the principal states are given below (X)

GREAT BRITAIN

The uniforms of the British Army fall into two main categories (a) full-dress and (b) service dress From 1881 to 1914 full-dress had not undergone any radical change, although minor alterations had been sanctioned in a few cases to express some regimental tradition or national sentiment On the outbreak of the World War full-dress ceased to be worn and up-to-date (1928) it has only been re-introduced for the Household Cavalry, Brigade of Guards and regimental bands

(a) **Full Dress.**—Within each arm of the service the regiments or corps composing it possess special distinctions. For details reference should be made to the British Army Dress and Clothing Regulations.

(i) *Cavalry*—There are two main divisions of Cavalry, viz. "Household Cavalry" and "Cavalry of the Line." The Household Cavalry consists of the The Life Guards and Royal Horse Guards The distinctive features of these regiments are their steel cuirasses, white leather breeches and high jack boots reaching above the knee They both wear single-breasted tunics, that of the Life Guards being scarlet and that of the Royal Horse Guards blue, and metal helmets with horsehair plumes Both regiments mount guard at "The Horse Guards" Whitehall, where their brilliant uniforms have attracted the attention of many generations of London sightseers

The Cavalry of the Line consists of Dragoon Guards, Dragoons, Hussars and Lancers All wear blue pantaloons (with broad distinctive stripes on the outside) and jack boots Dragoon Guards and Dragoons wear a single breasted tunic and metal helmet with horsehair plume (except The Royal Scots Greys [2nd Dragoons] who wear a bearskin cap) Lancers wear a double breasted tunic (the front or "plastron" reaching from the shoulders to the waistline) and lancer caps (the Polish Czapka) with drooping plumes Hussars wear a single breasted ribbed jacket and fur busby

(ii) *Infantry*—Foot Guards all wear tall bearskin caps, red single-breasted tunics with blue facings, blue trousers with a red stripe The regimental distinctions consist in the spacing of the buttons on the tunic, colour of the plume of bearskin, colour of cap-band and badges and titles on the tunic. Infantry of the Line wear a cloth helmet (dark blue, black or green) which is to be replaced by a shako scarlet tunic, blue cloth trousers with a red stripe, with the following exceptions; Rifle Regiment astrakhan cap, dark green tunics and trousers; Fusiliers wear a bearskin with hackle plume instead of a helmet. Scottish Regiments, both Highland and Lowland, wear a "doublet" with gauntlet cuffs, Highland regiments wear a tartan kilt and plaid and sporran, diced hose-tops and white spats. Lowland regiments wear tartan "trews." Highland regiments wear a "feather bonnet," Lowland the Kilmarnock bonnet. The Cameronians (Scottish Rifles) wear a shako

(iii) *Royal Artillery.*—All wear blue riding-breeches (with broad red stripes) and jack boots, cloth helmet and blue single-breasted tunic, except Royal Horse Artillery who wear a cylindrical fur busby and short ribbed jacket. The cylindrical fur busby, however, is to become universal throughout all branches of the Royal Artillery

(iv.) *Royal Engineers*—Scarlet tunic, blue trousers and cloth helmet (to be replaced by cylindrical fur busby)

(b) **Service Dress.**—As a result of experience gained during the Boer War (1899–1902) service dress of khaki serge was introduced in 1903 and is still in use At the same time a khaki great coat was introduced, and a peaked cap and puttees. During the World War the cap was made of "soft" flexible material. The Royal Tank Corps wear a bonnet of the "beret" pattern

(c) **Mess Dress.**—Officers mess dress consists of a jacket of Eton cut with roll collar, waistcoat, overalls and Wellington boots

The use of gas and the enormous increase in the use of shrapnel have led to an addition to the field uniform of the British soldier —viz, the gas respirator and the steel helmet With a view to accustoming the men to their weight and employment, they are now worn during all field exercises

THE UNITED STATES OF AMERICA

As with the British service, the full dress uniforms worn before the World War have not yet been authorised However, full dress was practically of one universal pattern and had few of the distinctions which is a characteristic of the British full dress. The olive drab service dress is now the prescribed uniform for ordinary wear. In the tropics or in hot weather white uniforms may be worn by officers and warrant officers when not on duty with troops under arms. When off duty and away from their station the wearing of civilian dress by officers is optional except in the Philippine, Hawaiian and Panama Canal Departments and in Porto Rico For wear in Alaska, special clothing is provided. heavy all wool underwear, double cloth-lined pea jackets, duck and fur parkas, buffalo overcoats, water and winter mucklucks, shoe pacs, goose-down filled bed comforts, fur caps and gauntlets

(a) **Full Dress.**—The Infantry pattern dress is the basis of all arms It consists of a dark blue, double-breasted tunic with thick gold shoulder cord, light blue gold laced collar, light blue trousers with white stripe, peaked cap of stiff blue cloth, light blue band with eagle badge The Cavalry pattern is the same as the infantry but with yellow collar, cap band and trousers stripes Artillery, the same as infantry but with red collar, cap band and trousers stripes Engineers, the same as infantry, but with red ground with white edges on collar and cap band. Ordnance Corps, the same as infantry but with dark blue red-edged trousers stripes

(b) **Undress.**—Universal dark blue single-breasted frock, black-braided and hooked, trousers as in full-dress; cap same shape as full-dress but with plain black braid band

(c) **Mess Dress.**—Blue with shoulder cords, and blue trousers

(d) **Service Dress.**—This is the ordinary uniform now worn at the present time by all ranks It is olive drab made of either wool or cotton according to the climate or weather The coat is single-breasted with shoulder loops of the same material and a notched lapel collar, and fastened with four equally-spaced regulation buttons. For enlisted men the skirt is slit at the back from the lower edge and $\frac{3}{4}$ of the distance to the waistline; for officers from the lower edge of the waistline. The breeches are made of material to match the coat. The overcoat is a double-breasted ulster of woollen material with pleated back, with a double row of buttons made of horn, four on each side The cap is of woollen material similar in the shape to the British pattern, but with a leather covered peak and a mohair braid band, with a chin strap of brown leather. There is also a hat of olive drab, wideawake type, Montana peak; the cord is of colours varying according to the rank and branch of the service.

The Army Nurse Corps.—For indoor wear all members wear a one-piece white uniform; outdoor they wear an olive drab skirt, coat and overcoat or cape with an olive drab cap. Student members of the Army Nursing School wear a one-piece blue gingham

uniform indoors and a navy blue shirt, blouse, overcoat and hat out of doors.

Field Service.—As in the British Service the World War has caused the gas mask and steel helmet to become permanent articles of equipment of the U S.A The Service Gas Mask now in use is the 1919 model and combines the portability of the British pattern and the comfort of the French Tissot type. A russet boot, with bellows tongue and laced to the top, is provided for wear by cavalry and field artillery.

FRANCE

1 The French Army The Metropolitan Army is clothed in "horizon" blue, the Colonial Army being clothed in khaki of a nature similar to the British All arms are dressed alike except for the different coloured patches on the collars of the uniform, and in some cases pipings on the trousers or breeches. Exceptions to this rule occur in the case of the Chasseurs à Pied who are clothed in dark blue, yellow piping on the breeches and yellow patches on the collars and who wear a beret except in war time Other exceptions are special corps like the Chasseurs d'Afrique and various regiments of Spahis all of whom wear a special dress with a very large coloured burnous outside it, and a fez or turban in the case of the native ranks

2 A steel helmet of a pattern introduced in the late war is universally worn on active service In peace time the army either wear a peaked forage cap, a "bonnet de police" or a beret.

3 Simplicity is the keynote of the French uniform, the full dress for officers merely consisting in adding epaulettes and full dress belt to the "horizon" blue uniform A survival of old times remains in the French foot soldiers' overcoat, which is normally worn in marching order and is of the old French pattern with a skirt which can be looped back for marching He wears breeches, puttees and ankle boots; in the case of mounted troops leather gaiters with side buckles over the infantry ankle boot.

Regiments specially distinguished in the war of 1914–1918 wear a fourragère or aiguillette of the colours of the "Legion of Honour," the "Medaille Militaire" or the "Croix de Guerre" on the left shoulder

GERMANY

Service Uniform.—The present uniform of the German army is derived from the field service uniform of 1914 and has been modified in accordance with the experience of the World War It is claimed to be durable, comfortable and inconspicuous The shade of "Feldgrau" (field grey) which is the prevalent colour employed is of practical protective value in most northern latitudes The regulations provide for five orders of dress, viz. (a) Marching order (Feldanzug), (b) Drill order (Dienstanzug), (c) Fatigue dress (Arbeitsanzug), (d) Sports kit (Sportanzug), (e) Normal walking-out dress (Strassenanzug)

Peace and field service uniforms are identical The jacket is made of field grey cloth and has cloth shoulder-straps edged with coloured piping indicating the branch of the service to which the wearer belongs The steel helmet is of the pattern introduced in 1916 and is now the only helmet in use in the German army It is roughly bell-shaped, is made of hard magnetic nickel steel and weighs about 2½ pounds On either side a large lug projects from the body of the helmet These lugs serve a double purpose. (a) A heavy bullet-proof protective face shield can be attached to them for use by snipers and observers (b) When not in use for this purpose, the lugs, which are hollow, serve to ventilate the helmet. On the left side of the helmet, which is painted field grey, a small badge is painted in the colours of the State of origin to which the wearer belongs

Two patterns of caps are used: the field service cap (Feldmutze) made of soft cloth with a cloth cockade of the State colours worn on the cap band; in cold weather this cap may be worn under the steel helmet: the service dress cap (Dienstmutze) is a peaked cap made of ordinary field-grey cloth, the cap-band is grey-green made of the special cloth for badges and piping in the colour of the arm of the service

Trousers and pantaloons of grey cloth without raised seams are issued to all arms. Trousers are worn by dismounted units when "half-jack" boots are worn and alternatively with overalls by all arms when walking out, pantaloons are worn by mounted men in field service marching order and by dismounted men when laced boots and puttees are ordered. The greatcoat worn by "other ranks" is of universal pattern and is made of field-grey cloth. The lower corners may be hooked up to facilitate marching in difficult country Gloves of grey cotton are issued to all ranks, though woollen ones are sometimes worn

POLAND

The Polish army is equipped with a universal pattern uniform of khaki The same uniform is in use for home service and in the field The tunic is of khaki serge, with upright collar On each side of the collar opening is a patch of coloured cloth, about 4″ long, with rear edging of different colours, varying with the arm, except in the cavalry and horse artillery, who wear in the same place a miniature pennon of identical colours with those of the lance pennon Trousers or breeches are of plain khaki serge or cord. General officers wear a double dark-blue stripe down both breeches and trousers

A modified form of the national headdress or czapka, has been adopted and made into the headgear for all ranks of the Polish army A band of coloured cloth, varying with the regiment, is worn round the cap in the cavalry On the front of the cap is worn the badge of rank A steel helmet of French pattern is worn by troops on manoeuvres and in war A silver eagle is attached to the front The soldier's greatcoat is of khaki cloth, single breasted, with broad collar, belt and shoulder straps The officer's is similar but the new pattern is similar to the double-breasted British During winter fur coats of no standard pattern, with fur collars, are allowed Khaki mackintoshes are also worn A gas mask is carried

BELGIUM

The Belgian Army is universally clothed in khaki, of a pattern very similar to the British The peace and war uniforms are identical Officers also invariably wear khaki uniform, the classes of dress for special occasions being varied by the addition of epaulettes, medals, and overalls for full dress or ceremonial purposes The uniform of all ranks is serviceable and solid No pre-war uniform is worn, except by the gendarmerie, who have retained their black and silver kit for general wear Wound and service stripes are universally worn by those entitled to them

THE NETHERLANDS

Review order has now been abolished entirely and field service uniform of a grey-green type is universal It consists of a kepi, tunic, knickerbockers, puttees (riding breeches and black leather leggings for mounted troops), black boots and overcoat Each soldier on joining the colours receives two tunics, one new and one part-worn The tunic is of grey-green cloth with one row of bronze buttons The collar is upright with coloured piping for all arms except cavalry and horse artillery The steel helmet is similar to the French pattern and weighs 2 2 lb

SWITZERLAND

In 1915, a grey-green field uniform was adopted. The universal pattern tunic is of grey-green cloth, with an upright collar (except for cyclists), breast and side pockets The different arms are distinguished by coloured collar patches, cuff tabs, pipings, etc. The trousers are of grey-green cloth with piping down the outer seams of the same colour as the facings Officers wear riding breeches. General Staff Officers wear a black stripe down the seam. The officer's cap is grey-green with a black leather peak and chin strap. It is of a peculiar shape, being high and full at the back of the head; piping the same colour as facings; gold and silver stripes varying in number and width according to rank Army Unit Commanders and General Staff officers wear a black cap band. The kepi is of felt, with peak before and behind. The kepi is now used for all training purposes, replacing it by a steel helmet of a distinctive pattern being high-crowned and coming low down over the ears and brow The gas mask is a combination of the French and German models. A new mask of American manufacture is being tested

THE NEW EUROPEAN STATES

Baltic States.—On the formation of their armies these states at first adopted provisional uniforms; these have now been replaced by some of an entirely new pattern, which approximate to the British in general cut and colour. For winter there are special caps, furred and with earflaps, short sheepskin overcoats for general purposes, and extra heavy greatcoats for guard purposes. For summer a light cotton tunic or blouse of Russian pattern is worn.

Yugoslavia.—(a) All ranks of the *Guards* are supplied with an elaborate full dress The service dress is of olive yellow cloth and consists of a soft service cap, a loose jacket with shoulder straps, on which are the number of the regiment and the badges of rank, loose breeches, tight from the calf to the ankle, puttees and black boots Mounted men wear riding breeches of the same colour, with black boots and leggings. Each army has a clothing department organized as a battalion of 2 companies. The steel helmet in appearance is much like a dragoon helmet

Czechoslovakia.—The Army is clothed in a light olive drab cloth, or cotton drills The gendarmerie, who are clothed in all respects as the army, use a field grey cloth For officers and permanent staff warrant officers and N C Os there are two orders of dress (a) *service dress* and (b) *walking-out-dress*, which is service dress with certain modifications. The various arms and services are distinguished by their facings, units are indicated by numerals or collar badges The same pattern cap badges and buttons, in various metals, are used by all.

Officers and Warrant Officers wear olive drab Trousers and pantaloons as for walking-out dress. Cap, soft forage cap without peak, with bronze badge This can be worn inside the steel helmet, and can be pulled down to cover the ears in cold weather. Other ranks wear a jacket of olive drab woollen material, four patch pockets Pantaloons, cavalry scarlet-cloth; other arms drab cloth Trousers, all arms drab cloth Cap, all arms, soft service dress cap as for officers N C Os are provided with, and privates may purchase for themselves, stiff forage caps, to be worn when walking out. Greatcoats, double-breasted with strap across back Cavalry have a short warm coat All ranks are provided with a cotton jacket of the same pattern as the service dress jacket for wear during summer training. Gas masks form a part of the equipment, as also do steel helmets of the German pattern

JAPAN

Officers and Warrant Officers have a full dress which they wear on ceremonial occasions when not on parade with troops Khaki is the normal uniform for all ranks, that for officers and warrant officers is similar in shade to that worn in the British Army, while that of the non-commissioned officers and men is of a more yellow shade The various arms of the army are distinguished by the colour of the collar patches. Units are distinguished by numerals on the collar patches. The cap and buttons are the same for all arms From June to September inclusive, non-commissioned officers and men wear uniform similar to Indian drill. In winter, for service in Korea and Manchuria, special articles of uniform are issued

Full dress consists of a blue kepi, of French pattern, the guards and military police wear a red kepi: a blue frock-coat, with gold collar, around which runs a coloured band, denoting the arm; gold aiguillettes from the right shoulder are worn by Generals and General Staff Officers; blue trousers, with a broad stripe down the outside of each leg of a colour to denote the arm of the service; military police wear red trousers Cavalry officers wear a blue tunic, blue breeches and black butcher boots Cavalry of the Guard wear red breeches

Khaki.—Dismounted officers wear a green shade; the winter uniform is made of thick nap cloth of rather hard texture, the summer cloth is a light but rather coarse gabardine. The cap and jacket are of German pattern, the breeches button below the knee. Puttees also are worn Mounted officers wear uniform as for dismounted officers except that long "pull-on" black boots are worn instead of puttees and ankle boots. Non-commissioned officers and men wear khaki serge, the jacket, trousers and puttees similar to the British pattern. Officers wear an armless cloak of khaki serge reaching to the knee. A hood is attached to go over the cap when required Officers' greatcoats are similar to the British pattern in 1914, but slightly shorter. They are double-breasted. The steel helmet is similar to the British pattern but heavier. It is dome-shaped with no back shield, giving a cap-like appearance. It is painted a sandy brown colour. It is not issued in peace. The gas mask is a British small box respirator with modifications suitable to the build of the Japanese soldier and his volume of respiration; is not issued in peace-time

SPAIN

(a) **Full Dress.**—This approximates the French in general style and hue The tunic and greatcoat (long cape in the cavalry) is blue throughout the army General officers and officers of the infantry wear red trousers The kepi is practically universal, corps being distinguished by its colouring.

(b) **Service Dress.**—Owing to the unsuitability for active service of the former pattern it was decided in 1927 to change it completely The new pattern consists of a cap, tunic, breeches and puttees all made of material of a greenish tint

ITALY

The wearing of uniform is obligatory at all times except for General officers The regulation full-dress and undress for all ranks, arms and services is of a grey-green cloth but, during the summer months, washable grey cotton drill is worn as undress by N C Os and men

Full Dress.—(a) A cap is the normal head-dress for officers but when under arms officers wear a steel helmet with the badge of the corps or a special head-dress appertaining to cavalry, bersaglieri, etc When actually in command of troops higher commanders wear an aigrette Braid shoulder straps, plaited in the form of the knot of Savoy are worn, the width being in accordance with the rank of the wearer, that of generals being ornate silver or gold A blue sash is also worn Officers of all dismounted arms, when on duty, normally wear a large cape (*mantellina*) extending to the knees, those of mounted arms wear a double-breasted greatcoat (*pastrano*) (b) Other ranks wear a cap similar to that of the officers, except that it is made of coarser material, and steel helmets or special head-dresses are worn when under arms The tunic is single-breasted, with plain pointed cuffs, and stand-up collar The regimental badge in metal is on the shoulder-strap Dismounted men wear pantaloons and mounted men breeches Mounted men wear grey-green greatcoats and dismounted *mantellina*

Undress.—(a) Officers on ordinary duty wear a cylindrical cloth cap but on special duty, *i e*, active service, ceremonial parades, etc, the steel helmet is worn Collars of stand-up pattern are universal except for bersaglieri cyclist officers who may wear turn-down collars. The shoulder-straps are detachable and are edged with piping the colour according to the different corps. The buttons are hidden by a flap down the front of the tunic The trousers and breeches have a wide dark grey silk braid stripe down the centre of which runs a narrow stripe of a distinctive colour according to the corps. (b) Other ranks wear the same head-dress as for full-dress except that the bersaglieri cyclists wear a red fez with a blue tassel The remainder of the undress is much the same as for full-dress

AIR FORCES

Great Britain.—(a) At the present moment full-dress has only been authorized for officers, and the provision of it is optional It is made of blue material and consists of a single-breasted tunic with plain cuffs, collar trimmed with ½ in gold lace in front and along the top and an oak-leaf device in gold embroidery on each side of the front of the collar. The trousers are without "turn-ups" with foot straps. The head-dress is of black chrome leather, trimmed with seal dyed nutria, with a gold and blue plaited cord across the front, ostrich feather plume dyed a distinctive blue (b) Service dress for officers is made of blue Barathea cloth. It is a single-breasted tunic cut loose above the waist with four pockets. The breeches are made of cavalry twill

and the cap has a peak of Barathea cloth. The rank of the officer is indicated by bands of black and blue braid worn round cuffs. The puttees are of the spiral pattern. Other ranks wear a similar uniform of a different material of the same colour. For foreign service all ranks wear a khaki drill uniform in which a Wolseley helmet is included on which is worn a "flash" bearing in silk the R A F colours. (c) Officers' Mess Dress is similar to the army pattern but is made of the distinctive R A.F. blue material. In hot climates abroad a white drill uniform is worn consisting of jacket, waistcoat, trousers, with which shoes are worn. The uniform for Flying Cadets consists of a coat similar in design to that of the Air Corps officers.

United States.—The Army air service being an integral part of the army, the members wear the uniform laid down for the army with particular distinctions, viz, aviators and observers wear a pair of wings and a vertical propeller in silver on the left breast; enlisted men wear the same on the sleeve; flying instructors a pair of wings only.

France.—The air service is an integral part of the army and its members' uniform is the same as the infantry except that the collar patches are dark blue instead of horizon blue and the piping on the uniform, orange for balloons, light blue for observation, green for fighting, red for bombing, grey for non-flying personnel.

Japan.—As part of the army the air service wears the universal khaki uniform with distinctive badges, viz., aviation pilots wear, on the right breast, an oval device of wings, propeller and sun's rays; members of aviation battalions wear a propeller across a steering wheel in the form of a gilt badge on the right collar patch, the number of the battalion being on the left patch.

Switzerland.—The flying corps wears the universal grey-green uniform with two wings and a propeller in light-brown thread as a distinguishing badge.

Czechoslovakia.—The air arm wears the army universal light olive drab cloth with distinctive sky-blue facings

Poland.—As part of the army the members of the aviation arm wear the universal khaki uniform with yellow collar patches

Yugoslavia.—As part of the army the air service wears the universal olive-yellow service dress with horizon blue collar patches

Baltic States.—The Estonian air service wears the universal greenish hairy khaki uniform with the following distinctions: a badge of wings and propeller in the form of a shield, silver braid for officers and white metal for other ranks, worn on the arm. The Latvian air force wears a black uniform with red cap, collar patch and piping, and the Lithuanian a greenish khaki uniform with black velvet collar patch and cap and dark red piping.

(T. J. E.)

NAVAL

Great Britain.—The dress of seafarers in the British Isles had attained a certain uniformity, principally brought about by the conditions and hazards of their calling, long before any regulations were made on the subject. Chaucer's description of the attire of the Shipman depicts a figure he had doubtless seen many times at Dartmouth, or in the streets of London in the neighbourhood of Bankside and the Pool A sea gown of "falding," reaching to the knee, a homely garment of rusty blue or brown, intended to stand hard usage, was long worn by seamen. In a book on costume by Caesare Vecellio, published in Venice in 1598, a full-length figure of an English mariner is shown, and the legend states that they wore short coats, sky blue, white, or some other colour, wide baggy breeches with many folds, and ruffs round their necks. Their caps were hairy, like those that pilgrims wore. Such expressions as a "sea gown," a "pitch'd jacket," and a "canvas shrowd," as synonyms for sailors' wear, are common in Tudor and Stuart literature

An important step leading to uniformity in the dress of the seaman was taken in 1628, when an order for the provision of ready-made clothing was given. Certain articles of attire were placed on board his Majesty's ships and hired vessels for issue to the officers and men, the cost to be charged against their wages. In 1638, an order for the prevention of over-charging was hung up in the steerage of every ship, and a list of the articles to be sold, with their prices. In 1663, the slop clothing included canvas suits, red caps, blue shirts, red or striped breeches, and blue neck-cloths, among the articles for sale. From 1706 until about 1750, the slop clothing consisted of grey kersey jackets, waistcoats of striped ticking or Welsh red, breeches of red kersey or striped shag, blue and white check shirts, grey stockings, shoes, and leather caps, faced with red cotton, or flat-topped three-cornered hats.

From the middle of the eighteenth century, when blue and white became the colours of the officers' uniform, the dress of the seamen gradually conformed to the same combination It comprised usually a blue jacket, a scarlet or buff waistcoat, a check or striped shirt, white or striped trousers "long in the legs and taut at the hips and ankles," a kerchief, black or brightly coloured, tied loosely round the neck with two corners hanging down outside the jacket behind to protect it from the chafe of the pigtail, the vogue of which was only from about 1780 to 1830. The round hat was made of straw, leather, or tarred canvas, turned up at the sides with a coloured lining, and a ribbon with the name of the ship painted on it. The strips of canvas sometimes sewn on the seams of the jacket were only to repair and strengthen old and used garments, as Jonas Hanway wrote in 1759, and not as ornamentation. After the first quarter of the nineteenth century, nearly all colours except blue had disappeared for all articles but waistcoats and kerchiefs

In 1787, a uniform for all officers was established, and remained in force until 1795, when, to commemorate Lord Howe's victory of June 1, 1794, gold epaulettes hanging down like tassels, with marks on them to indicate rank, were introduced At the same time, the white facings were abolished, with one exception, the patch on the midshipman's collar Nearly all the later portraits of Nelson and those of his band of brothers are in the full or undress of these regulations. In 1812, white facings were re-introduced, and this dress was worn during the War with the United States. New regulations were issued on January 1, 1825, with plans, which may be seen in the Admiralty Library. Since this date, regulations have been published in the Navy List, where the changes to the present time may be traced. The most important was made by William IV, who in 1832 altered the facings from white to red, and so they remained until June 30, 1843 Queen Victoria then restored white, and so it has remained ever since. Illustrated manuals of current naval uniforms were published by the Admiralty on May 7, 1879, and October 10, 1891. (X)

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United States.—The uniform, with its various insignia and devices, is designed primarily to indicate on sight those men belonging to the naval service; to show at a glance their rank, corps, or rating, and is required to be worn at all times by officers and enlisted men while on duty.

The United States naval officers' uniform in general corresponds to those worn by officers of the various navies of the world, and officers of different ranks are most readily distinguished by the sleeve markings, or sleeve stripes of gold lace which completely encircle the sleeve. In addition to this insignia of rank, officers of the several corps and warrants are indicated by individual corps devices embroidered above the sleeve stripes. Sleeve markings (stripes) for the various ranks follow:

Admiral	One 2-inch stripe with three ½-inch stripes above it.
Vice-Admiral	One 2-inch stripe with two ½-inch stripes above it.
Rear-Admiral	One 2-inch stripe with one ½-inch stripe above it.
Commodore	One 2-inch stripe.
Captain	Four ½-inch stripes.

Commander	Three ½-inch stripes
Lt.-Comdr.	Two ½-inch stripes with one ¼-inch stripe between the other two.
Lieutenant	Two ½-inch stripes
Lieut (jr grade)	One ½-inch stripe with one ¼-inch stripe above it.
Ensign	One ½-inch stripe
Chief warrant officer	One ½-inch stripe, the gold lace to be woven at intervals of 2 inches with dark-blue silk thread in widths of ½-inch.
Warrant officer	One ¼-inch stripe, the gold lace to be woven at intervals of 2 inches with dark-blue silk thread in widths of ½-inch.

Sleeve markings (corps devices) of the commissioned grades and line warrants are listed as follows:

Line officers	Five-pointed gold star.
Medical officers	A spread oak leaf, embroidered in gold, surcharged with acorn, embroidered in silver.
Supply officers	A sprig of three oak leaves and three acorns.
Chaplains	A Latin cross.
Naval constructors	A sprig of two live-oak leaves, spreading with an acorn on the stem between the leaves.
Civil engineers	Two sprigs of two live-oak leaves embroidered in gold and an acorn embroidered in silver in each sprig
Chief boatswain and boatswain	Two crossed foul anchors.
Chief gunner and gunner	Flaming spherical gold shell.
Chief machinist and machinist	A three-bladed gold propeller.

Uniforms worn by enlisted men of the United States navy consist in general of the conventional seaman's overshirt or jumper, with trousers that flare slightly at the bottom. The various enlisted ratings are indicated by rating badges worn on the sleeve midway between shoulder and elbow, consisting of an eagle, chevrons, and specialty marks. The chevrons indicate the rank or class of the petty or non-commissioned officer, while the specialty marks indicate, as the name implies, the branch in which the individual has been rated Enlisted men, other than petty officers, wear what is known as a branch mark, consisting of a stripe of braid, white for the seaman branch and red for the engineer branch, extending entirely around the shoulder seam of the jumper

Detailed description, accompanied by photographic plates of the various naval uniforms of the United States, together with regulations defining the occasions upon which worn may be found in a publication known as the *Uniform Regulations, United States Navy*, issued to members of the naval service and purchasable at the Government Printing Office, Washington, D C.

(R. H Le)

UNION, a town of South Carolina, U.S A , the county-seat of Union county; 65 m N W of Columbia, on Federal highway 176, and served by the Buffalo, Union-Carolina and the Southern railways Pop 6,141 in 1920, 30% negroes It is in the beautiful Piedmont region, near the foot of the Blue Ridge, and is one of the important textile-manufacturing centres of the State, with cotton-mills operating over 200,000 spindles and 4,700 looms in 1928.

UNION CARBIDE AND CARBON CORPORATION was organized in the State of New York on Nov 1, 1917, with an authorized capital stock of 3,000,000 shares, without par value, of which 2,742,072 were outstanding on Jan 1, 1929. It is a holding company owning all the common stock of over 35 subsidiary operating companies. The subsidiaries have been pioneers in the important industries in which they are engaged. Their raw materials are basic, including limestone, silica, coal, iron, oxygen, ores of metals, graphite, rare earths, air, rare gases, natural gas and petroleum From these have been developed a highly inter-related list of products essential in peace and war They maintain large laboratories for fundamental scientific research and the development of new products and processes. They manufacture and sell carbide and acetylene, and apparatus for their utilization They have perfected the separation of oxygen, in vast quantities from the air

Subsidiaries in the United States, Canada and Norway are the largest manufacturers of ferro-alloys These alloys, as ferro-silicon, ferro-chromium, ferro-manganese, silico-manganese, ferro-tungsten, ferro-vanadium, and zirconium alloys, impart greatly improved properties to steels. Practically all steels are treated with one or more of such alloys as a purifier or for producing the superior quality steels extensively used in modern manufacture. Another series of alloys are manufactured under the trade name Stellite. Such alloys are of extreme hardness and have the unusual quality of being tougher at red heat than when cold; they neither rust nor stain and are highly resistant to chemical corrosion. Stellite tools have remarkable cutting qualities. Subsidiaries also produce metals, such as silicon, chromium and manganese for the aluminum and other non-ferrous industries; as well as a wide variety of carbon products, including carbon electrodes for electric furnaces, and as a source of light for motion picture photography, streets and factories and for therapeutic purposes; brushes for dynamos, motors, generators and other electrical apparatus, dry cells for domestic and ignition purposes, flashlights and flashlight batteries; carbon specialties for many uses; and dry batteries for radio receiving sets They also produce many chemicals, the principal of which are ethylene dichloride, ethylene glycol, diethylene glycol, acetone and cellosolve used as solvents or intermediates in the rubber, explosive, artificial silk, lacquer and varnish industries. Ethylene glycol is also sold as an anti-freeze compound Hydrocarbon gases, such as pyrogen, used in the metal cutting process, and pyrofax, a portable fuel for industrial and domestic use, are also produced.

Early in 1929 subsidiaries had in continuous operation 145 plants. They had over 100 sales offices and 343 warehouses, and owned mines, quarries and other sources of raw materials.

(W M B)

UNION-CASTLE MAIL STEAMSHIP CO. LTD, a British joint-stock company combining long established steamship lines and in 1928 owning 41 vessels aggregating 340,090 gross tons The present company was formed in 1900. Of the two chief firms which it incorporated, the Union Steam Collier Co. dated back to 1853, while the Castle Line, its other component, was founded by Sir Donald Currie, G C M G , in 1862

In 1900, the Castle Line and the Union Line were amalgamated under the management of Donald Currie and company Sir Donald Currie died in 1909 and in 1912 Donald Currie and company retired from the management of the line, the Royal Mail and allied companies purchasing it, Sir Owen Philipps (now Lord Kylsant) becoming chairman Sir Owen at once proceeded to the Cape, where he arranged a new mail contract.

The authorized capital of the company is £8,240,000, consisting of 24,000 £10 4½% preference shares issued and paid, 5,000,000 £1 preference shares (of which 1,000,000 6% "A" shares and 1,500,000 6½% shares are issued and paid), and £3,000,000 ordinary shares or stock, £2,740,000 stock being issued and paid There is also £2,000,000 6% debenture stock, repayable in 1934.

(L. C. M.)

UNION CITY, a city of Hudson county, New Jersey, U S.A , ¼ m. W of the Hudson river, opposite New York city, on high ground above Weehawken, between Hoboken and West New York. Railroad facilities are provided through Hoboken, Weehawken and Jersey City. Pop. (1920) 60,725 (33% foreign-born white); 1928 local estimate 76,000. It is an important silk-manufacturing centre. The assessed valuation of property for 1928 was $72,100,462 Union City was formed in 1925 by the consolidation of Town of Union (incorporated 1864) and West Hoboken (incorporated as a town in 1884), which in 1920 had populations of 20,651 and 40,074 respectively

UNIONIST PARTY: *see* CONSERVATIVE PARTY.

UNION LEAGUE OF AMERICA, THE, sometimes called the Loyal League, was an organization for political purposes of Northern whites, later of Southern blacks, which originated in Ohio in 1862 when the Confederate military successes and political disaffection in the Northern States made the outlook for the North seem doubtful Within one year it had spread over 18 Northern States and among the Unionists of the South. The order raised troops, paid their expenses, sent supplies to the field and distributed political literature. At the close of the war it worked for radical reconstruction of the Southern States, punishment of the Southern leaders, confisca-

tion of property and negro suffrage. The Southern Unionists hoped to make it the nucleus of a new political party, but this was frustrated by the admission of the blacks for political purposes, after which the Southern whites generally deserted the league. After the Freedmen's Bureau agents and other Northern whites obtained command of the league in the South it became simply a machine to control the negro vote The league died out about 1870, but not before it had succeeded, with the Freedmen's Bureau and other forces, in permanently arraying the blacks and whites into opposing political parties.

UNION OF SOCIALIST SOVIET REPUBLICS, THE (U.S.S.R.), the official title of the State comprising most of the territories of the old Russian empire The constitution of the U.S.S.R., a change of the Soviet constitution adopted on July 10, 1918, was settled at a conference in Moscow on Dec 30, 1922, between delegates of the Russian, Ukrainian, White Russian and Transcaucasian Soviet Republics To these were added in 1924 the Uzbek and Turcoman Soviet Republics The Union also contains 18 "autonomous regions" and the following autonomous republics: Moldavia, Bashkir, Tartar, Kirghiz, Dagestan, Crimea, Yakutsk, Karelian, German Volga Settlements, Buriat (Caucasus) Mountains; Georgia, Azerbaijan and Armenia are constituent republics of the Transcaucasian Federal Republic

All of these republics are controlled by the Communist Party, and have a Soviet constitution. Employers and priests are excluded from voting and the government is officially declared to be the dictatorship of the proletariat The population in 1926 was 132,000,000 and the area 7,041,120 sq m The government is nominally vested in a Soviet Congress representing all States of the Union But the effective representative organ is the "Union Central Executive Committee" elected by this Congress. The executive body of the Committee is the Union Council of People's Commissaries (*See* RUSSIA, SOVIETISM)

UNION PACIFIC RAILROAD SYSTEM extends from the Missouri river at Council Bluffs, Omaha, and Kansas City, via Denver, Cheyenne, Ogden and Salt Lake City, to Los Angeles and the Pacific ocean in the south-west, to Portland, Ore., and to Olympia, Tacoma and Seattle on Puget sound in the north-west (and in connection with the Central Pacific, to San Francisco and central and northern California) The system embraces a total of 9,677 m of railroad in 13 States, owned and operated by the Union Pacific Railroad Company, a Utah corporation, and subsidiaries controlled through stock ownership The main line between Council Bluffs, Ia., and Ogden and Salt Lake City, Utah, 1,027 m., is double tracked, besides approximately 500 m in other sections The system owned as on Dec 31, 1927, 1,785 locomotives, 1,392 passenger cars, 57,877 freight cars and a one-half interest in Pacific Fruit Express Company, which owned 35,841 refrigerator cars.

The original company was incorporated in 1862 under an act of Congress, approved by President Lincoln, providing for the construction of railroads from the Missouri river to the Pacific as a war measure and for the preservation of the Union Constructed westwardly from Council Bluffs, and from Kansas City via Denver, the connection of the line with that of the Central Pacific, constructed eastwardly from San Francisco bay, at a point 53 m W of Ogden, May 10, 1869, completed the first transcontinental railroad

Settlement of the territories traversed was slow, construction of other railroads throughout the west rapid, and the growth of unrestricted and destructive competition disastrous; in the business depression of 1893 the company went into receivership and the Government and other mortgages were foreclosed The properties were reorganized by E H. Harriman and associates, the present company incorporated July 1, 1897, assumed operation Feb. 1, 1898. (C R. G.)

UNIONTOWN, a city of south-western Pennsylvania, U.S.A., 50 m. S. by E of Pittsburgh, the county seat of Fayette county; on Federal highways 40 and 119, at an altitude of 1,020 feet It is served by the Baltimore and Ohio and the Pennsylvania railways. Pop. (1920) 15,692 (82% native white); 1928 local estimate 21,000. A government airport and a commercial landing field are near by A village was laid out here in 1776 on land belonging to Henry Beeson. It was incorporated as a borough in 1796, as a city in 1916 and has a commission form of government. On the Old National road, 8 m E. of Uniontown, a monument marks the spot where Gen. Braddock met defeat and received his mortal wound. Two miles farther east is the site of Ft. Necessity, built by Washington in 1754.

UNITARIANISM, a system of Christian thought and religious observance, deriving its name from its doctrine of the single personality of God the Father, in contrast with the Trinitarian conception of His threefold being as Father, Son and Holy Spirit But the significance of the movement is imperfectly indicated by its name Its real importance lies in its teachings concerning mankind and the nature and work of Jesus Christ.

Free Study of the Bible.—The movement cannot be traced to any single teacher or any specific date; it had its sources in the thoughts of many minds in many lands.

During the 17th century separate religious communities arose in Poland (now extinct) and in Hungary (Transylvania, now part of Rumania), standing for Unitarian Christianity, though not under that name; and afterwards in England and in America, when the name came into general use These societies took seriously the rule of "the Bible and the Bible only." And at the end of the following century we find the English Unitarians, in the petition presented to parliament in 1792, explaining their position by saying that they conceived it to be "their duty to examine into and interpret the Holy Scriptures for themselves, and their right publicly to declare the result of their enquiries"

A Two-fold Tradition.—In the history of the movement two factors stand out as equally characteristic, distinctive and essential the demand for personal religious freedom, and the demand for clear, distinct and coherent religious thought and teaching

(1) The demand for personal religious freedom, so far as England is concerned, can be traced directly to the Act of Uniformity (1662), under which 2,000 clergymen were deprived of their livings Richard Baxter (*q v*) represents the spirit of the ejected ministers at its best He had no idea of complete toleration; but he stood for the endeavour to find a basis of agreement by reducing the number of the essentials and fundamentals The influence of this endeavour, with its implied comprehensiveness and recognition of degrees of certainty, went on working after his death, and led to results undreamt of in his day This history of a large number of Churches in England, whose members now profess Unitarianism, begins with the ejection of 1662

(2) Some of the ejected clergy, in the exercise of their freedom, arrived at the conviction that "the Trinitarian scheme" (by which they meant the whole scheme of salvation, with its doctrines of inherited guilt, eternal punishment, and vicarious atonement) was no part of essential Christianity. The advocacy of Joseph Priestley (*q.v.*), and the withdrawal of Theophilus Lindsey (1723–1808) from the Church of England to establish a Unitarian church in London (Essex street, Strand, 1774) aroused the liberal dissenters to consider their position, and to a large extent they found that they had grown into Unitarian Christianity.

There were also various interests which they had in common, in which they were threatened with serious injury The penal laws against deniers of the Trinity were not repealed until 1813, and the Corporation and Test Acts (against all dissenters from the National Church) not until 1828 The general desire for more united and effective action led to the formation of the British and Foreign Unitarian Association in 1825, by the amalgamation of three older societies for literature (1791), mission work (1806), and civil rights (1818).

Changing Bases of Belief.—At the beginning of the 19th century Unitarian Christianity was, broadly speaking, a biblical religion, accepting miracles, and rejecting creeds, not as incredible but as non-biblical, resting its hopes on an external revelation, and attaching little importance to what it regarded as the uncertain influences and promises of "natural religion." Then this system in its turn gave way to a revised theology which was part of the changed outlook on the world and human history, due to the development of scientific and historical knowledge during

the 19th century. A steady movement of doctrine can be traced among English Unitarian ministers and laymen, influenced by the personality and teaching of William Ellery Channing (1780–1842) and Theodore Parker (1810–60) from New England, and J. J. Tayler (1797–1869), J Hamilton Thom (1808–94), and above all, James Martineau (1805–1900), in England. The result of that movement has been that Unitarians no longer find the seat of authority only within the pages even of the best and broadest of books, but in religious history and experience, interpreted by the reason and conscience of mankind

The past history of the Unitarian movement has stamped certain characteristics on its life Many of its founders were forced into exile by exclusion from the larger historic Churches of Christendom; and this, together with its subsequent denominational history, has infused a certain habit of mind—of independent judgment, of bringing opinions to the bar of strong commonsense, of proving all things and holding fast that which is good. But the need of more effective corporate union is being deeply felt, and has led to the recent union of the principal denominational organizations in a new and representative body, the "General Assembly of Unitarian and Free Christian Churches" (1928)

BIBLIOGRAPHY —For statistical and other information see *Year Book of the General Assembly of Unitarian and Free Christian Churches* (1929 *seq*, continuation of the *Essex Hall Year Book*, 1890–1928). For the Unitarian point of view, *see* H Gow, *Unitarianism* (1927); J E Carpenter (edit. by), *Freedom and Truth* (1925), S. H Mellone, *The Price of Progress* (1924); J. Drummond, *Studies in Christian Doctrine* (1910), J E Carpenter, *James Martineau: A Study* (1905). On the history of the movement, *see* E M Wilbur, *Our Unitarian Heritage* (1926), and more briefly in J E Carpenter, *Unitarianism, a Historic Survey* (1923), and W G. Tarrant, *The Unitarian Movement* (1910); with special reference to the period 1825–1925, S. H. Mellone, *Liberty and Religion* (1925). (S. H. M)

UNITED STATES

Unitarianism in the United States followed essentially the same development as in England, and passed through the stages of Arminianism, Arianism, anti-tritheism, to rationalism and a modernism based on a large-minded acceptance of the results of the scientific and comparative study of all religions As early as the middle of the 18th century Harvard college represented the most advanced thought of the time, and a score or more of clergymen in New England were preaching what was essentially Unitarianism. The most prominent of these men was Jonathan Mayhew (1720–66), pastor of the West church in Boston from 1747 to 1766

The first official acceptance of the Unitarian faith on the part of a congregation was by King's chapel in Boston, which settled James Freeman (1759–1853) in 1782, and revised the Book of Common Prayer into a mild Unitarian liturgy in 1785 Unitarian congregations were organized at Portland and Saco in 1792 by Thomas Oxnard. in 1800 the First church in Plymouth accepted the more liberal faith. Joseph Priestley came to the United States in 1794. and organized a Unitarian church at Northumberland, Pa, in the same year, and one at Philadelphia in 1796. His writings had a considerable influence Thus from 1725 to 1825 a more tolerant belief was developing in New England, and to some extent elsewhere.

William Ellery Channing was settled over the Federal Street Congregational church, Boston, 1803; and in a few years he became the leader of the Unitarian movement. At first mystical rather than rationalistic in his theology, he took part with the 'Catholic Christians," as they called themselves, who aimed at bringing Christianity into harmony with the progressive spirit of the time His essays, *The System of Exclusion and Denunciation in Religion* (1815) and *Objections to Unitarian Christianity Considered* (1819), make him a defender of Unitarianism The Unitarian movement has grown slowly; and its influence has been chiefly exercised through general culture and the better literature of the country. Many of its clergymen have been trained in other denominations; but the Harvard divinity school was distinctly Unitarian from its formation in 1816, to 1870, when it became an unsectarian department of the university. The Meadville theological school was founded in Meadville, Pa., in 1844, and in 1926 was removed to Chicago. The Pacific Unitarian school for the ministry at Berkeley, Calif, was established in 1904. The Tuckerman school in Boston gives training for parish assistants and directors of religious education

Periods of Unitarian Thought.—Unitarian thought in the United States has passed through three periods. The first, from 1800 to 1835, was formative, mainly influenced by English philosophy, semi-supernatural, imperfectly rationalistic, devoted to philanthropy and practical Christianity. Dr. Channing was its distinguished exponent The second, from 1835 to 1885, profoundly influenced by German idealism, was increasingly rationalistic, though its theology was largely flavoured by mysticism The leaders of this second period were Emerson and Theodore Parker

The third period, beginning about 1885, has been one of rationalism, recognition of universal religion, large acceptance of the scientific method and ideas and an ethical attempt to realize the higher affirmations of Christianity. It has been marked by harmony and unity to a degree found in perhaps no other religious body, by steady growth in the number of churches and by a widening fellowship with all other progressive phases of modern religion. This last phase has been shown in the organization of the International Council of Unitarian and other Liberal Religious Thinkers and Workers at Boston on May 25, 1900, "to open communication with those in all lands who are striving to unite pure religion and perfect liberty, and to increase fellowship and co-operation among them." This council has held sessions in London (1901), Amsterdam (1903), Geneva (1905), Boston (1910), Paris (1913), Boston (1920), Leyden (1922) and Prague (1927). Since 1910 its title is International Congress of Free Christians and other Religious Liberals During this period the influence of Emerson has become predominant

Beyond its own borders the body has obtained recognition through the public work of such men as Henry Whitney Bellows and Edward Everett Hale, the remarkable influence of James Freeman Clarke and the popular power of Robert Collyer In 1927 the number of Unitarian churches in the United States and Canada (whose churches are affiliated with the American associations) was 422, with 491 ministers Adherents in the United States in 1927 numbered 131,912 The periodicals are *The Christian Register*, weekly, Boston; *Unity*, weekly, Chicago; *Pacific Unitarian*, San Francisco.

See Joseph Henry Allen, *Our Liberal Movement in Theology* (Boston, 1882) and *Sequel to our Liberal Movement* (Boston, 1897); John White Chadwick, *Old and New Unitarian Belief* (Boston, 1894) *See* especially Chadwick's *William Ellery Channing* (1903), *Unitarianism its Origin and History, a course of Sixteen Lectures* (Boston, 1895), also George Willis Cooke, *Unitarianism in America: a History of its Origin and Development* (Boston, 1902); Ephraim Emerton, *Unitarian Thought* (1911); Earl M Wilbur, *Our Unitarian Heritage* (Boston, 1925); Francis A Christie, "Unitarianism" in the *American Journal of Theology*, Oct, 1917, reprinted in *Freedom and Truth* (1925), and *Unitarian Year Book* (Boston). (J. H. L)

UNITED BRETHREN IN CHRIST, an American religious sect which originated in the last part of the 18th century under the leadership of Philip William Otterbein (1726–1813), pastor of the Second Reformed church in Baltimore, and Martin Boehm (1725–1812), a Pennsylvanian Mennonite of Swiss descent. Otterbein and Boehm licensed some of their followers to preach and did a great work, especially through class-meetings of a Wesleyan type; in 1789 they held a formal conference at Baltimore, and in 1800, at a conference near Frederick City, Md., the Church was organized under its present name, and Otterbein and Boehm were chosen its first bishops or superintendents.

The liberal branch had 3,135 organizations in 1927 with a total membership of 401,553. This body carries on missions in West Africa (since 1855), Japan, China, the Philippines and Porto Rico. It has a publishing house (1834) and Bonebrake theological seminary (1871) at Dayton, O., and supports Otterbein university (1847) at Westerville, O.; York college (1890) at York, Neb.; Philomath college (1867) at Philomath, Ore.; Lebanon Valley college (1867) at Annville, Pa.; Central university (1907) at Indianapolis, Ind., and Kansas City university (1924) at Kansas City, Kan. The "Old Constitution" body had 572 organizations

in 1906 with a total membership of 21,401. It has a publishing house at Huntington, Ind.

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UNITED FREE CHURCH OF SCOTLAND, a religious organization, representing the union made in 1900 between the Free Church of Scotland (except a dissentient section who separated off and retained the name of Free Church) and the United Presbyterian Church (*See* FREE CHURCH OF SCOTLAND and UNITED PRESBYTERIAN CHURCH.)

The first moderator was Dr Robert Rainy (*q.v*). The Free Church brought into the union 1,077 congregations, the United Presbyterians 599; the revenue of the former amounted to £706,546, of the latter to £361,743 The United Church has three divinity halls, at Glasgow, Edinburgh and Aberdeen, served by seventeen professors and five lecturers

The minority of the Free Church who had refused to join the union lost no time in testing the legality of the act of the majority in entering it. Their summons, dated the 14th of December 1900, claimed that in uniting with the United Presbyterian Church, which did not hold the principles of the Free Church, the majority had forfeited the right to the property of the Free Church, which must be judged to belong to the minority who remained faithful to the principles of the Free Church and were that Church. In the Scottish courts the case was decided in favour of the union on the 9th of August 1901, and on the 4th of July 1902; but, on appeal, the House of Lords, on the 1st of August 1904, by a majority of five to two, reversed these decisions, and found the minority entitled to the funds and property of the Free Church

Few legal decisions have occasioned so great consternation or such serious practical difficulties At first sight it deprived the majority of the Free Church section of the United Church of all its material goods—churches, manses, colleges and missions, even of the provision for the old age of the clergy, and handed them over to a body which could have little prospect of making effective use of them Nothing remained but to invoke the intervention of parliament to put an end to an impossible situation. In December a commission was appointed, consisting of Lord Elgin, Lord Kinnear and Sir Ralph Anstruther, to inquire into matters connected with the two churches, while the question of interim possession was referred to Sir John Cheyne, as commissioner, for inquiry and action. The commission sat in public, and after hearing evidence on both sides, issued their report in April 1905. They reported that the state of feeling on one side and on the other had made their work difficult They had concluded however that the Free Church was unable in many respects to carry out the purposes of the trusts, which, under the verdict of the House of Lords, was a condition of their holding the property, and that there was a case for parliamentary interference They recommended that an executive commission should be set up by act of parliament, in which the whole property of the Free Church, as at the date of the union, should be vested, and which should allocate it to the United Free Church, where the Free Church was unable to carry out the trust purposes. The Churches (Scotland) Act, which gave effect to these recommendations, was passed on the 11th of August 1905 The allocation of churches and manses was a slow business, and involved litigation; but at length was carried through (*See* FREE CHURCH OF SCOTLAND.)

The United Free Church, after rearrangement of the Synods and Presbyteries, has 12 Synods and 63 Presbyteries, and 2 Continental Presbyteries. The Supreme Court is the General Assembly, which meets the third week of May every year at the same time as that of the Established Church and of the remanent Free Church of Scotland. In the year ending Dec. 31, 1926, there were 1,449 congregations and 46 preaching stations. The total membership was 536,409, and there were 2,034 Sunday Schools, with 187,545 scholars and 24,784 teachers In 15 Foreign Mission Fields there are 430 European Mission Agents and 5,773 native pastors, evangelists, and teachers, including in both cases those of the Women's Foreign Mission. The amount raised on the field in 1925 was £303,361. The income of the Church at the close of financial year 1926 amounted to £1,543,648. (*See* also SCOTLAND, CHURCH OF)

UNITED FRUIT COMPANY was incorporated in New Jersey, on March 30, 1899 It is engaged in the production and transportation of tropical products, principally bananas, sugar, cacao and coco-nuts Its fruit is carried to U S ports by a fleet of 62 vessels and is sold there and in Canada by its subsidiary, Fruit Dispatch Company; in Great Britain and the Continent its fruit is transported and sold by Elders and Fyffes Ltd., its English subsidiary, which operates a fleet of 34 ships Sugar from its Cuban plantations is refined and distributed by its subsidiary, Revere Sugar Refinery at Boston, Mass.

The company operates 1,600 m of railways, 671 m. of tramways, 3,000 of telephone and telegraph lines; owns 1,900,000 ac. of land, 437,000 of which are cultivated, and leases 152,000 ac of which 32,000 are cultivated It maintains a weekly passenger freight and mail service between the ports of the United States, Europe, Cuba, Jamaica, Guatemala, Panama, Colombia, Costa Rica, Honduras and British Honduras, and a highly developed radio service

In 1927 the company paid in wages to the nationals of the countries in which it operates, $24,000,000 An equal amount was spent in the purchase of fruit from private growers

The United Fruit Company had in 1928 26,000 stockholders and 70,000 employees, a great many of whom own, or are subscribers to, the company's stock The stock and surplus on Dec 31, 1927 represented by 2,500,000 shares outstanding (no par value) was $181,028,729 It has had no bonded debt for many years. (V. M. Cu.)

UNITED KINGDOM OF GREAT BRITAIN AND IRELAND, the title of the former political unity composed of England, Wales, Scotland and Ireland, officially adopted on Jan 1, 1801, when the Act of Union between Great Britain and Ireland came into force The name Great Britain has been used since the union of the kingdoms of England and Scotland in 1707 as the official designation of the united countries

When, in 1922, 26 Irish counties were severed from the United Kingdom and erected into a dominion of the British empire under the name of the Irish Free State, no provision was made in the act for any change in the royal style or in the title of the imperial parliament It even seems to have been assumed that the Free State was to remain technically part of the United Kingdom, for in sec 2 (1) of the Free State Constitution Act we read that "Goods transported during the current year from or to the Irish Free State or from *any other part of the United Kingdom* or the Isle of Man shall not . ." From 1922 onward, however, the title of the United Kingdom of Great Britain and Northern Ireland was frequently used in official documents to designate those parts of the British Isles represented in the imperial parliament, meeting at Westminster.

In the report of the inter-imperial relations committee of the Imperial Conference of 1926 it was suggested that, in view of new constitutional developments, the words "United Kingdom" should be omitted from the royal style, which should run. "George V, by the Grace of God, of Great Britain, Ireland, and the British Dominions beyond the Seas King, Defender of the Faith, Emperor of India" By the Royal and Parliamentary Titles Act, 1927 (17 Geo. 5 ch 4), accordingly, the king was authorized to change the style and titles of the Crown by royal proclamation This was done, on May 13, 1927, by a proclamation adopting the recommendation of "the representatives of our Governments in Conference," and declaring that in the Latin style "Magnae Britanniae, Hiberniae" should henceforth be used, and in the English style "Great Britain, Ireland and . . ." instead of "the United Kingdom of Great Britain and Ireland"

By the same act of parliament (2, 1) it was enacted that "Parliament shall hereafter be known as and styled the parliament of the United Kingdom of Great Britain and Northern Ireland" (*See* also, GREAT BRITAIN; ENGLAND; IRELAND; IRELAND, NORTHERN; IRISH FREE STATE; SCOTLAND; WALES)

UNITED METHODIST CHURCH, or UNITED METHODISTS, an English Nonconformist community formed in 1907 by the union of the Methodist New Connection (1797), the Bible Christians (1815), and the United Methodist Free Churches (1857) The act of parliament which enabled this amalgamation received the royal assent on the 26th of July 1907. The union was completed on the 16th of September 1907 in Wesley's Chapel, City Road, London (For recent statistics concerning this religious body, *see* METHODISM)

UNITED METHODIST FREE CHURCHES, an English Nonconformist community merged since 1907 in the United Methodist Church (*q v*)

UNITED PRESBYTERIAN CHURCH (of Scotland). This Presbyterian organization, merged since 1900 in the United Free Church of Scotland (*see* above), was formed in 1847 by the union of the United Secession and Relief Churches

The general causes which led to the first great secession from the Church of Scotland, as by law established in 1688, are indicated in the article SCOTLAND, CHURCH OF Its immediate occasion rose out of an act of assembly of 1732, which abolished the last remnant of popular election by enacting that, in cases where patrons might neglect or decline to exercise their right of presentation the minister was to be chosen, not by the congregation, but only by the elders and Protestant heritors The act itself had been passed by the assembly, although the presbyteries to which it had been previously submitted as an overture had disapproved of it by a large majority; and in accordance with a previous act (1730), which had taken away even the right of complaint, the protests of the dissentient majority were rejected The protests however were vigorously renewed by Ebenezer Erskine minister of Stirling He was soon joined by other ministers, who in December 1733 constituted themselves into a presbytery, disowning the authority of the general assembly The members of the "Associate Presbytery" and its adherents steadily increased, until in 1745 there were forty-five congregations under its jurisdiction, and it was reconstituted into an "Associate Synod" A violent controversy respecting the religious clause of the oath taken by burgesses in Edinburgh, Glasgow and Perth ("I profess and allow with my heart the true religion presently professed within this realm and authorized by the laws thereof"), resulted in April of 1747 in a "breach," when two bodies were formed, each claiming to be the "Associate Synod", those who condemned the swearing of the burgess oath as sinful came to be popularly known as "Anti-burghers," while the other party, who contended that abstinence from it should not be made a term of communion, were designated "Burghers." The Associate (Antiburgher) Synod held its first meeting in Edinburgh on the 10th of April 1747 It grew with considerable rapidity, and for purposes of organization was formed into four provincial synods, and took the name of "The General Associate Synod" The Associate (Burgher) Synod held its first meeting at Stirling on the 16th of June 1747. The number of congregations under its charge also increased, and in 1820 the General Associate or Anti-burgher Synod (to the number of 129 congregations) united with the 154 congregations of the Associate or Burgher Synod The body thus constituted, "The United Secession Church," had increased by 1847 to 400 congregations.

In 1847 a union was formed between all the congregations of the United Secession Church and 118 out of 136 of the Relief Churches, in what now became the United Presbyterian Church. Doctrinally there was little difference between the United Presbyterian Church and the Free Church of Scotland, and between 1863 and 1873 negotiations were carried on for a union, which however were fruitless But in 1896 the United Presbyterian Church again made advances which were promptly met, and on the 31st of October 1900 the United Free Church of Scotland came into existence

UNITED PRESS ASSOCIATIONS, founded in 1907 on the principle of non-exclusive collection and distribution of the spot news of the world, has developed an organization which covers the United States and Canada with a network of 105,000 m. of leased telegraph lines The service also extends to 39 foreign countries. The management claims that the full leased wire service is used (1929) by 507 daily and Sunday newspapers, with limited service going to 339 additional clients. The founder was the late E W. Scripps, pioneer American newspaper publisher, whose group of papers, numbering 25 in as many cities of the United States, is now known as Scripps-Howard newspapers United Press was created from the merger of the Scripps-McRae Press Association and the Publishers' Press Association. Scripps opposed the principle of exclusive news franchises, granting none and seeking none United Press serves evening and morning and Sunday newspapers with news of every description In some 50 bureaux or branch offices staff employees collect and distribute the news of various prescribed territories and feed trunk-line wires which carry the reports to the general clientele Bureaux are maintained in every important capital of the world The principal foreign bureau is in London News is distributed in Great Britain by the British United Press, organized in 1922. The London bureau also serves clients in Spain, Italy, France and the Orient The Berlin bureau serves newspapers in Central Europe. Modern means of communication are employed and the management claims an annual expenditure of $4,500,000 for the collection and distribution of news. The general headquarters are in New York

(M. E P)

UNITED PROVINCES OF AGRA AND OUDH. One of the nine major provinces of British India, and second only to Bengal in population (45,375,787 in 1921) Marching with Tibet and Nepal along its north and north-east borders, it covers a compact area of 106,295 sq m , and imbedded in it are the three Indian States of Rampur, Tehri-Garhwal and Benares Including them, the province comprises the whole of the upper part of the Gangetic basin, from the Himalayas and the Punjab border to the Vindhyan plateau and the rice lands of Bihar, an area roughly corresponding to the Hindostan of the old Muslim chroniclers To this it adds the great semi-circular tract, watered by the Gogra and the Gumti, which was formerly the kingdom of Oudh

Physical Aspects.—At one end the province rises into the Himalayas and includes, at one extreme, some of the grandest of the peaks which look out upon upper Asia At the other extreme, where it borders on Central India, it has a fringe of rough, broken and picturesque country Apart from these, however, it is a level and somewhat monotonous expanse, well-drained, closely cultivated and studded with villages, the number of which (nearly 105,000) far exceeds that in any other province, many of them, standing high on the débris of older sites, have the air of fortified places, and the fine mango groves which often adjoin them redeem the bareness of the surrounding plain

The flora of the forests is rich and varied The *sal* tree yields the most important timber, the hard wood of the *shisham* is also valuable; and several other timber-trees afford materials for furniture or roofing shingle Among the scattered jungles in various parts of the province, the *mahua* tree is prized alike for its edible flowers, its fruits and its timber The fauna comprises most of the animals and birds common to the Gangetic plain; but the wild elephant is now practically unknown, except when a stray specimen loses its way at the foot of the hills Tigers are now found in any numbers in the *tarai* only Leopards still haunt the cane-brakes and thickets along the banks of the rivers; and *nilgai* and antelopes abound. Game birds consist of teal and wild duck, snipe, jungle fowl and peacock.

The Ganges and its great affluents, the Jumna, the Ramganga and the Gogra, rise in the Himalayas, and meet within the province. In addition there are the following secondary streams. the Kalinadi and the Hindan flow through the Doab; the Chambal intersects the trans-Jumna tract; in Bundelkhand the principal streams are the Betwa and the Ken; the Ramganga, rising in Garhwal, pursues a tortuous course through Rohilkhand; the Gumti flows past Lucknow and Jaunpur to join the Ganges; the trans-Gogra region is divided into two nearly equal parts by the Rapti. These rivers are constantly modifying the adjacent lands.

Climate.—The climate as a whole is hot and dry. The Himalayan districts of course are cool, and have a much greater rainfall than the plains They are succeeded by a broad submontane

belt, the *tarai,* which bears the reputation of being the most unhealthy in all India, and in many parts only the acclimatized aborigines can withstand its deadly malaria. The plain country is generally warm and dry, the heat becoming more oppressive as the general level of the country sinks towards Allahabad and Benares, or among the hills of Bundelkhand. The rainfall varies from 30 to 44 in in the plains, increasing gradually towards the Himalaya. The temperature in the hot season ranges from 86° to 115° F, and even higher, in the shade

Minerals and Agriculture.—Owing to the loamy nature of the soil, few minerals of any kind are found, and the chief underground product is the abundant nodular limestone (*kankar*) which is used for road-making Iron and coal exist in the southern hills, but not in paying quantities, and there are traces of old iron-workings in the lower Himalaya The course of tillage comprises two principal harvests, the *kharif*, or autumn crops, sown in July and reaped in October or November, and the *rabi*, or spring crops, sown in October or November and reaped in March or April. The great agricultural staple is wheat, but millets, rice, barley and pulses are also largely cultivated Speaking broadly, rice and oilseeds predominate in the eastern and sub-Himalayan districts, millets and cotton in Bundelkhand and wheat in the greater part of the Gangetic plain Sugar-cane, condiments and tobacco are locally important, and a little tea is grown in the submontane districts of Almora Garhwal and Dehra Dun.

Land Tenure.—Owing to historical reasons, the system of land tenure is not uniform In the Benares division, the land revenue was permanently fixed in 1795, on the same principles that had been previously adopted in Bengal, and there a special class of tenants, as well as the landlords, enjoy a privileged status. Throughout the rest of the province of Agra, temporary settlements are in force, usually for a term of thirty years, the revenue being assessed at one-half of the "assets" or estimated rental value The settlement is made with the landholders or *zamindars,* who are frequently a group of persons holding distinct shares in the land, and may be themselves petty cultivators. The privileged tenants are those possessing "occupancy" rights, defined by statute. All other tenants are merely tenants-at-will In Oudh, after the convulsion of the Mutiny, all rights in land were confiscated at a stroke, and the new system adopted was in the nature of grants to the *talukdars,* or great landlords, who were thus given a status that has no analogy in the rest of India By *sanad* (or patent) and by legislation the *talukdars* were declared to possess permanent, heritable and transferable rights, with the special privilege of alienation, either in lifetime or by will, notwithstanding the limits imposed by Hindu or Mohammedan law. In addition most of them follow the rule of primogeniture, while a power of entail has recently been granted The estates of *talukdars* extend over more than half the total area of Oudh. No "occupancy" rights based on continuous cultivation are recognized in Oudh, but any person admitted to the cultivation of land is entitled to hold it for seven years at the same rent, which may not be advanced by more than 6¼% at the end of the term.

Manufactures.—The principal manufactures are those of sugar, metal and coarse cotton cloth Ornamental metal-work is made at Benares. Among the factories on the English model are the Elgin and Muir cotton mills at Cawnpore, the Cawnpore wool-mill, tanneries and leather factories, the Shahjahanpur rum distillery, and breweries at Mussoorie and Naini Tal. There are also iron and brass foundries, lac factories and oil mills.

The export trade is chiefly confined to agricultural produce. The principal staples include wheat, oilseeds, raw cotton, sugar, molasses, timber and forest produce, dry-stuffs, ghee and tobacco. The imports consist mainly of English piece-goods, metal-work, manufactured wares, salt and European goods. The chief centres of trade are Cawnpore, Allahabad, Agra, Mirzapur, Benares, Meerut and Moradabad.

Irrigation.—The Doab is intersected by canals drawn from the great rivers The major productive works are the upper and lower Ganges, the eastern Jumna, and the Agra canals The greatest work in the province, and one of the greatest irrigation works in the world, is the upper Ganges canal, which is taken from the river where it leaves the hills, some 2 m. above Hardwar In the first 20 m. of its course this gigantic canal crosses four great torrents, which bring down immense volumes of water in the rainy season. The total length of the main canal is 213 m., navigable throughout, and designed to irrigate 1,500,000 acres. The lower Ganges canal is taken from the river at Narora, 149 m. below Hardwar After crossing four great drainage lines, it cuts into the Cawnpore, and 7 m. lower down into the Etawah, branches of the upper Ganges canal. These branches are now below the point of intersection, part of the lower Ganges canal system. The irrigating capacity of this canal is 1,250,000 acres A magnificent new canal has just been opened, to carry the waters of the Sarda over Oudh

Railways.—The province is well supplied with railways. The main line of the East Indian traverses it from end to end, on both banks of the Ganges, connecting with Bengal on the one side and the Punjab on the other, and linking up with the G I P. line at Allahabad, Agra and Cawnpore Besides this broad-gauge system, there is also a metre-gauge nexus (the Bengal and North-Western, with its associate, the Rohilkhand & Kumaun), which serves the whole of the submontane tract and projects into Bengal, while it also joins with the B B &C I at Muttra The trade of the province thus has access to the sea at Bombay, Calcutta and Karachi.

Administration.—The province is under the direction of a Governor, with an Executive Council and Ministers. There are seven secretarial departments, besides a board of revenue, which is the highest tribunal in rent and land revenue matters The legislative council is 118 strong. For ordinary business, the province is divided into 48 districts, each under a collector and magistrate, called also the deputy commissioner in Oudh and Kumaun; while the districts are grouped into nine divisions under commissioners The supreme judicial tribunals are the chartered high court at Allahabad with jurisdiction over the old Agra part of the province, and a chief court at Lucknow with jurisdiction over Oudh.

Population.—Out of the total census of 1921, no fewer than 38,405,624 are Hindus, and only 6,481,132 are Mohammedans, or 84·6% and 14·3% respectively Hindostani (or Urdu) and Hindi (Eastern and Western) are the chief languages

History.—If the present limits be slightly extended in either direction so as to include Delhi and Patna, the United Provinces would contain the area on which almost the whole drama of Indian history has been played Here lay the scene, known as *Madhya Desa* or "middle country," of the second period of Aryan colonization, when the two great epics, the *Mahabharata* and *Ramayana,* were probably composed, and when the religion of Brahmanism took form. Here Buddha was born, preached and died Here arose the successive dynasties of Asoka, of the Guptas, and of Harshavardhana, which for a thousand years exercised imperial sway over the greater part of India. Here ruled the Mogul for his most brilliant period at Agra and at Fatehpur Sikri Here finally, at the crisis of the Mutiny, British dominion was permanently established in India

The political vicissitudes through which this tract of country passed in earlier times are described under India *History.* It will be sufficient here to trace the steps by which it passed under British rule. In 1765, after the battle of Buxar, when the nawab of Oudh had been decisively defeated and Shah Alam, the Mogul emperor, was a suppliant in the British camp, Lord Clive was content to claim no acquisition of territory. The whole of Oudh was restored to the Nawab, and Shah Alam received as an imperial apanage the province of Allahabad and Kora in the lower Doab, with a British garrison in the fort of Allahabad. Warren Hastings augmented the territory of Oudh by lending the nawab a British army to conquer Rohilkhand, and by making over to him Allahabad and Kora on the ground that Shah Alam had placed himself in the power of the Mahrattas At the same time he received from Oudh the sovereignty over the province of Benares Lord Wellesley in 1801 obtained from the nawab of Oudh the cession of Rohilkhand, the lower Doab, and the Gorakhpur division, thus enclosing Oudh on all sides except the north. In 1804, as the result of Lord Lake's victories in the Mahratta War, the rest of the Doab and part of Bundelkhand, together with Agra, were secured from

Sindia. In 1815 the Kumaon division was acquired after the Gurkha War, and a further portion of Bundelkhand from the peshwa in 1817. These new acquisitions, known as the ceded and conquered provinces, continued to be administered by the governor-general as part of Bengal. In 1835 an act of parliament authorized the appointment of a lieutenant-governor for the North-Western Provinces, as they were then styled They included the Delhi territory, transferred after the Mutiny to the Punjab; and also (after 1853) the Saugor and Nerbudda territories, which in 1861 became part of the Central Provinces Meanwhile Oudh remained under its nawab, who was permitted to assume the title of king in 1819, until it was annexed in 1856 and constituted a separate chief commissionership Then followed the Mutiny, when all signs of British rule were for a time swept away throughout the greater part of the two provinces. The lieutenant-governor died when shut up in the fort at Agra, and Oudh was only reconquered after several campaigns lasting for eighteen months

In 1877 the offices of lieutenant-governor of the North-Western Provinces and chief commissioner of Oudh were combined in the same person; and in 1902, when the new name of United Provinces was introduced, the title of chief commissioner was dropped, though Oudh still retains some marks of its former independence. In 1920 the tract was created a governor's province under the new constitution.

UNITED STATES (OF AMERICA), THE, the foremost nation of the western hemisphere in the number and wealth of its people, and the second largest in area. It is situated advantageously in the temperate zone of the North American continent (25° 35′ to 49° N. lat.), and extends in a broad belt from the Atlantic ocean on the east to the Pacific ocean on the west (66° 55′ to 124° 45′ W. long). On the north it is bordered by the Dominion of Canada, the boundary in the west being an arbitrary line at the 49th parallel and in the east largely a natural one formed by the Great Lakes. The eastern half of the southern boundary is naturally defined by the Gulf of Mexico, but in the west the nation is separated from the Republic of Mexico by an oblique line following first the Rio Grande river and continuing afterwards generally west-north-west across the highlands to the Pacific ocean. The eastern coast is separated from Europe by approximately 3,000 miles of the Atlantic ocean which acts as a carrier for an enormous commerce between the two continents, but which, at the same time, gives the United States a degree of isolation from European affairs which has been welcomed and which has contributed greatly to its independent growth and progress. The Pacific ocean which separates the United States from the Oriental nations of the Far East is wider, varying from 5,000 to 6,000 miles, but in the Hawaiian Islands (*q v*) the United States has acquired possession of an important midway stepping stone.

The United States consists of 48 separate and theoretically sovereign States which are joined together by a Federal Government to which the original 13 States delegated certain powers as outlined in the Federal Constitution adopted in 1787 and put in force in 1789 The official name "The United States of America" is in general usage shortened to "United States," the term being used in the singular instead of a plural sense The total area of the nation is 3,026,789 sq m Its population in 1920 was 105,710,620, or 35·5 per sq m Of this number 89·7% was white and chiefly of European origin The official population estimate for 1928 was 120,013,000. In addition there are outlying possessions with a total area of 711,604 sq m. and a population in 1920 of 12,112,545 (For these possessions *see* ALASKA, HAWAIIAN ISLANDS, PHILIPPINE ISLANDS, PORTO RICO, GUAM, VIRGIN ISLANDS, etc)

The article which follows is divided into these sections:

I. Physical Geography
II. Geology
III. Climate.
IV. Fauna and Flora
V. Population and Social Conditions.
VI. National Finance
VII. Industry and Commerce.
VIII. Defence.
IX Constitution and Government
X History.

The reader is also referred to the articles on the separate States.

I. PHYSICAL GEOGRAPHY

Plan of Relief.—The primary features of the United States are: (*a*) a vast western highland covering a full third of the country, dominated by mountains of which the general trend is a little west of north, (*b*) a smaller and lower eastern highland south of the St. Lawrence river, trending north-east–south-west, roughly parallel to the Atlantic coast, (*c*) a broad interior plain sloping southward and interrupted by the smaller interior highland, and (*d*) a lowland belt bordering the Atlantic and the Gulf of Mexico

Major Physiographic Divisions.—The eight major divisions are as follows, the order being determined by the numbering of the physiographic provinces on the map (p. 720) and in table pages 721 and 722: *A*,—the Laurentian Upland covers most of eastern Canada and only a small part of the United States south of Lake Superior; *B*,—the Atlantic Plain embraces the Atlantic and Gulf coastal plains; *C*,—the Appalachian Highlands extend from the St. Lawrence south-west to the Gulf coastal plain with an average width of 300 miles *D*,—the Interior Plains are bordered on the east and west by great highlands of the continent and partly enclosed on the north by the Laurentian highland, but west of that they extend north to the Arctic ocean On the south these Interior plains give way to the Gulf coastal plain but not without a distinct descent *E*,—the Interior Highlands are surrounded by plains, the Interior plain on the west and north, and the Gulf coastal plain on the east and south *F*,—the Rocky Mountain System enters the United States from Canada and extends south to latitude 36° This system carries the main continental divide and, while not bearing the highest peaks, affords the greatest mass of land at high levels on the continent *G*,—the Intermontane Plateaux west and south of the Rocky mountain system, occupy approximately half a million square miles, most of it at high altitudes and half of it ribbed by mountains. *H*,—the Pacific Mountain System occupies a strip about 200 m. wide along the Pacific coast, embracing several distinct ranges and important valleys

Rivers and Harbours.—In a very general way the major divides follow the great highlands, hence the rivers entering the Atlantic between the St Lawrence and the Gulf of Mexico are of moderate size and of little direct value to navigation Their indirect value is great, however, because all their valleys were carved when the continent stood at a higher level Subsidence of the land drowned the lower courses of streams, making estuaries and harbours as at New York, Baltimore and all the other Atlantic seaports The Hudson was drowned to Albany and the Delaware to Trenton, permitting ocean vessels to reach Philadelphia. Chesapeake bay is the largest indentation thus made One of its branches, the Potomac, is at sea-level as far up as Washington.

The St Lawrence system embraces the five Great Lakes on the Canadian border. The divide limiting the drainage basin of these lakes on the west and south is not far from their shores, hence all tributary streams are short. But the mouths of these streams have likewise been drowned by the tilting of the basin in such a manner that the south-western shores of these lakes are being progressively submerged while the north-eastern shores are rising Milwaukee, Chicago, Toledo and some other ports owed their original harbours to this cause The extraordinary harbour of Duluth lies behind a sand bar which has cut off the western end of Lake Superior

Five-twelfths of the United States (1¼ million sq.m), mainly in the Interior plains, drain to the Mississippi and its branches These afford thousands of miles of navigable water, chiefly on the main stream and its tributaries from the humid east. The Ohio is the most navigated stream in America. New Orleans is a river city 100 m from the Gulf; it is a seaport only in the sense that sea-going vessels can reach it. Mobile and some other Gulf ports are on drowned valleys altered and supplemented by artificial works. A small estuary at Galveston is fronted by a broad sand reef on which the city stands.

The Mississippi river has received much attention on account of navigation and flood prevention. More than three-fourths of its water comes from three main streams, the Missouri, the Upper Mississippi (above the mouth of the Missouri) and the Ohio. Their several contributions are approximately as follows:

	Drainage area (square miles)	Average discharge in second-feet	Percentage of total discharge
Upper Mississippi	171,500	127,000	18·27
Ohio	202,000	300,000	43·17
Missouri	527,000	100,000	15·83
Mississippi at mouth .	1,238,000	695,000	

The Missouri drains the largest basin but has the least rainfall, hence its volume is least. Each year the Mississippi carries to the sea 340,500,000 tons of solid matter in suspension and 136,400,000 tons in solution Erosion would thus reduce the level of the entire drainage basin by one foot in 6,000 years.

West of the continental divide on the Rocky mountains are two long rivers, the Snake-Columbia in the north and the Colorado in the south, which traverse the full width of the Intermontane plateaux Other streams are short and the total amount of water reaching the Pacific is small in proportion to the great area drained. In this part of the United States, chiefly in the States of California, Nevada, Utah and Arizona, and in the adjacent part of Mexico is a vast area too arid to drain to the sea, comprising 3·2% of the area of the continent or nearly a quarter of a million square miles The Pacific shore, like the Atlantic, has suffered submergence, drowning the lower courses of most streams Thus was made the harbour of Portland, Oreg., on Columbia river, 100 m from the sea The local subsidence that made San Francisco bay came at a point where the chief rivers of California break through the Coast ranges to the Pacific Puget sound, with Seattle, Tacoma and other harbours, is similar to San Francisco bay San Diego, near the Mexican border, owes its harbour to the protection of a magnificent sand reef

Atlantic and Gulf Coastal Plain.—South of New York, the continent slopes almost imperceptibly to the shore, beyond which the sea bottom continues the very gentle slope many miles, and then descends less gradually to the oceanic abyss The line where this relatively rapid descent begins is the real edge of the continent and this margin of shallow sea bottom is the continental shelf. Within this margin is deposited most of the sand and mud carried down from the land A large part of the ocean's life is concentrated on this shallow bottom where the water is relatively warm and food is abundant.

Repeatedly in late geologic time this border of the continent has stood lower, and also higher, than at present, thus broadening and narrowing the continental shelf alternately The part of the shelf above water at any one time is coastal plain All that is shown on the map (p. 720) as coastal plain has been continental shelf at a time so recent that its structure remains unchanged. The materials of its underlying strata are the same as those now accumulating beneath the adjacent shallow sea. Some of the sand, clay and ooze has been poorly consolidated into sandstone, shale or limestone. All beds dip faintly seaward, the older and lower ones passing seaward beneath the younger beds, so that the several formations appear at the surface in strips parallel to the coast, the lower beds outcropping farthest inland. As the beds offer unequal resistance to erosion and are unlike in their soil-making properties, the striped pattern of the geologic map is apt to be reproduced in the topography of the coastal plain.

Topography.—As the surface of the continental shelf is extremely flat, so also is the land nearest the coast, which has but recently emerged and lies too near sea-level to permit the cutting of valleys. The landward edge of the coastal plain was necessarily first to emerge from the sea. It is also the highest. For both of these reasons it is more deeply eroded and more completely dissected by small streams than is the seaward edge. In the southern States this inner edge is at places more than 700 ft. above the sea and has a relief of 300 to 400 feet. At places erosion has even made new lowlands or peneplains. Other things equal, the number and depth of valleys increase inland.

Where the underlying strata resist erosion unequally, a strong stratum may give rise to a cuesta, a ridge with a very gentle slope down dip towards the sea and a steeper slope cutting across the strong stratum and leading down to an "inner lowland" on the underlying weak stratum. The effect on topography is to make the *belted coastal plain* wherein the stronger beds (usually sandy) make higher, rougher and less fertile belts and the weaker beds (usually clay, marl or "chalk") make belts of smooth, fertile lowland. Thus central Alabama has its well known "Black Belt" on the outcrop of the Selma chalk (Cretaceous) which erosion has reduced to a lowland with a rich black soil, famous for its cotton Dipping seaward, the chalk passes under stronger sandy beds which are poor soil makers, hence the rich lowland is paralleled by a broad, now much dissected cuesta of poor upland. Another lowland and another upland follow but are less well known Northern Texas has a similar belt, the "Black Prairie," along the western boundary of the coastal plain. It is likewise on a chalk outcrop and has on its seaward side an infertile cuesta. New Jersey has a similar lowland on the weak Raritan clays which outcrop along the landward edge of the coastal plain From Trenton south-westward this low strip is followed by Delaware river. North-east from Trenton it is followed by the great railroads running from New York to Philadelphia.

Islands—It will be observed that the coastal plain is broadest at the south and narrows toward the north The opposite is true of the continental shelf, indicating that the continent is now relatively depressed at the north and elevated at the south. One effect of this is seen in the islands from New York to Cape Cod. These islands, Staten, Long, Block, Martha's Vineyard and Nantucket, are disconnected fragments of the coastal plain, parts of one or more cuestas whose corresponding inner lowlands are submerged. The low strip described across New Jersey is continuous with Long Island sound The same weak clays underlie both

Coastline—Throughout the Atlantic and Gulf coast recent (not necessarily current) sinking is in evidence From New England to Texas the smaller streams have estuaries, as the larger ones had also until filled by sediments. North of southern Virginia all the major streams crossing the coastal plain are drowned across its entire width The numerous large estuaries from New York to North Carolina make that part of the coast extremely ragged or crenulated Sand reefs or barrier beaches form a nearly straight "outer coast" and these continue most of the way from Long Island to Mexico They are especially long and continuous along the coast of Texas where tides are weak

The peninsula of Florida is due to an uplift of the sea bottom on an axis almost at right angles to the outline of the continent Its southern third is so little above sea-level that valley cutting is all but impossible. Here are the vast Everglades (*q v*), swamps whose water surface is less than 20 ft. above the sea. Its most valuable part is a low limestone ridge on the Atlantic side, bearing Miami and other winter resorts On this ridge and a line of coral reef wrapping around the southern end of the peninsula the Florida East Coast railroad passes to Key West The northern part of the peninsula has suffered some erosion Its underlying limestone suffers solution, giving rise to many sinkholes, some of them clogged and making lakes of considerable size. Here are the largest deposits of phosphate rock in eastern United States

Mississippi Embayment.—In the vicinity of the Mississippi river the coastal plain is greatly widened, extending north in a pronounced embayment to southern Illinois The greater part of this area is occupied by the alluvial plains, 40 to 80 m wide, of the Mississippi and its tributaries. At the south this plain merges with and includes the great protruding delta, the entire alluvial plain covering an area of nearly 30,000 square miles A large part of it is subject to flooding, or would be if not protected by artificial levees. The breaking of the levees in 1927 allowed most of the area to be inundated, the river at Arkansas City, Ark, rising at one time to 60·5 feet. The natural levees are at places 15 to 20 ft. above the back swamps Slopes of 5 ft. per mile from the

river are common Slopes of 10 and even of 12 ft. are known.

Piedmont and Blue Ridge Provinces.—Inland from the Atlantic coastal plain is a belt underlain mainly by very old rocks, much deformed, generally metamorphosed and resistant This belt extends from central Alabama north-eastward into Canada, but the part to be described here terminates at Hudson river. Its greatest width in the south is nearly 200 m, but north of Potomac river it averages barely 60 miles This relic of the early Paleozoic continent is marked now by a mountain range on its north-western side. From southern Pennsylvania, where it is called South Mountain, to southern Virginia, where it is called Blue Ridge, it is rarely more than 10 or 15 m wide and from 1,500 to 3,000 ft high. In North Carolina and adjacent States it broadens to 70 m and culminates in Mt Mitchell (6,711 ft), the highest point in eastern United States The range is interrupted by a short gap in southern Pennsylvania. North-eastward from this gap it is known as the Highlands of New Jersey and New York This part, being detached from the main range (Blue Ridge Province) and contiguous with the New England province, which is largely of the same character, is considered a part of the latter From New England to southern Virginia the crest as viewed from a distance is gently undulating and is considered to be the remains of an uplifted peneplain preserved by the strength of the rocks, while weaker rocks on both sides have been reduced to a new and lower peneplain In western North Carolina the ancient mountains were never worn down to the peneplain indicated by the crest farther north Partly for this reason and partly because of greater recent uplift these mountains are several thousand feet higher

Between the mountains and the coastal plain is the Piedmont province, most of it a low plateau sloping seaward, consisting in the main of the same rocks found in the mountains Where the rocks of the piedmont and mountain belts are similar the existence of a newer and lower peneplain in the former and not in the latter is explained by the fact that the new peneplain developed first along the lower courses of streams flowing from the mountains to the sea It spread westward, its limit of advancement being the eastward slope of the Blue Ridge This newer peneplain is itself uplifted and dissected by revived streams Much of the northern end of the Piedmont province in Pennsylvania and adjacent States is exceptional, consisting of softer Triassic rocks As these were more readily worn down and, as already pointed out, the continent in this latitude has been less uplifted, this part of the Piedmont province is lowland rather than plateau, though still distinctly higher than the coastal plain Taken as a whole the rocks of this province are not very good soil makers, but the position, especially of its northern part, favours intensive cultivation Parts of the upland farther south are adapted to fruit trees and an important cotton district in South Carolina is in this province

New England Province.—The New England province is a broadened north-eastward extension of the belts already described. It has the same rocks along with some younger Paleozoics, generally deformed, metamorphosed and peneplaned Residual mountains rising above the general level to an altitude of 4,000 to 6,000 ft are found in the Green mountain section of Vermont and Massachusetts and the White mountain section of New Hampshire and Maine Between and around these mountains the upland level is generally a little above 1,000 ft, studded here and there with isolated residual mountains or "monadnocks," the original Mount Monadnock being in south-western New Hampshire This upland is an uplifted peneplain, itself dissected by sharp valleys since uplift. The surface declines seaward to the "Seaboard Lowland" and it is probable that newer and lower peneplains are here represented. The coastal margin below a level of 500 ft. has a rolling surface with wide open valleys in contrast with the narrow and steeper valleys that incise the plateau. The land below 500 ft also includes the broad valley of Connecticut river carved from Triassic rocks and analogous in every way to the low northern end of the Piedmont province With this valley included, the relatively narrow seaboard lowland contains the greater part of New England's population and industry

Elevation was followed by depression and the valleys are drowned This is typically shown on the coast of Maine where the style of depressed coastline is quite different from that of the coastal plain because of difference in topography previous to drowning. Outlying islands, formerly hills or mountains of hard rock, are abundant here Harbours are numerous and fishing is favoured by this as well as by the broad continental shelf.

Unlike the Piedmont and Blue Ridge provinces, New England was severely glaciated, its mountains overridden and scraped by the continental ice sheet, and its surface generally covered by ice-laid drift abounding in boulders Some of its valleys are partly filled with sandy outwash Both topography and the stony soil are unfavourable to agriculture. The northern part of the province was long the great lumbering district of eastern United States. One of the chief effects of glaciation was the dislocation of streams. Drainage in beginning anew was obliged to fill many basins and cross many rocky ledges Lakes and rapids, therefore, abound, the latter being a great source of power New England, with its poor soil, abundant water power and excellent harbours early developed manufacturing and commerce

The Adirondacks.—In its physical geography the Adirondack area in northern New York is much like northern New England, a combination of subdued mountains and hilly plateaux, all severely glaciated and abounding in lakes Like the White Mountains and New England coast it is much used as a summer resort The State of New York has reserved large areas of forest

Appalachian Valley-and-Ridge Province.—West of the Piedmont, Blue Ridge and New England provinces is a narrow belt of folded sedimentary rocks stretching from the St Lawrence valley to the Gulf coastal plain. The length is 1,000 m and the width rarely 75 m, more often half that amount. Between New England and the Adirondacks it is very narrow In its present state this belt consists of alternating ridges and valleys, the former being parallel, even-topped and rarely 3,000 ft high For the most part they are nearly straight and in line with the major belt but a zigzag pattern appears in Pennsylvania The valleys occupy more than half the space Throughout its length the Paleozoic sandstones, shales and limestones are folded and often faulted by great lateral compression which made mountains of great height The ridges now seen are not those made by the folding Those lay far above the level of the present mountain tops Even the synclinal trough bottoms were above the present crests All were eroded away to a peneplain covering this and adjacent provinces At the time of its making it could not have been, at highest, more than a very few hundred feet above the sea The tilted strata came to the surface of this plain in parallel strips. Later came a general rise of the whole Appalachian region and the limestones and shales were worn down to a new and lower level (generally a peneplain) while the sandstones, being stronger, along with the hard rocks of the Blue Ridge province and the sandstone-capped plateau on the west, retained almost their former level. The tops of the present even-crested ridges indicate approximately the level of the old peneplain

The greatest breadth of this Valley-and-Ridge province is in Pennsylvania where it is almost 90 miles From here to southern Virginia the eastern third or fourth is almost without ridges. Its several parts from the Lebanon valley in Pennsylvania to the Shenandoah valley in Virginia are well known for their agricultural wealth. In this central portion the master streams cross the belt transversely, their longitudinal tributaries being developed on the softer outcrops In the northern section of the province; Hudson-Champlain valley, and again in the southern section, Valley of East Tennessee and neighbouring States, the main streams are longitudinal. In the latter case this came about by the headward elongation of Tennessee river capturing the former streams which flowed from the Blue Ridge to the Ohio river.

Appalachian Plateaux.—West of the Valley-and-Ridge province is a plateau of almost equal length with a minimum width of 35 miles at the south but more than 200 miles wide farther north. On the side toward the Valley-and-Ridge province, it is at least as high as the ridges already described, 2,000 to 3,000 ft., but it declines north-westward and is barely 1,000 ft. high where its edge approaches Lake Erie. Its rocks are almost horizontal, generally outcropping on the south-east in an escarp-

ment overlooking the adjoining valley of the folded province. Except at the north end the rocks at the surface are Carboniferous and Permian. Thick beds of strong sandstone are common and generally cap the hills. Soils, therefore, are generally not good. They are least fertile at the south end where the sandstones are most dominant, and best at the north end where Devonian rocks form the plateaux and glaciation has left its heterogeneous drift.

The larger part of the province is almost or quite completely dissected by stream valleys. These may approximate 1,000 ft. in depth on the higher south-east side, but the relief diminishes toward the north and west. Nevertheless the hilltops are about at the same altitude and the horizon is nearly level. The Cumberland plateau at the southern end, mainly in Tennessee, is exceptional in preserving large patches of undissected upland on beds of strong sandstone. In parts of the eastern margin the beds are mildly folded though not enough to develop the topography of the next province to the east. The surface is less plateau-like than elsewhere in this province and the horizon less level. As these are also places of greater height these districts are known as mountains, the Allegheny mountains in Pennsylvania, and the Cumberland mountains in Kentucky and Virginia, but these names are applied somewhat broadly, and without exact boundaries, to the deeply dissected eastern margin The Catskill mountains in south-eastern New York are like the adjacent plateau but covered by an additional thick plate of strong conglomerate now deeply and maturely dissected The plateau in New York, and to some extent in Pennsylvania and Ohio, was glaciated, leaving the hills and valleys less angular; leaving also many lakes and displaced streams, some of which in carving new valleys have made picturesque falls and gorges The main plateau ends at the north in an escarpment not far south of the 43rd parallel and 600 to 1,000 ft high West of Rome, N Y, this escarpment overlooks the lacustrine plain along Lake Ontario, a part of the central lowland East of Schenectady the descent from the plateau is to the valley of Hudson river (Valley-and-Ridge province). Between these two cities, the descent is only to a lower bench of the plateau province. In this bench Mohawk river has cut its valley connecting the two lowlands named. As all strata here dip slightly southward, the valley of the Mohawk is a strike valley It is the greatest avenue of travel and commerce between the Atlantic coast and the central lowland

The glaciated northern portion of the Appalachian plateau is favoured agriculturally and is one of the leading dairy districts of the United States. The remainder of the province is almost co-extensive with the great Appalachian coal fields, 75,000 sq m in extent As this area was never folded the coal remains bituminous. In the province to the east the folds were so high that the carboniferous beds, being uppermost, were almost wholly eroded away. Only in a few small spots were the synclines so deep as to leave the coal below the base level of erosion Here the coal was metamorphosed to anthracite The total original area of the anthracite fields was 484 square miles In the central part of the plateau province are also the great Appalachian oil and gas fields

Interior Low Plateaux.—West of the southern part of the Appalachian plateaux is a lower plateau province, mainly in the States of Kentucky and Tennessee At its eastern edge it abuts against the western escarpment of the Cumberland plateau. Here the lower plateau is 1,000 to 1,500 ft high and scored by valleys between which the surface is little eroded The ragged escarpment of the Cumberland plateau rises 800 ft higher Everywhere the level of the Interior Low Plateau declines toward Ohio river, near which in western Kentucky the uplands are little more than 500 ft. high. Dissection by streams increases toward the west end where it is complete. The most important parts of this province are two basins. The Nashville basin in central Tennessee is entirely surrounded by an inward facing escarpment 500 ft. high. The Lexington basin in Kentucky is overlooked by escarpments on the east, south and west but merges with the Till Plains at the same level on the north. These basins contain the most fertile lands and the greatest wealth of the province. The term "Blue Grass Region" is sometimes applied to both basins but more commonly to the central and most fertile part of the Lexington basin. Both basins originated as mild structural domes These being eroded down to a common base level exposed the underlying Ordovician (Lower Silurian) limestone and shale surrounded by the Mississippian (Lower Carboniferous) cherty limestones. The latter resisted erosion, making a poor soil while non-resistant Ordovician rocks produced soils that are famed for their fertility Western Kentucky receives the south end of a great coal field with its centre in Illinois. Here is a broad, faint syncline in which the upper Carboniferous rocks were sufficiently depressed to escape the erosion that stripped them away from neighbouring areas Here again, in western Kentucky, the soil is better and produces the famous Burley tobacco.

Central Lowland and Superior Upland.—The term lowland is not capable of exact definition. As applied to north central United States it signifies that most of the area is not obviously much above the level to which streams can cut down.

Within this great province, roughly one-fourth of the United States, the chief contrasts in topography are determined by glaciation The entire province may be divided into six sections. Two of them were never covered by the ice; two of them were left after glaciation as relatively smooth till plains without lakes; two others were left with abundant moraines and undrained basins. Referring to the accompanying map and table, the Eastern Lake section (*12a*) has a topography controlled in detail by its thick glacial deposits, though its large features betray the relief of the underlying rock as carved by pre-glacial drainage Terminal and recessional moraines and outwash deposits, with morainic lakes and swamps, cover perhaps half of the area; the other half is till plains (ground moraine) and lacustrine plains The beds of all the Great Lakes, except Superior, follow belts of weak strata which were presumably lowlands in pre-glacial time and were deepened by glacial erosion As the ice front retreated northward from the Mississippi-St Lawrence divide, lakes formed between the divide and the ice. With further retreat of the ice these lakes expanded and merged, changing from time to time in shape, altitude and outlet but generally discharging into the Mississippi system When the vanishing ice covered only the St Lawrence the lakes discharged for a time through Mohawk valley to the Hudson As each newly discovered outlet lowered the lake levels the water was progressively withdrawn from the farther ends of the basins and the old lake bottoms at the heads of the lakes (south or west ends) were laid bare An important though minor part of this Eastern Lake section consists of these perfectly flat former lake bottoms The glaciation of this section was in the last, or Wisconsin, ice epoch and the surface has been little altered by erosion Lakes and swamps are beginning to disappear but stream systems are poorly developed West of Lake Michigan, in this section, is the leading dairy district of the United States

The Western Lake section in Minnesota, northern Iowa and the Dakotas is similar but with a smaller proportion of morainic topography. It has also a smaller rainfall, so that forests are limited to northern Minnesota. An important feature of this section is the great lacustrine plain of former Lake Agassiz in the valley of Red river. This valley was flooded when the retreating ice cap obstructed the drainage to Hudson bay The lacustrine plain (most of it in Canada) is now the greatest area of spring wheat production in America

The two sections already described are separated by the Superior Upland and the Wisconsin Driftless Area The former, as compared with the lake sections, is higher, is less deeply covered with drift, has a larger number of lakes and vastly more swamp Its rocks are mainly igneous and metamorphic pre-Cambrian Topographically it is a peneplain, upraised, somewhat eroded, then glaciated This is an important part of the great area of northern pine forest Much is now cut-over land, only a minor part being valuable for agriculture. It contains the chief copper mines of eastern United States and the greatest iron mines of the world

South-western Wisconsin and small parts of adjacent States were missed by the several ice invasions though surrounded by a glaciated surface that extends 250 m. farther south Probably at no one time did the ice close around it. The margin of the ice sheet

was divided into lobes following the great valleys. In the different ice epochs they came from different directions, at one time from the north-west, at another from the north-east, the areas covered by these different advances overlapping south of this Driftless Area. The southern and western parts of this area are limestone uplands rather deeply and at places sharply carved by erosion. The northern part is mainly a lowland underlain by friable Cambrian sandstone covered by glacial outwash. With due allowance for the effects of different kinds of rocks on topography, this driftless area may be regarded as a sample of the topography that was elsewhere overridden by the ice It is not very different from that which is seen beyond the limit of glaciation in eastern Ohio or western Kentucky or central Missouri.

Most of Illinois, Indiana and western Ohio have a drift cover remarkable for its small relief and distinguished by a total absence of lakes. The flatness is not absolute, for the retreating ice front halted at various stages, building recessional moraines, a few of which have the distinctive topography of moraines, while others are barely visible, being made apparent only by their effect on drainage. The major streams have cut down moderately into this surface and tributaries are developing, but not much headway has been made except near the Ohio and the Mississippi. A margin near these streams belongs to an older drift sheet (Illinoian) while most of the section was again covered by ice in the last (Wisconsin) glacial epoch. West of this section in Iowa and northern Missouri and parts of eastern Nebraska and Kansas, are the Dissected Till Plains, distinguished from the Till Plains east of the Mississippi by greater erosion This difference results from the fact that the glacial mantle west of the Mississippi was spread in the Kansan glacial epoch and is the oldest glacial drift exposed in the central lowland Complete drainage is re-established; valleys now occupy fully four-fifths of the area In the type of agriculture that distinguishes the central lowland (grains and domestic animals) the Till Plains and Dissected Till Plains are pre-eminent.

South of the latitude of Kansas City (39°) the central lowland (Osage section) was not glaciated It extends almost to central Texas in a belt nearly 200 m. wide The underlying rocks dip gently west beneath the Great Plains syncline and away from the Interior Highland As the surface slopes in the opposite direction the formations outcrop in parallel strips trending nearly north and south. The stronger beds form cuestas with east-facing escarpments, some of them so eroded as to make hilly belts a few miles wide.

Interior Highland.—Surrounded by the lowlands of south-central United States is the Interior Highland. Its northern and larger part consists of the Ozark plateaux on nearly horizontal though slightly domed rocks. The rocks of its southern third are folded along east-west axes. Altitudes in the Ozark plateaux are generally less than 1,600 ft., being highest near the centre, but in northern Arkansas on the southern slope of the dome the strong sandstone beds of the upper Carboniferous are preserved in a plateau that is locally more than 2,000 ft. high and ruggedly eroded, making the Boston mountains. In south-eastern Missouri in the midst of the plateau stand the St. Francois mountains, composed of granite, rising no higher than the surrounding horizontal sediments which once covered all. These ancient granite mountains were buried by marine sediments and are now being exhumed. They are among the best examples of their class. The Ozark province is one of the leading sources of lead and zinc.

The belt of folded structure in Arkansas and Oklahoma, the Ouachita mountains (15*b*) is essentially like the Appalachian Valley-and-Ridge province, the product of two cycles of erosion, with ridges on the stronger outcrops and intervening lowlands on the weaker rocks. The rocks of the Arkansas Valley (15*a*) are but mildly folded and although the stronger sandstones make either flat or sloping uplands the whole strip is less uplifted than its neighbours. This province has large supplies of coal. The Ouachita mountains have the famous Hot Springs of Arkansas and produce the novaculite (natural honestone) of the United States. In and near it also are important bauxite deposits.

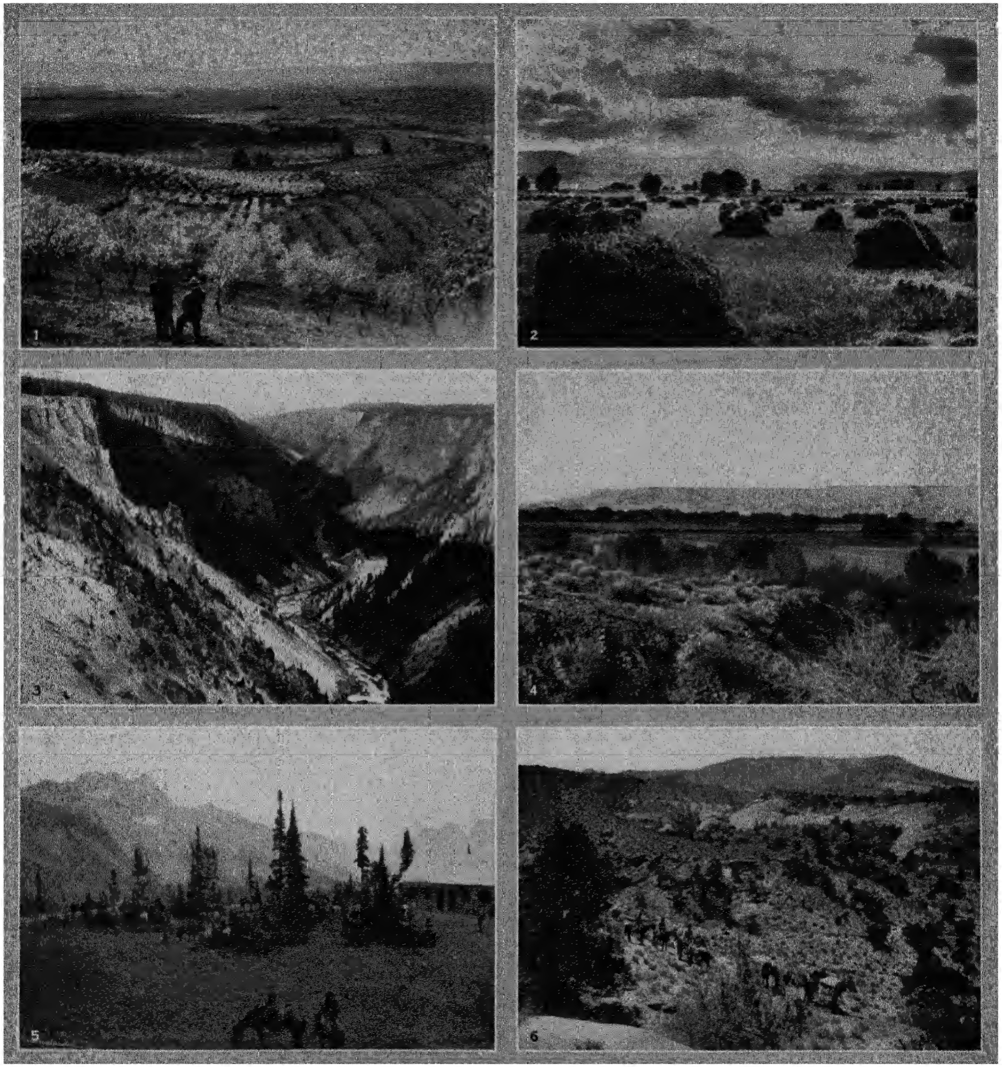
Great Plains Province.—The vast area known as Great Plains is a north-south belt averaging about 400 m. in width between the mountains of western United States and the lowlands of its centre. Its height at the base of the mountains is 5,000 to 6,000 ft. and at its eastern edge 1,500 to 2,000 feet. An eastward slope of 10 ft. to the mile is common. A part of this great area is literally plain, most of the northern third is peneplain and considerable areas on the borders, both in the east and west, are dissected into hills. All of it is semi-arid and the only trees are in river bottoms or on certain isolated mountains like the Black Hills. Most of it has good soil without the necessary water to take full advantage of the fertility. Perhaps a tenth part may be irrigated.

The flat portions of the province are best illustrated in the Llano Estacado (Staked Plains) of Texas and eastern New Mexico (13*d* on the accompanying map and table). Interrupted by the valleys of transverse streams these flats extend north to southern Nebraska and, in modified form, to the South Dakota boundary forming a belt known as the High Plains. These are remnants of a vast alluvial slope made by coalescing alluvial fans from the mountains. When the streams ceased their depositing habit and began again to erode, the eastern edge of the fluviatile deposit was first to suffer. In Texas the edge is retreating westward as a well defined escarpment, there being but a few miles between the flat upland and the lowland on the east. In Kansas and adjacent States the wasting edge of the former upland plain is represented by a broad belt of hills (13*e*). In Nebraska, a thick mantle of loess obscures the transition from high plains to central lowland. Between the belt of preserved high plains and the mountains, erosion was also more favoured, partly by original slopes, partly by the nature of the vegetation. Here (13*f*-*g*-*h*) the fluviatile mantle, where formed, was destroyed and the present landscape is one of varied relief The South Platte, Arkansas and Pecos have broad terraced and well-farmed valleys, but north-eastern New Mexico and the adjacent part of Colorado is a region of plateaux, trenched by angular valleys and surmounted by various features of volcanic origin The Edwards plateau at the southern extremity of the province (13*i*) is a limestone tableland almost as flat as the Llano Estacado but without the fluviatile mantle. It is cut off on the south and east sides by the great Balcones fault which for 300 m. forms the inner boundary of the coastal plain. Streams are dissecting the plateau at the edges and have in part removed the same limestone from a large area just north of the Edwards plateau. This hilly section in central Texas (13*k*) is in a stage of the erosion cycle intermediate between the youth of the well preserved plateaux and the old age of the lowlands on the north.

North of latitude 43° the Great Plains province is in large part upraised peneplain, though perhaps not all of the same cycle Second in areal importance are the extensive gravel plains, some of them perhaps being remnants of a sheet similar in origin to that which covers the high plains Others are simple stream terraces of Pleistocene age. Some of the streams, especially near the mountains, have valleys hundreds of feet deep and their tributaries have deeply dissected the upland. Isolated mountains are dome-like uplifts, the largest of which is the Black Hills, almost 100 m. long and 50 m. wide, crossing the Dakota-Wyoming border. The structural uplift approximates 10,000 ft. but erosion has truncated the dome leaving the actual height less than 4,000 ft. above the plain on the east. The core of granite has thus been exposed at the top, while the strata outcrop in concentric ellipses, the stronger ones making ridges.

The northern part of the Great Plains province and a margin on the east (13*a*) was covered by the Pleistocene ice-cap, leaving a strongly morainic topography in the Dakotas. The present course of Missouri river results from the obstruction of former drainage north-eastward to Hudson bay. The ponded waters overflowing from basin to basin found the present south-eastward course. Its relative youth is shown by the small width of its valley (1 to 3 m. between bluffs) as compared with that of the Yellowstone and other tributaries.

Rocky Mountains.—As shown on the map (p. 720) the Rocky Mountain system is divided into four parts. The Southern Rocky Mountain province is a group of linear uplifts initiated



BY COURTESY OF (1) THE S... PHOTOGRAPHS, (2) PUBLISHERS PHOTO SERVICE, ... L. M. NEWMAN FROM PUBLISHERS PHOTO SERVICE, (4) EWING GALLOWAY

VIEWS IN WESTERN UNITED STATES

1. Looking down on a large prune orchard in blossom in the Santa Clara Valley of California
2. Harvest scene in Colorado at twilight
3. Deep canyon in the Yellowstone National Park in Wyoming
4. Cultivated field in an arid western region, surrounded by sagebrush
5. A horse corral in the Glacier National Park, Montana
6. Pack train travelling through the arid foothills of the mountains in Arizona

PLATE II

UNITED STATES OF AMERICA

PHOTOGRAPHS BY (1, 6, 7) VISUAL EDUCATION SERVICE, (2) UNITED STATES FORESTRY SERVICE, (3) SOUTHERN PACIFIC PHOTO, (4) PUBLISHERS PHOTO SERVICE, (5) GOVERNMENTAL PHOTO, (8) EWING GALLOWAY

FLORA OF THE UNITED STATES

1. Monterey Cypress. This true cypress, native to a small area along the shore of Carmel bay, California, is widely planted for ornament. The crowns of the native trees are often flattened and broken by the ocean gales
2. Red fir and western red cedar along a roadside in the State of Washington. Both are characteristic forest trees of the Pacific coast region
3. Redwood (*Sequoia sempervirens*), a valuable lumber tree confined to the fog belt of the California coast. This immense conifer is sometimes taller than, though never so massive as, the giant sequoia or big tree of the Sierra Nevada mountains
4. Live oak. A lane near St. Augustine, Florida, over-arched with spreading live oak branches, which are festooned with Spanish moss
5. Pine forest in central Louisiana, composed chiefly of yellow (long-leaf) and loblolly pines, both valuable lumber trees
6. Mixed forest in the Mississippi valley, composed of various hardwood (deciduous) trees, with heavy undergrowth
7. Tree yucca (*Yucca mohavensis*) in Arizona. The arborescent yuccas, some of which attain a height of 60 ft., are a characteristic feature of the deserts in the south-western States
8. Cholla (*Opuntia Bigelovii*), an exceedingly spiny cactus abundant in the Colorado desert of south-eastern California and in the Gila basin of Arizona

by east-west compression. The original folds were in large part levelled by erosion which thereby exposed the underlying granite, now revealed in north-south belts with a maximum width of 40 miles. Later uplift raised the general level to mountain heights but without sharp deformation. The old erosion surface was warped rather than folded, producing intermont basins. This later uplift enabled erosion to carve valleys in the granite and reduce the weaker rocks to lowlands. Commonly the granite belts are bordered by upturned sedimentary rocks, the several formations being of unlike strength, thus developing monoclinal foothills and valleys. Some large areas of granite 8,000 to 10,000 ft. high are plateau-like with a relief of only several hundred feet. These plainly represent a former lowland made by approximately peneplaning the first mountains. The largest of these tracts is South Park, 9,000 to 10,000 ft. high, west of Pikes peak. The same surface farther east and at many other places is carved into mountains whose summits approximate the same level. Looking across these crests, or over the undissected upland, Pikes peak is seen to rise as an isolated eminence 5,000 ft above the level. It was a monadnock on the South Park peneplain. North of the Park and extending almost to Wyoming is the main crest of the Front range with many peaks 12,000 to 14,000 ft. high. Along this entire line residual mountains rise clearly above a dissected plateau Only a minor part of what is called "mountains" in the southern Rockies consists of these residual eminences. The greater part are carved from the uplifted peneplain In the entire system, both north and south, most of the residual mountains have "alpine" features due to former glaciers These are cirques and U-shaped troughs, often separated by steep and narrow crags The San Juan mountains in south-western Colorado consist largely of volcanic rocks which once covered the area in sheets of relatively small relief. Later they were carved by water and ice into their present forms.

The Middle Rocky mountains, between the Wyoming basin and Yellowstone National park, consist of definite ranges in which structures and trends are clearly related. The axes radiate from Yellowstone park to the south, south-east and east. A long sickle-shaped arm whose eastern side is the Bighorn range almost surrounds the Bighorn basin. Of the group of ranges trending south, the Wasatch in northern Utah is outlined on the west by a great fault, the range on the upthrown side overlooking Great Salt lake on the downthrow. Meeting this range at right angles is the Uinta range which extends eastward forming the southern rim of the Wyoming basin.

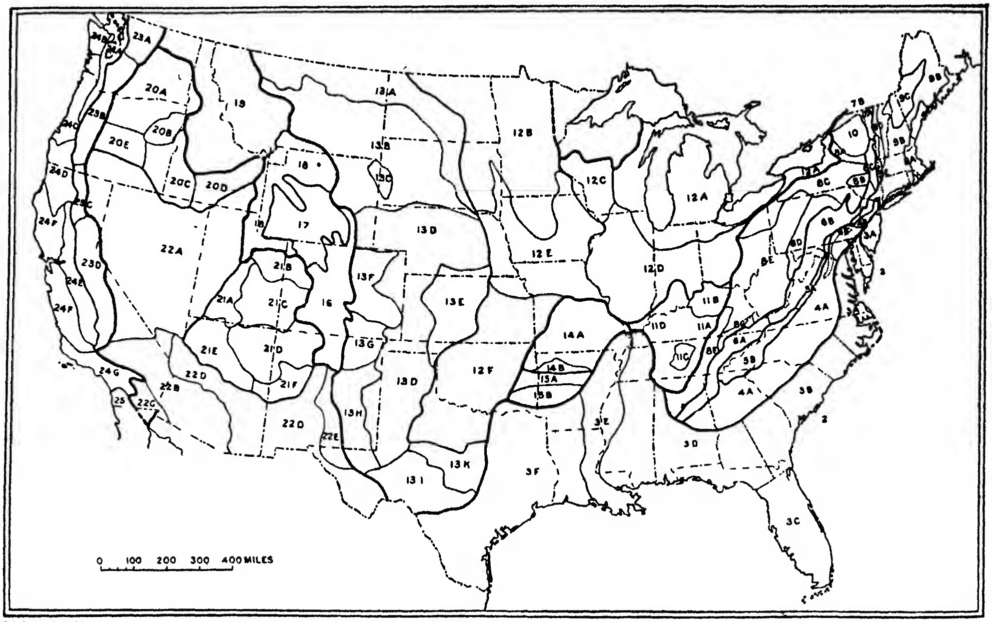
Yellowstone park is a plateau of rhyolitic lava with an average height of about 8,000 ft, enclosed by mountains on three sides but open to the west where a rapid descent leads down to the Snake river (basalt) plateau. A single narrow belt of mountains north and east of the plateau connects those to the north and those to the south. The lava fills a basin probably 2,000 ft. deep and appears to have conserved the heat revealed by geysers and hot springs. The hot springs are among the most extensive in the world and the geysers have no rival.

North and west of Yellowstone park the mountains (with few exceptions) are not in "ranges" in the usual sense of that word. Linear arrangement in agreement with structure is found to a limited extent, *e g.*, in the Lewis range of Glacier National park, but in general the present relief does not suggest corrugation. Much the larger part of the area is a vast mountain upland divided only by stream valleys or by "Tertiary basins" in which the mountain surface has sagged. Generally the dominant ridges within a single view are of sub-equal height so that the horizon is not far from level. Altitudes between 6,000 and 9,000 ft. are prevalent. The Bitterroot mountains on the Montana-Idaho boundary are the upturned edge of a fault block tilted westward. Except for this deformation the surface is as described above. The history of the Northern Rocky mountains is much like that of those farther south. At similar altitudes glacial features are more pronounced. They are specially marked and picturesque in Glacier National park in the Front range near the Canadian boundary. The Selkirk and Bitterroot ranges are likewise noteworthy in this respect.

Wyoming Basin.—North of the southern Rocky mountain province is the Wyoming basin whose floor, almost 40,000 sq m. in extent, is a plateau 6,500 to 7,500 ft. high and largely free from mountains. Beneath its horizontal Tertiary rocks, and rising through them here and there, are the older folded sedimentaries and granite, showing that the Rocky mountain system is structurally continuous. Within and around this plateau the drainage is strikingly out of harmony with structure and topography Green, Yampa, Bighorn, North Platte and Laramie rivers all leave the basin by canyons 1,000 to 3,000 ft. deep which might be avoided by going around the mountains. Green river, especially, was once a favourite illustration of antecedent river. This assumes that the river was in its place before the mountains rose across its course. It is now known that these streams are superposed, *i e.*, they chose their courses when the mountains were buried by weak Tertiary rocks lying on top of those that now make the basin floor.

Colorado Plateau.—South and west of the Rocky mountains is a region of 125,000 sq m. whose underlying rocks are in the main horizontal and whose surface is tabular. In part it consists of wide-spreading plains at high altitude; elsewhere the plateau consists of tabular remnants between deep and branching canyons In general the plateau abuts against the mountains on the north and east and ends in an escarpment overlooking lowlands on the west and south. The best known part of the province is the south-western section (21*e*) traversed by the Grand Canyon of the Colorado This has a maximum depth of 6,000 ft and a minimum width of less than 5 m. from rim to rim. The conditions favouring canyons are all present in this province. Great altitude above base level, strong through-flowing streams and geologically recent uplift favour downcutting, while strong rocks and arid climate favour preservation of steepness In this section the surface is on Permian limestone not deeply eroded. These rocks dip north under younger strata At the same time the surface rises terrace-like over system after system until Eocene (Tertiary) beds and lava flows are found capping the high plateaux of Utah (21*a*) 9,000 to 11,000 ft. high, bounded, both east and west, by escarpments. Most of the strata underlying the high plateaux formerly extended southward over the plateau in which the Grand Canyon is cut A mass of rock equal in thickness to the entire depth of the canyon was stripped from this plateau leaving a relatively low surface which was later uplifted. In other words, if the present canyon broadens and similar canyons develop and broaden until the entire plateau has been carried away to the depth of the present canyon bottom, then the streams of the present, newly inaugurated erosion cycle will have accomplished what was done once before. The same Eocene beds which appear in the high plateaux form a wide band on the northern margin, dipping northward until they turn up in the foothills of the Uinta range, and ending at the south in an escarpment. The general surface slopes agree with the structure. This is the Uinta basin (21*b*). South of it, and east of the high plateaux is the area of arid Canyon Lands (21*c*) deeply trenched by Colorado river and its tributaries, though its eastern margin in Colorado contains some broad fertile valleys. Farther south is the Navajo section (21*d*), like the Canyon lands but more arid and less canyoned because there are no mountains on the border to supply through-flowing streams. The Datil section (21*f*) on the south-east is largely lava-covered as is a very considerable area farther west (San Francisco mountain and vicinity) in the Grand Canyon section. Here also is the Zuni uplift, a dome like the Black hills.

Basin-and-range Province.—West and south of the Colorado plateau is a region marked by numerous small, roughly parallel mountain ranges separated by nearly flat detrital plains generally 4,000 to 5,000 ft. above the sea, but declining in altitude toward the Gulf of California. The northern half has long been known as the Great Basin and is the largest area of internal drainage in North America. The 100 or more mountain ranges divide it into an almost equal number of undrained basins. The hydrographic centres of some of these are marked by salt lakes; some others have playas, mud flats covered occasionally by a few inches of



BY COURTESY OF THE GEOLOGICAL SURVEY, U.S. DEPT OF INTERIOR

MAP SHOWING PHYSIOGRAPHIC DIVISIONS OF THE UNITED STATES (SEE TABLE P 721)

water All are filled or veneered by detritus eroded from the mountains and deposited as alluvial fans. Such surfaces are nearly level and tend to rise until the basin is full. A few basins along the course of Humboldt river have been so aggraded with detritus as to establish through drainage which may reach Carson Sink or stop at Humboldt lake, according to season and weather. Many of the mountain ranges are 50 to 75 m. long and 3,000 to 5,000 ft. above the basins and trend approximately north–south. Trees appear only in exceptional spots Some of the ranges are known to be upraised or up-tilted fault blocks. As there is a strong family resemblance among ranges, it is considered probable that faulting is at least the master process in the making of these ranges. The internal structures are complex showing that the rocks were strongly folded and (in the best known cases) peneplaned and lava-covered before faulting made the present mountains In northern Nevada and southern Oregon the mountains were uplifted so recently that their origin by faulting is beyond doubt Farther south some ranges are so old and eroded that their origin is not obvious. Some of the ranges bear evidence that the master faults were made before the peneplain, the present mountains consisting of the more resistant fault-blocks exhumed by selective erosion The extent to which this explanation is applicable to the mountains of this province is not yet definitely known

South of latitude 35° 30′, and extending from California to New Mexico, many of the intermontane basins are connected by through drainage or at least by continuous slopes on which water might flow to the sea if the rainfall were sufficient

Columbia Plateau.—The surface of the Columbia plateau between the Northern Rocky mountains and the Cascades is made by flows of dark lava. These flows submerged an uneven surface of erosion, locally almost mountainous as may be seen in vertical section in the mile-deep canyon of Snake river between Idaho and Oregon. The Snake river basin east of the 115th meridian represents the simplest and most youthful phase of lava plains Here the flat surface, 4,000 to 5,000 ft. high, remains as it was when the lava cooled, without erosion and only beginning to weather and to form soil It is trenched only by the canyon of Snake river whose depth increases westward to 700 feet. Farther west, in south-western Idaho and south-eastern Oregon, there is more erosion Near the State boundary the terraced valleys afford valuable irrigable land. The plateau in eastern Washington declines from nearly 3,000 ft. on the east to less than 500 ft where Columbia river breaks through the Cascades. This northern section (20*a*) consists of older lavas, subjected to long erosion and having a rolling surface covered (at least in the east) with wind-blown soil. Here are the famous wheat fields of eastern Washington and western Idaho, cultivated by methods of "dry farming" by which a crop is raised in alternate years In eastern Oregon near the middle of the province a group of mountains stood as an island in the floods of lava. Around these a later bulging raised the plateau surface to 7,000 ft, exposing it to greater erosion. This is the Blue Mountain section (20*b*). The rise lay across the course of Snake river which succeeded in cutting down as fast as the land rose, making a canyon 5,000 ft. deep

Sierra-Cascade Mountains.—From Canada to southern California a continuous barrier of mountains separates the Pacific border from the Intermontane plateaux. The Sierra Nevada south of the 40th parallel presents to the Great Basin one of the highest and steepest mountain fronts on the continent. It is the escarpment of a great fault, or compound fault, west of which an old mountain range, worn down almost to a lowland, rose again with a westward tilt Streams descending its long western slope have greatly increased its ruggedness by cutting gorges. These were later occupied by glaciers which deepened the valleys and steepened their sides. Yosemite valley is only an extra fine example of the typical glacial trough with its uneven floor whose basins retained lakes until filled by gravel, and its over-steepened walls notched at the top by tributary valleys, the "hanging valleys" which end in falls. These mountains are mainly of granite but in the northern half is a belt of folded and metamorphosed sedimentaries making the "Gold Belt" which has yielded a large part of California's output of gold.

Table Showing the Physiographic Divisions of the United States

Divisions	Characteristics
Laurentian Upland	
1. Superior Upland	1. Submaturely dissected, recently glaciated peneplain on crystalline rocks of complex structure.
Atlantic Plain	
2. Continental Shelf	2. Sloping submarine plain of sedimentation.
3. Coastal Plain	
a. Embayed section	3a. Submaturely dissected and partially submerged, terraced coastal plain.
b. Sea Island section	3b. Young to mature terraced coastal plain with submerged border
c. Floridian section	3c. Young marine plain sandhills, swamps, sinks and lakes.
d. East Gulf Coastal Plain	3d. Young to mature belted coastal plain
e. Mississippi Alluvial Plain	3e. Flood plain and delta.
f. West Gulf Coastal Plain	3f. Young, grading inland to mature coastal plain.
Appalachian Highlands	
4. Piedmont Province	
a. Piedmont Upland	4a. Submaturely dissected peneplain on disordered resistant rocks, moderate relief.
b. Piedmont Lowlands	4b. Less uplifted peneplain on weak strata; residual ridges on strong rocks.
5. Blue Ridge Province	
a. Northern section	5a. Maturely dissected mountains of crystalline rocks, accordant altitudes
b. Southern section	5b. Mature to subdued mountains of disordered crystalline rocks
6. Valley-and-Ridge Province	
a. Tennessee section	6a. Second-cycle mountains of folded strong and weak strata, valley belts predominating over even-crested ridges.
b. Middle section	6b. The same, but even-crested ridges predominate over valleys except on east side
c. Hudson Valley	6c. Glaciated peneplain on weak folded strata.
7. St. Lawrence Valley	
a. Champlain section	7a. Rolling lowland, glaciated, in part covered by young marine plain.
b. Northern section	7b. Young marine plain with local rock hills.
8. Appalachian Plateaux	
a. Mohawk section	8a. Maturely dissected, glaciated plateau, varied relief.
b. Catskill section	8b Maturely dissected plateau of mountainous relief and coarse texture (glaciated).
c. Southern New York section	8c Mature glaciated plateau of moderate relief.
d. Alleghany Mountain section	8d. Mature plateau of strong relief, some mountains due to erosion of open folds.
e. Kanawha section	8e Mature plateau of fine texture, moderate to strong relief
f. Cumberland plateau section	8f. Submaturely dissected plateau of moderate to strong relief
g. Cumberland Mountain section	8g. Higher mature plateaux and mountain ridges on eroded open folds.
9. New England Province	
a. Seaboard Lowland	9a. Peneplains below 500 feet, past-maturely eroded and glaciated, few monadnocks.
b. New England Upland	9b. Dissected and glaciated peneplains on complex structures; monadnocks
c. White Mountain section	9c. Subdued and glaciated mountain masses of crystalline rock.
d. Green Mountain section	9d Linear ranges of subdued and glaciated mountains and residual plateaux
e. Taconic section	9e. Maturely dissected and glaciated mountains and peneplain on resistant folded strata.
10. Adirondack Province	10 Subdued mountains and dissected peneplain glaciated
Interior Plains	
11. Interior Low Plateaux	
a. Highland Rim section	11a Young to mature plateau of moderate relief
b. Lexington Plain	11b Peneplain on weak rocks; trenched by main rivers and locally dissected.
c. Nashville Basin	11c Peneplain on weak rocks, slightly uplifted, moderately dissected.
d. Possible Western section (not delimited)	11d Low, maturely dissected plateau with silt-filled valleys.
12. Central Lowland	
a. Eastern lake section	12a Maturely dissected and glaciated cuestas and lowlands; moraines, lakes, and lacustrine plains.
b. Western lake section	12b. Young glaciated plain, moraines, lakes, and lacustrine plains
c. Wisconsin Driftless section	12c. Maturely dissected plateau and lowland invaded by glacial outwash (Margin of old eroded drift included)
d. Till Plains	12d. Young till plains, morainic topography rare, no lakes
e. Dissected Till Plains	12e. Submaturely to maturely eroded till plains
f. Osage Plains	12f. Old scarped plains beveling faintly inclined strata; main streams entrenched.
13. Great Plains Province	
a. Missouri Plateau, glaciated	13a. Glaciated old plateaus, isolated mountains.
b. Missouri Plateau, unglaciated	13b Old plateau, terrace lands, local badlands, isolated mountains
c. Black Hills	13c. Maturely dissected domed mountains.
d. High Plains	13d. Broad inter-valley remnants of smooth fluviatile plains
e. Plains Border	13e. Submaturely to maturely dissected plateau.
f. Colorado Piedmont	13f. Late mature to old elevated plain.
g. Raton section	13g. Trenched peneplain surmounted by dissected, lava-capped plateaux and buttes.
h. Pecos Valley	13h. Late mature to old plain.
i. Edwards Plateau	13i. Young plateau with mature margin of moderate to strong relief.
k. Central Texas section	13k. Plateau in maturity and later stages of erosion.

Table Showing the Physiographic Divisions of the United States—continued

Divisions	Characteristics
Interior Highlands	
14 Ozark Plateaux	
a Springfield-Salem plateaux	14a. Submature to mature plâteaux.
b. Boston "Mountains"	14b. Submature to mature plateau of strong relief.
15 Ouachita Province	
a. Arkansas Valley	15a. Gently folded strong and weak strata; peneplain with residual ridges
b. Ouachita Mountains	15b. Second-cycle mountains of folded strong and weak strata
Rocky Mountain System	
16. Southern Rocky Mountains	16. Complex mountains of various types, intermont basins
17 Wyoming Basin	17. Elevated plains in various stages of erosion, isolated low mountains.
18 Middle Rocky Mountains	18. Complex mountains, mainly anticlinal ranges; intermont basins.
19. Northern Rocky Mountains	19. Deeply dissected mountain uplands, not anticlinal ranges, intermont basins.
Intermontane Plateaus	
20. Columbia Plateaux	
a. Walla Walla Plateau	20a Rolling plateau with young incised valleys.
b. Blue Mountain section	20b. Complex mountains and dissected volcanic plateaux.
c. Payette section	20c. Young plateaus of prevailingly weak rocks; broad alluvial terraces (Applies to northern part only)
d. Snake River Plain	20d. Young lava plateau.
e. Harney section	20e. Young lava plateau, features of recent vulcanism, internal drainage.
21. Colorado Plateaux	
a High Plateaus of Utah	21a High block plateaux, in part lava-capped, include terraced plateaux on south side
b. Uinta Basin	21b Dissected plateau, strong relief
c Canyon Lands	21c. Young to mature canyoned plateaux, high relief
d. Navajo section	21d Young plateaux; smaller relief than 21c. into which it grades.
e Grand Canyon section	21e High block plateaux, trenched by Grand Canyon
f. Datil section	21f. Lava flows entire or in remnants, volcanic necks.
22. Basin-and-Range Province	
a Great Basin	22a Isolated ranges (largely dissected block mountains) separated by aggraded desert plains
b. Sonoran Desert	22b Widely separated short ranges in desert plains
c. Salton Trough	22c Desert alluvial slopes and delta plain, Gulf of California
d. Mexican Highland	22d Isolated ranges (largely dissected block mountain) separated by aggraded desert plains
e. Sacramento section	22e. Mature block mountains of gentle dip, block plateaux, bolsons
Pacific Mountain System	
23 Sierra-Cascade Mountains	
a Northern Cascade Mountains	23a. Sharp alpine summits of accordant height, higher volcanic cones
b Middle Cascade Mountains	23b. Generally accordant summits; higher volcanic cones
c Southern Cascade Mountains	23c. Volcanic mountains variously eroded, no very distinct range.
d. Sierra Nevada	23d Block mountain range tilted westward, accordant crests, alpine peaks near east side.
24. Pacific Border Province	
a. Puget Trough	24a. Lowlands of diverse character, in part submerged
b. Olympic Mountains	24b. Generally accordant crests, local alpine peaks
c. Oregon Coast Range	24c. Uplifted peneplain on weak rocks, dissected, monadnocks of igneous rock.
d. Klamath Mountains	24d. Uplifted and dissected peneplain on strong rocks, extensive monadnock ranges
e California Trough	24e. Low fluviatile plains.
f California Coast Ranges	24f Parallel ranges and valleys; on folded, faulted and metamorphosed strata, rounded crests of subequal height
g Los Angeles Ranges	24g. Uplifted fault blocks, alluviated lowlands
25 Lower Californian Province	25 Dissected west-sloping granite upland (in northern part)

North of Feather river the range changes completely. There is no evidence of uplift, only a piling up of volcanic materials from hundreds of vents Lava flows, ash beds and cinder cones are of all ages from those that are fresh and shapely to others almost eroded away Mt Shasta with its beautiful cone (14,380 ft), and Lassen's peak, the only volcano in the country witnessed in action, belong to this southern section of the Cascades (*23c*) A little north of the Oregon boundary there is evidence that crustal uplift is added to volcanic accumulation Farther north the range owes its height more and more to uplift and less and less to the piling up of ejecta The volcanic cover gives out entirely in central Washington, north of which the Northern Cascade mountains (*23a*) consist of metamorphosed Paleozoic rocks and granite, intricately dissected into sharp peaks and ridges most of which, in a single view, rise to an almost uniform height. The level thus determined varies from 6,000 to 8,500 ft, being gently arched. Above this nearly level horizon in both Oregon and Washington rise the isolated cones of extinct volcanoes 3,000 to 7,000 ft higher. The best known are Mt Rainier (14,526 ft.) in Washington and Mt. Hood (11,225 ft) in Oregon. Crater lake in southern Oregon is the finest example of its class in America. It originated by the engulfment of the upper part of a volcano thus truncating the cone and leaving a pit 5 to 6 m in diameter at the water-level, which is here 6,117 ft. high Above it the walls of the caldera rise 500 to 2,200 ft. and below it the basin is 2,000 ft. deep.

Pacific Border.—The Pacific Border embraces a chain of coast ranges with long and important valleys between these and the Sierra-Cascade mountains The most northerly range is the Olympic mountains (*24b*), not unlike the Northern Cascades but lower. The Oregon Coast range (*24c*) is a gentle anticline of Tertiary beds, relatively recent in origin It is succeeded on the south by the Klamath mountains, (*24d*), a range of long standing, consisting largely of metamorphosed Palaeozoic rocks, once eroded down to a peneplain but uplifted again, locally as high as 7,000 ft., then deeply and ruggedly eroded. Most of the California coast is occupied by the California coast ranges (*24f*). These are relatively low mountains (generally between 2,000 and 4,000 ft.)

ranged in parallel ridges due largely to faulting of an earlier, much deformed and much worn down mountain belt. Some broad valleys south of San Francisco are filled with late Tertiary sediments because of depression at that time. Still later the coast seems to have been depressed some 1,500 ft. below its present level. Shore-lines etched against the mountain side are preserved here and there at various levels between the sea and the 1,500 ft contour. As shown by these old shorelines, the depression that caused San Francisco bay is relatively recent.

Puget sound is the submerged northern end of a trough (24*a*) 350 m. long between the Cascades and the Coast range. Its southern end is the valley of the Willamette, a southern tributary of the Columbia Some of the valleys in this long trough are agriculturally rich. Commercially the region of the sound is favoured by its fine harbours and the four or more transcontinental railroads which these harbours have attracted. The Great Valley of California (24*e*) between the Coast range and the Sierra Nevada is 400 m long and 50 m. wide. In the upwarp of the adjacent mountain belts, this belt was bent down As a consequence it was covered with the silt, sand and gravel washed from the mountain slopes That deposition is still going on in the valley is evident from the habits of the two master streams, the Sacramento from the north and the San Joaquin from the south These have small gradients and run between high natural levees; sandbars are abundant; at the head of San Francisco bay the two streams unite to build an extensive delta The filling of the valley is mainly from the higher mountains on the east Deposition is in the form of alluvial fans which in the southern part have crowded the San Joaquin westward to the foot of the Coast range, the great alluvial fan of Kings river, extending across the valley, has cut off its southern third forming Tulare basin, partly occupied at times by a playa lake. Here the climate is so arid that all inflow is evaporated and there is no drainage to the San Joaquin Irrigation is highly developed, especially in the more arid southern half on the great alluvial fans. Fruits, nuts and raisins are the chief products

The Sierra Nevada and the Great Valley extend south to latitude 35° beyond which there are ranges trending nearly east-west from the Mohave desert to the Pacific These and smaller ranges to the south partly enclose the famous fruit-growing lowlands of southern California The sea on the south-west forms the remaining boundary Roughly half of this lowland is underlain by marine sediments The other half consists of small basins filled with detritus from the mountains and overflowing to the sea. Considerable areas both in the basins and on the coastal plain yield artesian water. In the mountains and lowlands of southern California are the great oil fields of the Pacific coast (N M. F)

II. GEOLOGY

All the great general systems of rock formations recognized in Europe are represented in the United States, but close correlation across the Atlantic is not possible in all the systems. The generalized geologic chronology for the United States, including part of the Pre-Cambrian from Canada, is shown in the next column.

Archaeozoic Group.—The rocks representing the Archaeozoic era, the oldest group, outcrop in many parts of the United States, as in the cores of some of the western mountains and in some of the deep western canyons, in the worn down bases of the old mountain complexes of Wisconsin, Minnesota, New England and the eastern piedmont plateau of the Appalachians, and other regions of geologically ancient terrain. They have been revealed in deep borings in many other places and are believed to underlie the younger formations everywhere. They have been described as a "complex of basic and acidic surface and deep-seated igneous rocks, of schists and gneisses in part derived from them and in part of unknown origin, and of shreds and small masses of metamorphosed sediments, all unconformably below and older" than the Proterozoic sedimentary rocks.

No incontrovertible *direct* evidence has been uncovered of Archaeozoic life, though globular masses of metamorphosed limestone of distinctive structure described from Canada and elsewhere, designated ***Eozoon canadense***, are widely believed to be calcareous depositions made by marine algae. The indirect evidences of life are the presence of sedimentary carbon in the form of graphite, and possibly of bacteria-precipitated limestone and bacteria-oxidized iron oxides, in the rocks of the Archaeozoic era. Locally the Archaean rocks are rich in iron ores, chiefly oxides, as in northern Minnesota, and in graphite, as in the Adirondacks.

Eras of Time *Groups of Systems*	*Periods of Time* *Systems of Rocks*	
Psychozoic	Recent Post-glacial	
Cenozoic	Pleistocene (*Quaternary*)	
	Pliocene	(*Tertiary*)
	Miocene	
	Oligocene	
	Eocene	
	Transition—(Arapahoe and Denver Formations)	
Mesozoic	Cretaceous	
	Wide-spread unconformity	
	Comanchian	
	Jurassic	
	Triassic	
Palaeozoic	Permian	(*Carboniferous*)
	Pennsylvanian (*Coal Measures*)	
	Wide-spread unconformity	
	Mississippian	
	Devonian	
	Silurian	
	Wide-spread unconformity	
	Ordovician	
	Cambrian	
Proterozoic	*Great unconformity*	(*Algonkian*)
	Keweenawan	
	Wide-spread unconformity	
	Animikian	
	Wide-spread unconformity	
	Huronian	
	Great and wide-spread unconformity	
	Sudburian (Sudbury, Temiscaming, Doré and Seine Series)	(*Neo-Laurentian*)
Archaeozoic	*Great and wide-spread unconformity*	(*Palaeo-Laurentian*)
	Keewatin (*Grenville*)	
	Coutchiching	

Proterozoic Systems.—The rocks of the Proterozoic systems are widely spread in the United States adjacent to the outcrops of the Archaean rocks, from which they are not always easily distinguished or separated, and in a few other places, but the areal extent of their outcrops is relatively limited. The Sudburian has been but little studied by the geologists of the United States, whereas in Canada, like the other formations of the Proterozoic, it is extensively represented and has been allotted a great deal of attention due to its relation to the great metalliferous ore-bodies which have there been discovered and exploited The Huronian has been much more thoroughly studied by United States geologists, particularly in the Lake Superior region where it is well exposed in the great iron-producing districts The basal members of the Huronian contain tillites (consolidated deposits of glacial till or boulder clay) indicating a glacial climate in this early period of the geologic history of America. Upon this tillite lies a series of heavy quartzites and above this a marine limestone in which are found an abundance of the oldest undoubted fossils *Atokania lawsoni*, an algal growth of considerable size, and definite structure The Animikian is found in the United States only in northern Michigan and Minnesota where it has been exhaustively studied in connection with the rich deposits of hematite and other iron oxides for which the region has become famous and which have their origin principally in the Animikian In nearly all the Animikian areas small or large bodies of hematite are concentrated as a secondary enrichment from extensive deposits of cherty ferruginous carbonate or oolitic greenalite or jasper, and from the productive fields, Mesabi, Penokee-Gogebic, Menominee, and Marquette.

The Keweenawan, the uppermost of the Proterozoic systems, is not extensively represented in the United States, but in Canada it is wide-spread about the Laurentian Shield and of exceeding

economic importance because of its heavy mineralization—"copper, nickel, and silver in large amounts; cobalt, gold, platinum, and palladium in much smaller amounts, and if the iron mines are left out of account, almost all the metalliferous deposits of the southern margin of the Canadian Shield have resulted from the coming of its (Keweenawan) dikes, or sheets, or lava streams." The Keweenawan differs from the earlier Proterozoic systems in enormously thick lava beds which apparently welled up through great fissures to form a thickness of almost or quite 6 m of igneous material, indicating a period of local volcanism unsurpassed in geologic history

The Proterozoic formations of the western cordillera in Montana, Idaho and British Columbia attain a thickness of over 37,000 ft., and in the Grand Canyon region over 12,000 ft. remain after an unknown amount of erosion The Proterozoic formations elsewhere in the continent cannot with even approximate certainty be correlated with the Lake Superior members, because the fossils are too few and indistinct to permit a correlation upon the life of the period, and the lithologic character and sequence of the series are not at all similar.

Palaeozoic Groups.—At the opening of the Palaeozoic era most of the United States, as it now is, was submerged beneath the sea. Over its northern border in north-eastern Minnesota and northern Michigan projected the southernmost extension of that ancient nuclear shield of the North American continent, *Laurentia* Along its eastern seaboard from Maine to northern Florida lay the mountainous western edge of old *Appalachia*, the eastern shore of which has disappeared in the abysmal depths of the Atlantic The south-eastern tip of Florida was included within the northernmost tip of *Antillia*, a land which extended eastward from Central America to the most easterly of the Lesser Antilles Most of Texas and small parts of Louisiana and New Mexico formed the north-eastward point of ancient *Columbia*, and on its north-western border from west-central Nevada to Puget sound the south-westerly shore of *Cascadia* constituted a fifth land mass which, like the other four, has been largely submerged or eroded These five great land masses bounded the great interior sea, within which a complete and fairly continuous series of Palaeozoic series of sediments derived from the erosion of these bordering lands was laid down to record the geologic history in the rich development of life upon the surface of the earth during that early time

Nowhere else in the world is the Palaeozoic record so complete or so full as in North America, and chiefly in the United States. Almost everywhere southward from the Great Lakes and the St Lawrence the strata of the Palaeozoic outcrop, occupies practically all of the Ohio basin, most of the Upper Mississippi and the eastern third of the Missouri Nearly everywhere these strata are relatively horizontal and undisturbed except in the Appalachians where they are much broken and folded, in the Cincinnati uplift where they are gently arched and in the Ozark uplift, an extensive dome where they are more steeply inclined The Palaeozoic strata are also exposed locally in folded narrow bands from north-western Mexico to the Arctic and from the Pacific States as far east as Denver

The Cambrian, the oldest system in the Palaeozoic, is not exposed at the surface over large areas, but is widely distributed across the United States from California to the Appalachians, and from the St Lawrence to Alabama, outcropping generally along the borders of the Pre-Cambrian rocks of old *Laurentia, Appalachia* and *Cascadia* The earliest Waucobian, the first period of the Cambrian found in the United States, has been discovered only in southern California, though the latest Waucobian extends from there to the eastward across the Sierras and northward approximately through Nevada, Utah, Idaho and parts of Wyoming, Montana, Oregon and Washington, and thence to the Arctic ocean, and along the Appalachians from the Gulf of Mexico to the St Lawrence. The outcrops of the Acadian, the middle period of the Cambrian, and of the Croixian, the upper period, are more widely distributed The Ozarkian, which has been only recently definitely established and not yet exactly delimited in vertical extent and which comprises members formerly referred to the Upper Cambrian and Lower Ordovician, is best developed in the southern Appalachians, but is rather widely distributed in the Mississippi valley region and along the borders of old *Appalachia* as well. These four periods, of which the first three are indisputably Cambrian, and the last possibly part of the same system, are characterized by the development of a rich marine fauna in their relatively shallow seas—trilobites, brachiopods and gastropods.

The rocks, dominantly limestone, of the Ordovician system outcrop widely in the United States, but, like the Cambrian, not over very large areas, though in some regions, like the Lexington basin in Kentucky and the Nashville basin in Tennessee, they are extensively exposed. Like the Cambrian, too, the Ordovician exposures are generally distributed about the peripheries of the old Pre-Cambrian land masses, but naturally farther out from their shores. The Canadian, the earliest period of the Ordovician (if the Ozarkian be included within the Cambrian), has not been even roughly delimited, but the submergence during which the Canadian deposits were laid down was restricted to the eastern United States and the Great Basin of Nevada and Utah, and the Acadian section of Canada. The Champlainian period, following the Canadian, was characterized by a submergence of the North American continent to an extent not since approached, with consequent deposit of Champlainian sediments rich in marine fossils—bryozoans, brachiopods, gastropods, cephalopods, crinoids locally, silicious sponges, hydroids, ostracods and early corals—over wide areas. The Cincinnatian, the closing period of the Ordovician, was also a period of extensive submergence during parts of its continuance, but the epicontinental seas varied greatly in extent and position as a whole. The Cincinnatian closed with such a wide-spread withdrawal of these seas that the configuration of the American continent at the close of the Ordovician approached its present outline in its major characteristics

Little indication of volcanic activity during the Ordovician is found in North America, but the period was distinguished by important tectonic movements which resulted in the Taconic deformation in the eastern United States, whereby the sedimentary deposits which had been laid down in a trough between the Appalachians and a land mass lying eastward in New England, from the St Lawrence to Long Island, were folded sharply and metamorphosed profoundly, to constitute the Taconic complex; and the Cincinnati arch and other central interior anticlines were initiated in the middle of the period and at its close were elevated and greatly enlarged.

In the Ordovician, not only of America, but elsewhere, the adaptation of life to environment seems almost as well established as now. The muddy bottoms of the seas into which rivers of medium grade emptied, were characterized by certain forms that were quite distinct from those that developed in seas with sandy and gravelly bottoms, and the clear water areas developed still other groups The differentiating effect of isolation is clearly brought out in the fossils of the Ordovician wherever a portion of the epicontinental sea was cut off by such a barrier as an anticline, or wherever ocean currents of different temperature or salinity prevented intermingling of the faunas. Thus the life of the Ordovician was fuller, richer and higher in the evolutionary stage than that of the Cambrian. Trilobites, cephalopods, gastropods, pelecypods, cystoids, graptolites and corals of advanced and varied types predominated, and bryozoans, crinoids and fishes appeared for the first time.

The Ordovician formations have yielded much, if not most, of the natural gas and petroleum of Ohio and Indiana and a great deal in other eastern States; lead and zinc have been produced from the sulphide and carbonate ores from the Galena formation of eastern Iowa, south-western Wisconsin and north-western Illinois which is a Middle Ordovician member; calcium phosphate, a valuable fertilizer is obtained from the Ordovician of central Tennessee; and limestone, marble and cement are widely quarried from the members of the Ordovician from Vermont to Tennessee.

The Silurian of North America is nearly everywhere rather readily cut off from the Ordovician by a relatively distinct, angular unconformity in the east and by an equally distinct disconformity in fossil content in the interior. The Oswegan, the lowest of the

three distinct major divisions of the Silurian, initiates the period with the epicontinental seas apparently confined to three major extensions upon the area of the present continent: one stretching up the Mississippi valley to northern Illinois; a second extending across Newfoundland and northern New Brunswick, and a third occupying the Appalachian trough, and stretching east and west over central New York and Ontario. Following the Oswegan, the Niagaran continues the period with an expansion of the Silurian seas over the United States east of the Mississippi river and over a large part of Canada to the Arctic ocean, and an extension of two seas on the west, one from California through Idaho to Canada, and another from Mexico into Arizona and New Mexico. The Cayugan closes the period with a withdrawal of the Silurian seas until they covered only the region from Wisconsin and Illinois through New York and over the Appalachian trough.

During the Silurian the Cincinnati uplift or anticline continued a prominent physiographic feature separating distinct marine basins and faunal provinces. The Ozark uplift likewise constituted a conspicuous feature of the continental landscape; and more land emerged in western United States than ever before.

The Silurian fauna is characterized by a wealth of types with radial symmetry, as was the Ordovician; the brachiopods became larger and sturdier, the eurypterids or "sea-scorpions" were common and corals widely scattered. It was in the Niagaran when the seas were most widely extended that the life was richest and most cosmopolitan The first recognized land plants—of low form—are from the Cayugan. Fishes probably occupied the fresh waters of the whole Silurian period, but their fossils appear only in the closing part.

The Salina group, one of the upper members of the Cayugan, yields the salt obtained from wells in New York, Ohio and Ontario; and the Clinton formation, the basal member of the Niagaran, yields hematite, or red iron ore, from New York to Alabama, now worked extensively only in the Birmingham region, and considerable oil and gas in central Ohio and eastern Kentucky.

The Devonian system is widely distributed in North America, but the lower groups are confined to the margins of the continent, whereas the middle groups also occupy a considerable portion of the interior of the continent, where the disconformity in faunal succession makes it easy to separate the Devonian from the underlying Silurian The Catskills constitute one of the most impressive sections of the Devonian in the United States, and the Eureka district of Nevada another. Excellent type sections also outcrop along the shore of Lake Erie for about 25 m west of Buffalo, and about Cumberland, Md Cleveland, Ohio, is situated on Upper Devonian; Sandusky and Columbus, in the same State; Milwaukee, Wisconsin, Davenport, Iowa and Alpena, Michigan, are situated upon Middle Devonian.

When the Devonian period opened practically all of North America had emerged from the ocean, only narrow seas occupying the Appalachian, Acadian and Cordilleran troughs, and an embayment extending northward from the Gulf to the base of the Cincinnati uplift and the Ozark dome The continent began submerging early, however, and by the Middle Devonian the Gulf embayment with its warm waters had spread northward to Hudson bay, and the Cordilleran trough was occupied by a widened sea that extended northward to the Arctic During the Upper Devonian the seas gradually withdrew again until the interior and the Cordilleran area were no longer inundated Only small crustal movements, except the notable Shickshockian disturbance which affected eastern Canada and north-eastern United States, and little volcanic activity distinguish the Devonian of North America

The life of the Devonian in America may be arranged in three provinces: the Atlantic, especially in the Lower Devonian, with its life forms related to those of the Rhine district of Europe; the Central Interior, or Gulf, its life related to that of South America; and the Cordilleran, its life derived from the Pacific and the Arctic. In general, the life resembled that of the Silurian, except that fishes had become exceedingly abundant, and amphibia had begun to appear, indicative of the evolutionary trend toward vertebrate dominance, and the further rapid development of air-breathing animals to occupy the land and the air.

> There is no more significant or picturesque period in the history of the earth than the Devonian. This is the time when the former nakedness of the lands becomes clothed with a deeper verdure and the first forests appear, providing the needed homes and food for the invasion of the continents by the ever-hungry descendants of the denizens of the sea. The conquest is first attained by the invertebrates —the scorpions, shell-fish, worms and insects Of greater significance, however, is the adaptation of other marine animals to the land, which eventually leads to the origin of the fishes, the advance guard of the vertebrate hosts, through the development of lungs and the increase in mentality
>
> The invasion of the land is fairly under way in the Devonian, chiefly in the rivers and lakes, but due to the prevailingly arid climates a fierce struggle is instituted among the inhabitants of the then temporary waters, resulting in the dominancy of the better equipped air-breathing fishes, an issue prophetic of vertebrate ascendancy, hereafter never to be questioned in its onward sweep to its culmination in man (Pirsson and Schuchert, *Text-book of Geology*, p. 714)

Petroleum and natural gas in large quantity have been derived from the Devonian formations of Pennsylvania, West Virginia, Ohio and New York

The Carboniferous periods, including the Mississippian (Lower Carboniferous), the Pennsylvanian (Upper Carboniferous) and the Permian, are best considered together, because while there is general unconformity between the Mississippian and the Pennsylvanian, the only areas of continuous sedimentation persisting in Utah and Arizona, the transition from Pennsylvanian to Permian is so gradual as to make definite separation impracticable, and the evolution of life forms is continuous and interrelated through the whole period

When the Devonian period closed the seas had retreated from most of North America, but in Waverlian time (early Mississippian) the Gulf States and the western side of the Cincinnati uplift were inundated over small areas which later gradually expanded to large size, and the Cordilleran sea submerged extensive areas in the Rocky Mountain region, connecting with the embayment in the Central Interior The northern Appalachian basin during Waverlian time extended over Ohio, Michigan and Pennsylvania, the Central Interior sea from central Iowa southward and south-eastward to the Gulf, and south-westward to Texas; and the Acadian seas flooded a connected series of narrow troughs between mountain ranges At the close of Waverlian time the seas had apparently withdrawn from the whole Cordilleran basin, and from practically the whole of the continent, so that the sedimentary record to the Tennesseean is broken Tennesseean time is characterized by general emergence with limited areas of sea in the Central Interior embayment and the southern Appalachian and Cordilleran troughs.

The marine life of the Waverlian was distinguished by a great abundance and rich variety of crinoids, and the *Productus* type of brachiopods flourished Reef-building corals were rare but bryozoans and cup corals were numerous Sharks dominated the seas Trilobites were almost gone On land no record has been found of animals but low forms of plants were wide-spread The marine life of the Tennesseean closely resembled that of the Waverlian, while the land record is better in that it reveals tracks of many amphibians. Petroleum and natural gas have been obtained from the Mississippian of Ohio, Pennsylvania, West Virginia and Kentucky

The Pennsylvanian is distinguished by the greatest known accumulations of coal, not only in America but in Eurasia as well, that have been laid down in all geologic history, though some of the later formations, especially those of the Cretaceous, also bear coal in much smaller extent and quantity. In the United States the Pennsylvanian formations of the Rocky Mountains bear no significant coal beds such as are found in the central and eastern parts of the country

The Pennsylvanian-Permian was a period of quiet inundation, the seas transgressing the land from the south-west and spreading northward and eastward. Only local warping or uplift occurred in this period in most of America, except in the Pacific area from northern California to Alaska, though in Eurasia it was a period of extensive tectonic disturbance. In the Appalachian basin east of the Cincinnati uplift, and in the Interior Sea west of this axis into Nebraska, Kansas, Oklahoma and Texas the sea-level was

oscillatory and deep-sea conditions alternated with littoral and marsh conditions, the coal being formed when the latter conditions prevailed. The Pennsylvanian-Permian seas receded from the North to the south-westward and finally vanished in Permian time, when the Appalachian revolution raised mountains probably 3 m. high in the eastern part of the United States, and the whole continent emerged to the same extent, approximately, as now.

The life, both plant and animal, of the Pennsylvanian-Permian was characterized by its relatively cosmopolitan character and distinguished by the change of dominance in biologic interest from the sea to the land. The vegetation, particularly of the humid, tepid marshes of the Pennsylvanian, was extremely luxuriant The numbers, sizes and varieties of ferns and fernlike plants, horsetails, clubmosses, sigillarias or seal-trees, and lepidodendrons or scale-trees has apparently never been surpassed in geologic history, and though many other low forms were abundant, it was these that gave the flora of the period its unique quality and furnished the parent material for the great coal beds. Through these bizarre forests a host of insects, some of them of great size and including some 500 species of cockroaches, swarmed, and grotesque amphibians and reptiles crawled from pool to pool and among the giant boles. The freshwater and marine life was likewise rich and varied with an abundance of sand-loving or mud-loving forms frequenting the shallow pools, lagoons and seashores With the desiccation and glaciation attendant upon Permian time both plant and animal life declined in vigour and variety, but made great advances in evolution toward adaptation to modern conditions.

The most important product, by far, of the Pennsylvanian formations, is coal. The important coal beds of Nova Scotia and New Brunswick, the great Appalachian coal-field including the anthracite beds of north-eastern Pennsylvania; the Michigan coal-field; the great Indiana-Illinois-Kentucky coal-field; the Iowa-Missouri-Texas field; all these are of Pennsylvanian origin. Beds of iron ore in a few places, particularly Ohio and Pennsylvania, are associated with the coal, and fire-clay is often taken from the mines and pits where coal is extracted. Petroleum and natural gas have been found in some of the Pennsylvanian sandstones in Illinois, Kansas and Oklahoma.

Mesozoic Groups.—The Mesozoic formations are, in general, more important in the western part of the United States than in the eastern, for while the present configuration and character of the eastern part of the North American continent were practically completed as they now are by the Appalachian revolution which concluded the Palaeozoic era, the western part was essentially modified and determined in the Mesozoic

In the Triassic, the earliest period of the Mesozoic, the eastern part of the United States was almost entirely land, with wind, water and other agents of erosion wearing down the eminent ridges and peaks formed by the Appalachian revolution at the close of the Permian, with deposition of sediments in intermontane seas and marshes such as the trough in which the Connecticut valley now lies, and with considerable volcanic activity locally; the Rocky Mountain region was covered over in part with some marine sediments from seas intruding from the west, but in much greater part with freshwater mud and sand, or wind-blown sand and loess; and the Pacific coast belt was submerged beneath a sea in which normal marine deposits were laid down The Triassic formations of the eastern part of the United States—in the Connecticut valley, across northern New Jersey, south-eastern Pennsylvania, Maryland, and into Virginia and North Carolina, are prevailingly red in colour, coarse, and indicate by the character of their sediments and fossils that they were worn down from a high land of crystalline rocks, and deposited, in a semi-arid climate with hot summers and possibly cold winters, upon the surface of such troughs as that of the Connecticut valley. The Triassic formations of the Rocky Mountain cordillera comprise a series of red or variegated sandy shales and cross-bedded sandstones, with thick beds of gypsum The Triassic formations of the Pacific border are dominantly calcareous and rich in corals and other marine fossils; submarine or littoral volcanoes poured out thick beds of igneous material, particularly from the middle Jurassic to its close. The Jurassic closed with a significant uplift of great block mountains in the eastern part of the country, known as the Palisade disturbance.

The life of the Triassic, strikingly new and different from the Permian, has not been adequately recorded in the rocks and only fragmentary knowledge has been discovered. The floras were small; the insect life was negligible; fish were rather abundant in the freshwater lakes and lagoons and in the salt seas; land vertebrates were varied, particularly such reptiles as the great dinosaurs; primitive reptilian mammals had evolved; and the seas swarmed with ammonids, squids and siphonate gastropods, and reef-building corals formed reefs hundreds of feet thick. Coal beds of limited extent were laid down in the Triassic depressions in Virginia and North Carolina, and at the close of the Triassic some copper ore was deposited in New Jersey with the copious basaltic intrusions

The Jurassic in the eastern United States opened with a period of active erosion as a result of the great uplift of the Palisade disturbance, which continued throughout the period and reduced the high Appalachian and massive Palisade mountains to a peneplain. Along the Pacific coast the sea, after its withdrawal from the continent at the close of Triassic time, again began in the Jurassic to transgress upon the coast and into the Californian sea of Oregon, California and Nevada, where great thicknesses of sandstones and shales and some limestone were deposited From Alaska and British Columbia a middle Jurassic sea, Logan sea, invaded Montana, Idaho, Wyoming, Colorado and Utah, where widely and locally variable deposits of sandy clays, shaly marls, impure limestones, crossbedded sandstones and universally present oyster shells indicate only shallow water conditions. Great tectonic activity characterized the close of the Jurassic in the western part of North America; the Sierra Nevadas, the Coast range of California, the Humboldt range of Nevada, the Cascades and the Klamath mountains were elevated A great geosyncline, called the Coloradoan, east of the Sierra Nevadan uplift, and the Great valley of California were formed near the close of the Jurassic Considerable volcanic activity continued throughout the period, increasing in intensity and extent toward its close.

The life of the Jurassic includes a cosmopolitan land flora revealing a rich, varied growth of Cycads and the beginning of modern types; a great number of insects; diversified and advanced reptiles, both terrestrial and marine, the earliest birds; and a wealth of marine invertebrate and vertebrate forms including sharks of modern types and the first flat fishes.

The Jurassic Mariposa and Auriferous slates (Gold Belt series) of the Sierra Nevadas contain the gold-bearing veins of quartz in which lie the "mother" lode from which the rich placer deposits of California have been derived.

The Comanchean, by which American geologists distinguish the Lower Cretaceous, which corresponds approximately to the lower series of six or perhaps seven stages generally included within the Lower Cretaceous of Europe, appears in the United States as a continental phase in limited areas along the Atlantic coast and in extensive regions in the Rocky Mountains; and as two distinct marine faunal provinces: the Shastan, a Pacific coastal overlap, and the extensive Comanchean of the Gulf of Mexico over Arizona, New Mexico, Texas, Oklahoma, Kansas, Arkansas and Colorado from which the group derives its name. The Comanchean extension proper was limited in extent in the United States during Middle Comanchean time, but became more widespread in Late Comanchean The waters of this sea apparently were shallow, muddy and brackish from the fresh water poured in by the rivers debouching upon it The Shastan overlap at first filled chiefly the Great valley of California and the Willamette-Puget sound basins but later spread widely to become a shelf sea into which rivers from the highlands to the eastward poured a great thickness of generally coarse-grained sediments. The continental deposits of the Great Plains country from Montana southward into New Mexico were apparently laid down over a relatively low, flat plain occupied by small shallow lakes and lagoons, rimmed by broad marshes in which many great dinosaurs lived. Some of these same dinosaurs lived also in the Triassic

swamps of the Atlantic coast, where the deposits indicate fresh-water deposits laid down in river valleys in the earlier part of the period, and estuarine beds along the seaboard in the later part.

Toward the close of the Comanchean, crustal movement is evident along the Pacific coast throughout the coast ranges and the Cordilleran Intermontane disturbance initiated the process by which the high plateaux of the western part of the United States and northward and southward were elevated. Along the Atlantic coast the Piedmont and Appalachian regions were elevated somewhat, thus rejuvenating the streams flowing from them.

The record of the life of the Comanchean indicates the wane of the cycads and the rapid rise, probably in the eastern United States, of the angiosperms, the ancestors of the dominant forms of modern floras, and the growth of the first "hardwood" forests —oaks, elms, poplars, maples and magnolias, for instance; the maximum development, both in size and variety, of the dinosaurs, and the decline of the ammonites in the seas.

The last system of the Mesozoic, the Cretaceous, records the last wide-spread transgression of the sea over the United States The extensive peneplanation of the preceding periods had reduced much of the land to river or coastal plains or low rolling hill lands, and when the Cretaceous submergence began it progressed fast over these. The whole Pacific coast was submerged, practically the whole interior west of the Mississippi, the Gulf States as far north as Illinois, and the Atlantic coast as far north as New Jersey The broad Coloradoan interior sea extended from the Gulf of Mexico to the Arctic ocean Always a shallow sea, the sediments rapidly accumulating after the Laramide revolution in late Cretaceous time soon filled it, but while it persisted deltas, bars and low islands were formed in its shallow, muddy, marshy waters The Laramide revolution was a profound orogenic change by which the mountains of western North America and South America were raised to a grandeur that they have never lost.

The life of the Cretaceous embraces the end of the dinosaurs and their contemporaries The close of the period marked the culmination of the "mediaeval" period in the evolution of animal life, a period long passed by the evolution of the flora; for the flora of the Cretaceous was distinctly modern, including birch, beech, maple, oak, walnut, sycamore, tulip, laurel, holly, ivy, sweet gum, breadfruit and hazelnut The first sedges and grasses appeared Large reptilian carnivorous birds appeared, and many mammals The Cretaceous was a time of extinction for many marine forms, of toothed birds and dinosaurs, and the destruction of reptilian supremacy

The chief economic product of the Cretaceous is the coal which was laid down in many places in the western part of the United States, and ranging in grade from lignite to anthracite.

Cenozoic Groups.—The lower four groups of the Cenozoic—the Eocene, Oligocene, Miocene and Pliocene—record no great epeiric seas in the United States, but merely epicontinental or marginal overlaps which oscillated back and forth over the relatively narrow areas of submergence Along the North Atlantic coast Eocene deposits are not found north of New Jersey, though beds occur in Maryland, Delaware and Virginia; Miocene sands, clays and marls are found all the way from Massachusetts to Alabama; marine Pliocene deposits are few and scattered, the Oligocene is not represented In the eastern Gulf section from Cape Hatteras southward and westward to the Mississippi river, Eocene and Oligocene deposits are well distributed with an excellent sequence of Oligocene and Miocene in Florida. In the western Gulf section from the Mississippi river to Mexico stages of the Eocene are found in rather extensive deposits; the Oligocene is well developed in Louisiana; the Miocene is known only in deep wells; and the Pliocene is missing.

California, Oregon and Washington reveal marine Cenozoic sediments: Eocene to a depth of 8,000 to 12,000 ft.; late Miocene in California, 8,000 ft ; and Pliocene and Pleistocene south of San Francisco to a depth of 13,000 feet Continental Cenozoic deposits are wide-spread in the foot-hills and high plains east of the Rocky Mountains. Great tectonic and volcanic activity characterized the Cenozoic in the United States, and the great Cascadian revolution was initiated, and continued, the great uplift responsible for the Colorado plateaux and the cutting of the Grand Canyon, and the grand volcanoes—Rainier, Shasta and Lassen—which remained active throughout the Pleistocene The close of the Pliocene was a time of great deformation, a critical period of geologic history in the United States, when the final aspect of the surface as we know it was largely determined.

The Pleistocene or Quaternary, the final division of geologic chronology, was marked by the culmination of the Cascadian revolution, and the extensive glaciation that followed, when more than the northern half of North America and Europe was buried beneath great strata of ice Three great ice caps formed in America: the Labrador, east of Hudson bay; the Keewatin, west of Labrador; and the Cordilleran, over the Canadian Rockies Many smaller outlying caps or shields were formed about the margins of these caps. The glaciation was not continuous, but five stages of ice formation and extension with four interglacial stages have been generally recognized in the United States

Divisions of Pleistocene Time in North America[1]

Post-glacial or present time	Vanishing of ice-sheets Champlain marine invasion Lowering of water-level of Great Lakes Gradual amelioration of climate. Gradual extinction of elephants, mastodons, *Megalonyx*, musk-oxen, etc
Fifth or Wisconsin glacial stage Wurm stage in Europe	Spread of ice-sheets and drift Fauna and flora driven south.
Fourth or Peorian inter-glacial stage	Record not well determined Formation of peat beds and soils Wide distribution of loess.
Fourth or Iowan glacial stage	Spread of ice-sheets and drift. Record not well determined.
Third or Sangamon inter-glacial stage	Accumulation of peats, soils and loess Horses, elephants, mastodons, bison, peccaries and tapirs probably present.
Third or Illinoian glacial stage Riss stage in Europe	Spread of ice-sheets and drift. Deposition of loess Apparently 60% of present land fauna then living Mastodons, mammoths, horses, tapirs, bison, deer and sabre-tooth tigers.
Second or Yarmouth inter-glacial stage	Formation of peats, soils and bluish loess Animals about as in Illinoian stage
Second or Kansan glacial stage Mindel stage in Europe	Spread of ice-sheets and drift. Extinction of certain camels and horses
First or Aftonian inter-glacial stage	Great abundance of mylodons, megatheres, *Megalonyx*, mastodons, elephants (3 species), horses (6 species), camels (4 species), sabre-tooth tigers, bears, etc. A warm temperate fauna
First or Sub-Aftonian glacial stage	Spread of ice-sheets and drift Includes Pre-Kansan, Nebraskan and Albertan drifts.
Pliocene	

During the Pleistocene glaciation the surface of the areas covered by the ice as well as those contiguous to its borders was profoundly modified by the ice itself or by the waters resulting from its meeting About the centres of origin of the several ice caps the terrain was scoured, sculptured, deeply grooved by the moving ice; about the peripheries this erosive action was minimized and depositional changes were most pronounced As the ice receded the whole character of the Great Lakes was changed, the drainage systems of the whole area disturbed, and the aspect of the entire area was significantly changed

The extensive lands of Cenozoic time were dominated by mammals, and even the seas contained representatives of this great group. The life that characterized the Mesozoic was practically extinct before the close of the Eocene and by the time the Oligocene had dawned the mammal life had assumed a distinctly modern aspect, though still rather primitive With increasing des-

[1]Pirsson and Schuchert, *Text-book of Geology*, p 949.

iccation and cold in the Miocene, and consequent extension of grasslands, ruminants and rodents increased in number and variety. Prominent among the forms of this time were horses, camels, rhinoceroses, deer, sabre-tooth tigers and many others. The Pliocene is equally interesting for its life, but because the land stood high and little deposition was taking place on land, few fossils formed The evolution of the horses, the camels and the elephants has been most fascinatingly worked out The first primates, from which man is considered to have descended, appear as lemurs or lemuroids in the American Eocene; the oldest ape appears in the Egyptian Oligocene; the oldest ape man in the Javan Pleistocene; and the first dawn-man with the characteristic qualities of the modern *Homo sapiens* is thought to have originated on the steppe plateaux of Central Asia when first appeared conditions necessitating his leaving the trees and walking upright on the grasslands The evolution of man, *Homo sapiens,* is a Pleistocene record, of which little that can be authentically substantiated has been written in the United States, though skeletal remains and cultural artifacts found in Florida, Oklahoma, Texas and Colorado may in time prove valuable pages in the history.

The Psychozoic age is the present and has little geologic significance. As Charles Schuchert, the doyen of American palaeontologists and stratigraphers, states. "We are now living in a time of rugged lands, obliteration of old peneplains, cold polar climates, and marked temperature belts . . . Human mentality now dominates the organic world, and to it all creation will soon be more or less subservient"

Bibliography.—The publications of the U S. Geological Survey and all articles on American geology have been thoroughly indexed on every phase and branch of American geology Modern general treatises include Pirsson and Schuchert's *Text-book of Geology;* Chamberlin and Salisbury's *Geology*, Grabau's *Text-book of Geology*, Scott's *Introduction to Geology*, Cleland's *Geology, Physical and Historical;* and a number of others The *Journal of Geology, Economic Geology* and the *Bulletins* of the American Association of Petroleum Geologists are the chief serial publications on the subject of U S geology The publications of the U S Geological Survey and of the several State Geological Surveys are particularly important (W. E E)

III. CLIMATE

The climates which are found within the boundaries of the continental United States are extremely diverse, yet it is possible to deduce certain facts of broad application concerning them The country lies wholly in the temperate zone Hence its mean annual temperatures are intermediate between those of the Arctic regions on the one hand and those of the torrid zone on the other, a fact not inconsistent with the occurrence, in some parts of the country, of summer maximum temperatures surpassing any found within the tropics, and in other parts of winter minimum temperatures rivalling those of the Arctic The country also lies, for the most part, within a so-called "belt of prevailing westerly winds" This expression implies a general drift of the atmosphere from west to east within the region concerned, but it does not imply anything like constant wind directions in particular localities. The winds of this belt are much modified locally by topography, they are subject to certain seasonal variations, and they vary markedly, especially in the northern part of the country, with the constant passage of the disturbances known as cyclones and anticyclones These disturbances, which, with some exceptions, cross the country in a general west-to-east direction at speeds averaging from 500 to 600 m a day, bring with them frequent weather changes—ups and downs of temperature, alternations of clouds and sunshine—which are a striking feature of the climate in most parts of the United States

The eastward atmospheric drift from the Pacific ocean gives the western coast of the United States a marine climate; which means essentially a small range of temperature, annual and diurnal. This is, however, confined to the immediate border of the Pacific, on account of the mountain barriers that prevent the influence of the ocean from extending far inland Even the relatively low coast range gives the valleys east of it a quasi-continental climate, and "continentality" becomes pronounced east of the lofty Sierra Nevada-Cascade system Wide ranges of temperature are found thence eastward all the way to the Atlantic coast, except in the far south, where trade winds, blowing from easterly quadrants, bring the land under the climatic control of the Atlantic ocean and the Gulf of Mexico. The mountain barriers above mentioned, besides their striking effects on temperatures to the eastward, precipitate most of the moisture brought by winds from the Pacific on their windward slopes, and are thus responsible for the great region of arid and semi-arid climates, embracing about one-third of the country, which extends roughly from the 120th to the 100th meridian. Farther east a moderate to ample rainfall is supplied mainly by intermittent cyclonic air currents, which import moisture from the Atlantic and the Gulf. One more factor of major importance controlling climates east of the Rockies is the absence of mountain ranges trending east and west. A broad open lowland stretches from the Arctic ocean to the Gulf of Mexico. Thus winds of cyclonic origin have a clear sweep between the northern and southern borders of the country and are enabled to exercise profound effects upon the distribution of both temperature and moisture. In winter a flood of cold air from the interior of Canada sometimes causes freezing weather along the Gulf coast; in summer, warm, muggy air from southern waters often affects the comfort of people living inland

For purposes of climatographic description the country has been variously divided into larger or smaller units. The United States weather bureau has published elaborate climatic data for 106 "sections" of the country, the boundaries of which are mainly political or arbitrary In this sketch of regional climates we adhere to the simple system of "climatic provinces" proposed by Prof. Robert De Courcy Ward of Harvard in the year 1915

Eastern Province.—Because of the predominant westerly winds, the Atlantic ocean, though it frequently influences temperatures far inland, does not prevent the occurrence over the whole of this province and even for some distance off shore of the wide temperature ranges characterizing a continental climate "Spells" of extremely cold weather occur in winter, and of intensely hot weather in summer. The latter are frequently attended by high humidity, and are the cause of much distress and discomfort In summer the difference in temperature between the northern and southern parts of this province is relatively small, but in winter it is very marked. In January the mean monthly temperature decreases northward at the rate of 2 7° F for each degree of latitude, both on the Atlantic coast and in the Mississippi valley. The normal rainfall is adequate for crops throughout the province The snowfall is generally heavy in the northern States, where the expense of keeping streets and rural highways open to traffic amounts to many millions of dollars every winter. Frequent weather changes due to cyclonic disturbances are characteristic of the eastern province, especially in the north-eastern part.

Gulf Province.—This region has a semi-marine and semi-tropical climate, less subject to cyclonic control and much more affected by oceanic influences than the climate of the eastern province The summers are long and hot and the winters are prevailingly mild, though occasional severe frosts and freezes cause enormous losses in the rural industries The rainfall is normally copious over most of the region, but severe droughts are known.

Plains Province.—The outstanding climatic feature of this region is the light rainfall—mostly less than 20 in. in the average year. Agriculture is practised with the aid of irrigation, or by dry-farming methods, but over a great part of the province gives place to grazing. The cyclonic control of the weather is less pronounced over the plains than in the eastern States; the diurnal ranges of temperature are greater; the air is drier, there is more sunshine and more wind. Parching "hot winds" sometimes blow in summer, causing much local damage to crops. The "chinooks" that blow down the eastern slopes of the Rocky mountains are *Föhn* winds, the heat and dryness of which are responsible for especially striking effects in winter. The blizzard is a dreaded episode of winter over the northern plains.

Plateau Province.—This region, lying between the Rocky mountain divide on the east and the Sierra Nevada-Cascade divide on the west, has a very light rainfall, except where increased locally by altitude, and includes the most pronounced desert regions of the United States, in south-eastern California, south-

western Arizona and western Nevada Dry, stimulating air, abundant sunshine and a wide diurnal range of temperature are dominant features of the climate. The south-western deserts are notorious for the heat and aridity of their summers Death Valley, Calif., has the smallest mean annual rainfall—1·65 in at Greenland Ranch—recorded anywhere in the country Greenland Ranch likewise registers the highest shade temperatures in the United States, with an absolute extreme of 134° F.

Pacific Province—Marine influences combined with rugged topography give to this region a remarkable diversity of climates. The whole coast has mild winters and cool or moderately warm summers The interior valleys have hot summers In the great central valley of California temperatures of 110° to 120° are sometimes registered on summer days In the northern part of the province, near the coast, the rainfall is the heaviest in the United States (over 100 in), while the southern part of the province is semi-arid The upper slopes of the Sierra Nevada and Cascade ranges have the heaviest snowfall found in North America Precipitation is much heavier in winter than in summer in both the north and the south, and in California the summers are almost rainless. Fog is very prevalent along the coast.

About 100 tornadoes are recorded in the United States annually, and some of them are terribly destructive within small areas They occur mainly in the warmer months and are rare west of the 100th meridian Cyclones of tropical origin ("West Indian hurricanes") cause serious damage on the south Atlantic and Gulf coasts at intervals of a few years Ice storms—cold weather rainstorms coating terrestrial objects with ice—sometimes cause very extensive breakage of trees, wires, etc., especially in the north-eastern quarter of the country

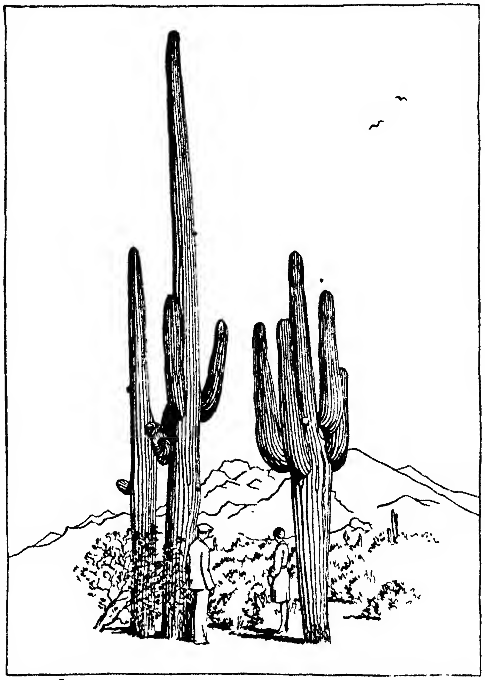
BIBLIOGRAPHY—The latest and most useful descriptive work applying to climates throughout the country is R. De C. Ward's *Climates of the United States* (Boston, 1925) A. J Henry's *Climatology of the United States* (United States weather bureau *Bulletin* [Washington, 1906], contains much more copious numerical data and larger charts) The chief statistical work is the United States weather bureau *Bulletin W*, "Summaries of Climatological Data by Sections," 2nd ed (Washington, 1926) The parts relating to each of the 106 "sections" of the country may be obtained separately. Splendid detailed climatic charts are a feature of the *Atlas of American Agriculture*, which the United States Department of Agriculture has been publishing in instalments for some years. The first section on climate—*Frost and the Growing Season*—appeared in 1918 Statistics and extensive discussions of individual elements of the climate (temperature, rainfall, etc) have been published in bulletins of the weather bureau and elsewhere Abundant climatographic literature will be found in the monthly *Weather Review* (Washington) Among the more remarkable of the numerous works on the climates of particular areas are O. L. Fassig, *Report on the Climate and Weather of Baltimore and Vicinity* (Baltimore, 1907), H J Cox and J H Armington, *Weather and Climate of Chicago* (Chicago, 1914); W H Alexander, *Climatological History of Ohio* (Columbus, 1923) (C. F. T.)

IV. FAUNA AND FLORA

Fauna.—Differences of temperature have produced in North America seven transcontinental life-zones or areas characterized by relative uniformity of both fauna and flora; they are the Arctic, Hudsonian and Canadian, which are divisions of the Boreal Region; the Transition, Upper Austral and Lower Austral, which are divisions of the Austral Region, and the Tropical.

The Arctic, Hudsonian and Canadian enter the United States from the north and the Tropical from the south; but the greater part of the United States is occupied by the Transition, Upper Austral and Lower Austral, and each of these is divided into eastern and western subzones by differences in the amount of moisture. The Arctic or Arctic-Alpine zone covers in the United States only the tops of a few mountains which extend above the limit of trees, such as Mt. Washington in the White Mountains of New Hampshire, and the loftier peaks of the Rocky, Cascade and Sierra Nevada mountains. The larger animals are rare on these mountain-tops The Hudsonian zone covers the upper slopes of the higher mountains of New England, New York and North Carolina and larger areas on the elevated slopes of the Rocky and Cascade Mountains; and on the western mountains it is the home of the mountain goat and mountain sheep.

The Canadian zone crosses from Canada into the northern parts of Maine, New Hampshire, Michigan, Minnesota and North Dakota; it covers the Green Mountains, most of the Adirondacks and Catskills, the higher slopes of the mountains from Pennsylvania to North Carolina and Tennessee, the lower slopes of the northern Rocky and Cascade Mountains, the upper slopes of the southern Rocky and Sierra Nevada Mountains and a strip along the Pacific coast as far south as Cape Mendocino. Among its characteristic mammals and birds are the lynx, porcupine, northern red squirrel, varying and snowshoe rabbits, white-throated sparrow, spruce grouse, and Canada jay, within this zone in the North-eastern states are a few moose and caribou

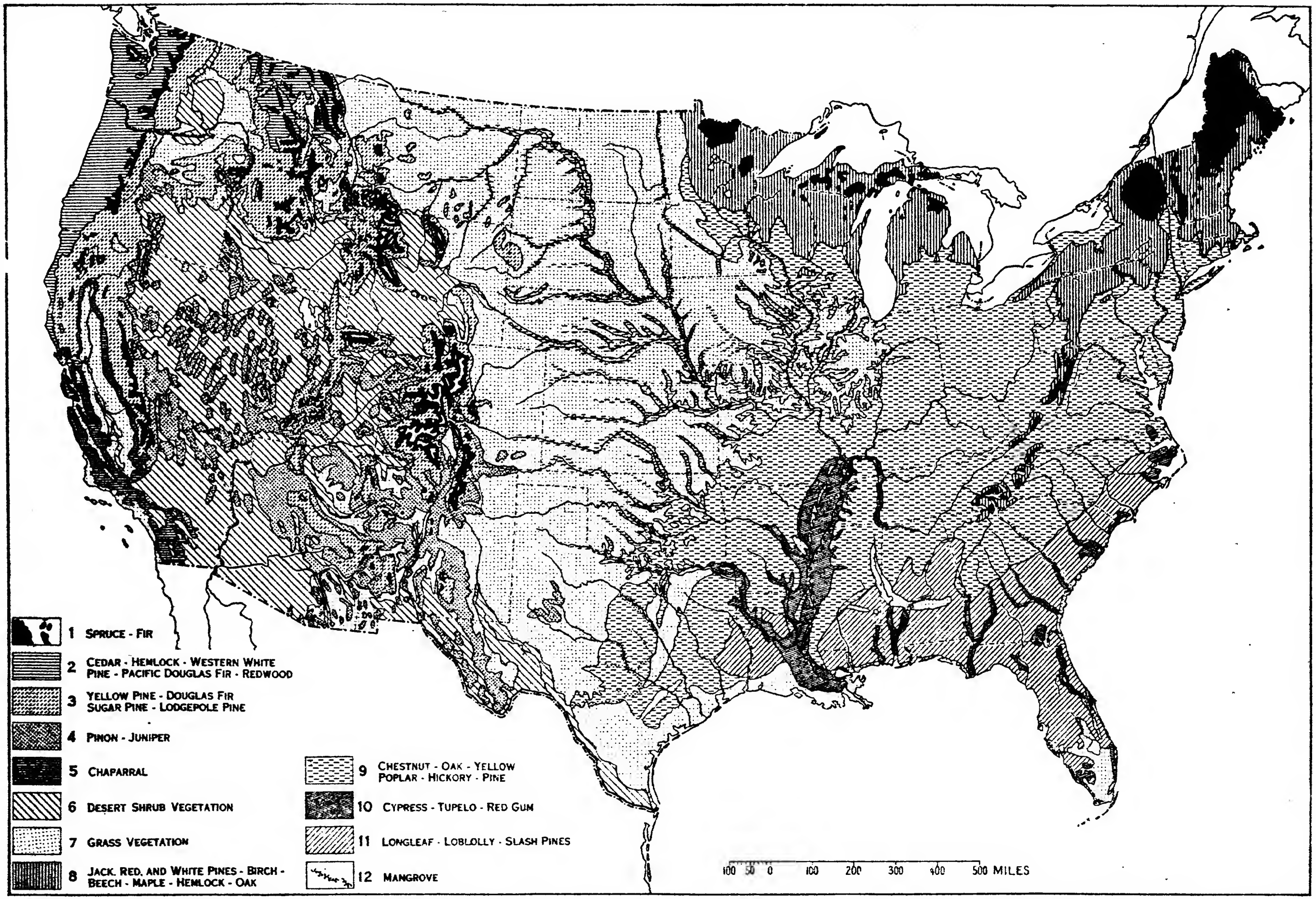


SAGUARO OR MONUMENT CACTUS (CEREUS GIGANTEUS)

This giant cactus, a characteristic feature of the hot deserts of S. Arizona and S.E. California, sometimes attains a height of 60 feet and a trunk diameter of 2 feet The spiny, deeply ribbed, erect stem, often unbranched but usually with several trunk-like ascending or erect branches, bears a profusion of large, showy, white flowers, and red, juicy, edible fruit

The Transition zone, in which the extreme southern limit of several boreal species overlaps the extreme northern limit of numerous austral species, is divided into an eastern humid or Alleghanian area, a western arid area, and a Pacific coast humid area The Alleghanian area comprises most of the lowlands of New England. New York and Pennsylvania, the north-east corner of Ohio, most of the lower peninsula of Michigan, nearly all of Wisconsin, more than half of Minnesota, eastern North Dakota, north-eastern South Dakota, and the greater part of the Appalachian Mountains from Pennsylvania to Georgia It has few distinctive species, but within its borders the southern mole and cotton-tail rabbit of the South meet the star-nosed mole and the varying hare of the North, and the southern bobwhite, bluebird, catbird, chewink, thrasher and wood thrush are neighbours of the bobolink and the hermit and Wilson's thrushes.

The Arid Transition life-zone comprises the western part of the Dakotas, north-eastern Montana, and irregular areas in Washington, Oregon, Idaho, Wyoming, California, Nevada, Utah, Colorado, Arizona, New Mexico and western Texas, covering for the



DISTRIBUTION OF THE MAIN TYPES OF NATURAL VEGETATION IN THE UNITED STATES. THE THREE MAJOR NATURAL DIVISIONS OF VEGETATION ARE FOREST, GRASSLAND AND DESERT SHRUB. THE FOREST FALLS INTO TWO CLEARLY MARKED REGIONS, WESTERN AND EASTERN. THE WESTERN REGION COMPRISES SEVEN LARGE FOREST SUBDIVISIONS AND TWO SUBDIVISIONS OF WOODLAND. THE EASTERN REGION COMPRISES NINE FOREST SUBDIVISIONS. FOUR-FIFTHS OF THE FOREST WAS ORIGINALLY IN THE EAST. OF THIS ORIGINAL FOREST THERE REMAINS NOW ONLY ABOUT 10 PER CENT IN VIRGIN CONDITION, 50 PER CENT HAVING BEEN CLEARED FOR FARMLAND, 30 PER CENT CUT OVER AND NOW GROWN UP TO TREES OF SUFFICIENT SIZE FOR SAW LOGS OR CORDWOOD, AND ABOUT 10 PER CENT CUT OVER OR DEVASTATED BY FIRE AND REDUCED TO BRUSHLAND

most part the eastern base of the Cascade and Sierra Nevada Mountains and the higher parts of the Great Basin and the plateaus. Its most characteristic animals and birds include the white-tailed jack-rabbit, sage-hen and sharp-tailed grouse. The Pacific Coast Transition life-zone comprises the region between the Cascade and Coast ranges in Washington and Oregon, parts of northern California, and most of the California coast region from Cape Mendocino to Santa Barbara. It is the home of the Columbia black-tail deer, western raccoon, Douglas red squirrel, tailless sewellel, Oregon ruffed grouse, and Pacific winter wren

The Upper Austral zone is divided into an eastern humid (or Carolinian) area and a western arid (or Upper Sonoran) area The Carolinian area extends from southern Michigan to northern Georgia and from the Atlantic coast to western Kansas, comprising practically all of this region except the highlands and mountains. It is the northernmost home of the opossum, grey fox, fox squirrel, cardinal bird, summer tanager and yellow-breasted chat. The Upper Sonoran life-zone comprises south-eastern Montana and eastern Wyoming; portions of western South Dakota, Nebraska, Kansas and Oklahoma; north-western Texas, eastern Colorado and south-eastern New Mexico; the lower plains of Utah, Idaho, Washington and Oregon, and narrow belts in California, Nevada and Arizona Among its characteristic mammals and birds are the black-tailed jack-rabbit, sage chipmunk, prairie-dog, burrowing owl and sage thrasher

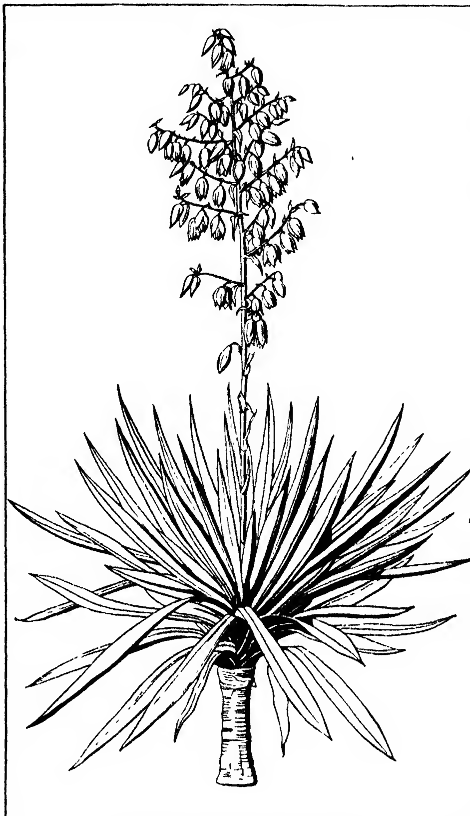
The Lower Austral zone occupies the greater part of the Southern states, and is divided near the 98th meridian into an eastern humid or Austroriparian area and a western arid or Lower Sonoran area. The Austroriparian zone comprises the Atlantic coastal plain from Virginia to Georgia and nearly all the Gulf States as far west as the mouth of the Rio Grande; it also extends up the lowlands of the Mississippi valley to southern Illinois. It is the home of the southern fox-squirrel, cotton rat, wood rat, mocking bird, painted bunting, red-cockaded woodpecker, chuckwill's-widow, and the swallow-tailed kite. A southern portion of this zone, comprising a narrow strip along the coast from South Carolina to Florida and Texas, is semi-tropical, and is the northernmost habitation of several small mammals, the alligator, the ground dove, and the Florida screech owl

The Lower Sonoran zone comprises the most arid parts of the United States south-western Texas, south-western Arizona and a portion of northern Arizona, southern Nevada and a large part of southern California Among its characteristic mammals and birds are the desert fox, kangaroo rats, road runner, cactus wren, hooded oriole and Gambel's quail It is the northernmost home of the armadillo, ocelot and jaguar There is some resemblance to the Tropical life-zone at the south-eastern extremity of Texas, but this zone in the United States is properly restricted to southern Florida and the lower valley of the Colorado river. The area in Florida is small, but it has the true crocodile and is the home of a few tropical birds.

Most of the larger American mammals are not restricted to any one faunal zone The bison, now nearly extinct, formerly roamed over nearly the entire region between the Appalachian and the Rocky Mountains The black bear and beaver were also widely distributed The Virginia deer still ranges from Maine to the Gulf states and from the Atlantic coast to the Rocky Mountains The grizzly bear, cougar, coyote, prairie dog and antelope are still found in several of the Western states, and the grey wolf persists from northern Michigan westward.

Flora.—The Alpine flora, found in the United States only above the limit of trees, consists principally of small plants which bloom brilliantly for a short season. The flora of the Hudsonian and the Canadian zone consists largely of white and black spruce, tamarack, canoe-birch, balsam-poplar, balsam-fir, aspen and grey pine. In the Alleghanian Transition zone the chestnut, walnut, oaks and hickories of the South are interspersed among the beech, birch, hemlock and sugar maple of the North. In the Western Arid Transition zone the flora consists largely of the true sage brush (*q v.*), but some tracts are covered with forests of yellow or bull pine. The Pacific coast Transition zone is noted for its forests of giant conifers, principally Douglas fir, Sitka spruce, Pacific cedar and western hemlock Here, too, mosses and ferns grow in profusion, and the salal, thimble berry, salmon berry and devil's club (*Fatsia horrida*) are characteristic shrubs

In the Carolinian zone the tulip tree, sycamore, sweet gum, rose magnolia, short-leaf pine and sassafras find their northernmost limit. Sage brush is common to both the western arid Transition zone and the Upper Sonoran zone, but in suitable soils of the lat-



SPANISH DAGGER (YUCCA GLORIOSA)

This handsome species of yucca, with a woody trunk sometimes 8 feet high and 6 inches in diameter, is native to sand dunes and sea beaches from North Carolina to Florida and bears in October immense clusters of large creamy-white flowers. Many varieties are widely cultivated in mild climates as garden ornamentals

ter several greasewoods are characteristic species, and on the mountain slopes are some nut pines and junipers The Austroriparian zone has the long-leaf and loblolly pines, magnolia and live oak on the uplands, and the bald cypress, tupelo and cane in the swamps The Lower Sonoran zone is noted for its numerous cactuses, some of which grow to the height of trees, the mesquite, creosote bush, acacias, yuccas and agaves are also common. The Tropical belt of southern Florida has the royal palm, coco-nut palm, banana, manchineel and mangrove, the Tropical belt in the lower valley of the Colorado has giant cactuses, desert acacias, palo-verdes and the Washington or fan-leaf palms

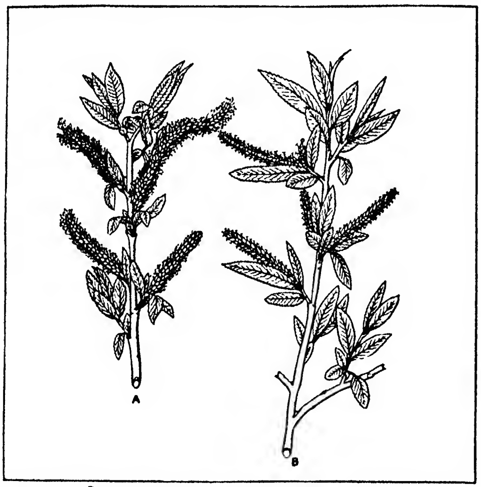
Almost all of the United States east of the 98th meridian is naturally a forest region, and forests cover the greater part of the Rocky Mountains, the Cascades, the Sierra Nevada and the Coast Range, but throughout the belt of plains, basins and deserts west of the Rocky Mountains and on the Great Plains east of the

Rocky Mountains the prevailing type of vegetation ranges from bunch grass to sage brush and cactuses.

The eastern forest region differs from the densely forested region of the Pacific Coast Transition zone in that it is essentially a region of deciduous or hardwood forests, while the latter is essentially one of coniferous trees, it differs also from the forested region of the Rocky Mountains in that the latter is essentially a region of coniferous trees which occupy only a part of its area

The United States is rich in the variety of its native forest trees, some of which, as the species of sequoia (*q v*), are the most massive known C. S Sargent (*Manual of North American Trees*, 2nd ed, 1922) describes 717 species, together with numerous varieties; G. B. Sudworth (1927, see *Bibliography* below) gives the names and geographical distribution of 1,177 species and varieties. Of these, 182 are of economic value, either because of the timber and other useful products which they yield or by reason of their importance in forestry. This forest flora not only includes numerous coniferous soft woods and deciduous hard woods but it also embraces various subtropical trees

Besides the native flowering plants, estimated to comprise from 12,000 to 15,000 species, many hundred species, introduced from other regions—chiefly Europe, Asia and tropical America—have become naturalized A large proportion of these are common annual weeds of fields, pastures and roadsides In some districts these naturalized "aliens" comprise 50% or more of the total plant population W L Jepson in his *Manual of the Flowering Plants of California* (1925) enumerates 4,019 species, of which 3,727 are native to the State (1,416 species endemic) and 292 (7%) are naturalized from other regions In the north-eastern United States from Minnesota to Kansas and eastward the proportion of introduced species is much greater, *Gray's New Manual of Botany* (1908) giving 4,885 species and varieties of which 4,179 are native and 706 (14%) introduced



CRACK OR BRITTLE WILLOW (SALIX FRAGILIS)
Branches with narrow clusters (catkins) of (A) male and (B) female flowers. This hardy tree, a native of Europe and Asia, is representative of a numerous group of Old World trees that have become widely naturalized in the United States, largely as a result of ornamental planting

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V. POPULATION AND SOCIAL CONDITIONS

Geographical Growth of the Nation.—The achievement of independence found the people of the United States owning the entire country from the Gulf of Mexico to the Great Lakes, excepting Florida, as far west as the Mississippi river, but the actual settlements were, with a few minor exceptions confined to a strip of territory along the Atlantic shore. The depth of settlement, from the coast inland, varied greatly, ranging from what would be involved in the mere occupation of the shore for fishing purposes to a body of agricultural occupation extending back to the base of the great Atlantic chain, and averaging some 250 miles. Westward, beyond the general line of continuous settlement were four extensions of population through as many gaps in the Appalachian barrier, constituting the four main paths along which migration westward first took place: the Mohawk valley in New York; the upper Potomac—upper Ohio river connections, the Appalachian valley through south-western Virginia into Tennessee; and, around the southern base of the Appalachian system Four outlying groups beyond the mountains—one about Pittsburg, one on the Great Kanawha river in West Virginia, one in northern Kentucky and the last along the Cumberland river in Tennessee—constituted perhaps a twentieth part of the total population of the nation. Finally, there were in 1790 about a score of small trading and military posts, mainly of French origin, scattered over the then almost unbroken wilderness of the upper Mississippi valley and region of the Great Lakes.

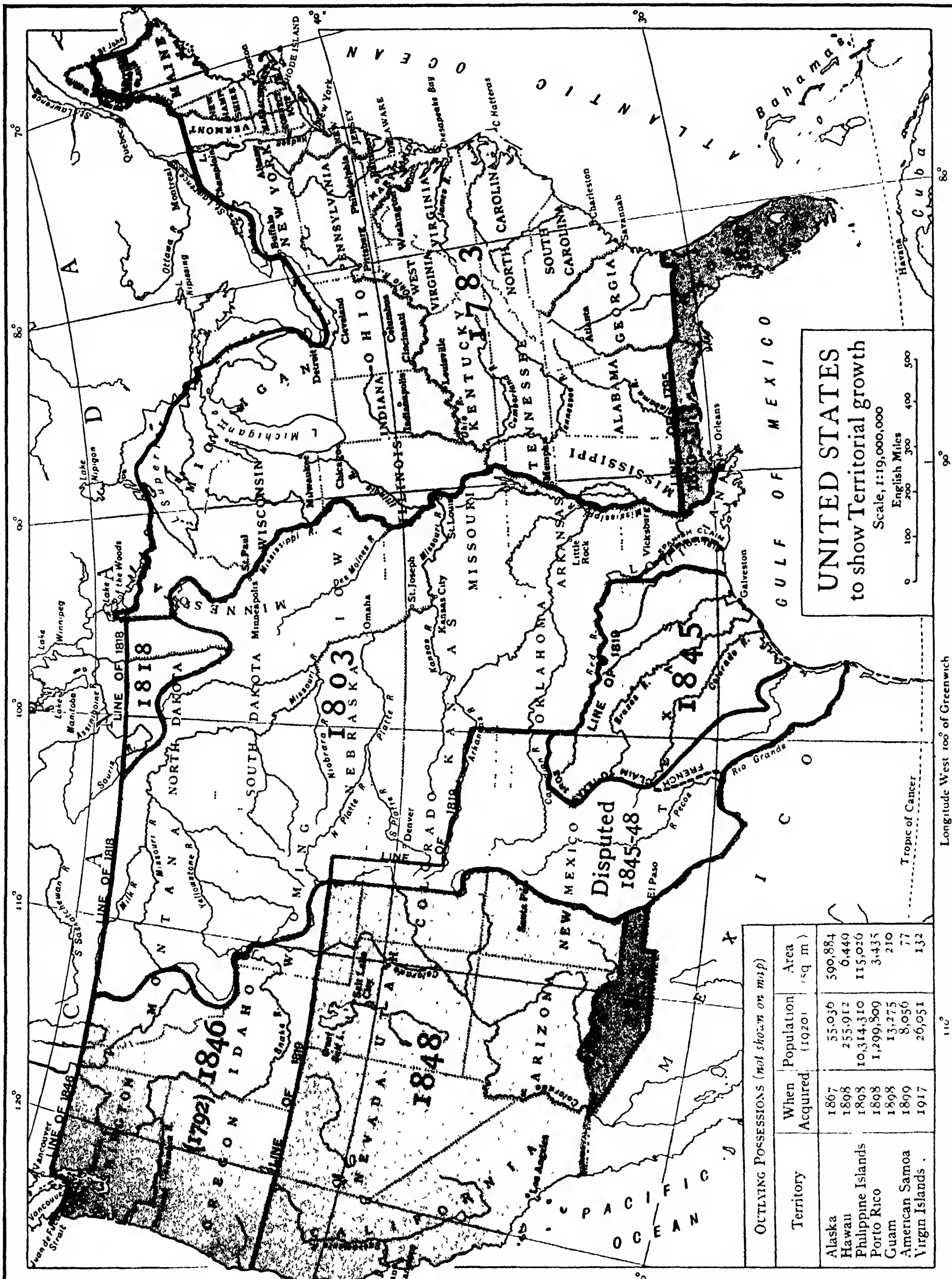
Thirteen decennial censuses taken since that time (1800–1920) reveal the extraordinary spread of population over the expanding area of the United States[1].—

Continental United States, exclusive of Alaska

Census years	Land area in square miles	Population	Decennial increase per cent	Per cent of increase from 1790	Population per square mile	Number of foreign immigrants entering in preceding decade
1790	867,980	3,929,881			4·5	
1800	867,980	5,308,483	35·1	35·1	6·1	
1810	1,685,865	7,239,881	36·4	84·3	4·3	
1820	1,753,588	9,638,453	33·1	145·3	5·5	250,000[2]
1830	1,753,588	12,866,020	33·5	227·4	7·3	128,502
1840	1,753,588	17,069,453	32·7	334·4	9·7	538,381
1850	2,944,337	23,191,876	35·9	490·2	7·9	1,427,337
1860	2,973,965	31,443,321	35·6	700·2	10·6	2,747,897
1870	2,973,965	38,558,371	22·6	881·3	13·0	2,123,219
1880	2,973,965	50,155,783	30·1	1,176·5	16·9	2,742,137
1890	2,973,965	62,947,714	24·9	1,502·0	21·2	5,248,568
1900	2,974,159	75,994,575	20·7	1,834·1	25·6	3,694,294
1910	2,973,890	91,972,266	21·0	2,240·7	30·9	8,202,388
1920	2,973,776	105,710,620	14·9	2,590·4	35·5	6,347,380

[1] In the *Statistical Atlas* of the 1910 census (Washington, 1914) there is for 1790, and for each decennial census thereafter, a map showing the distribution of population, with indication of the density of settlement, and an elaborate explanatory text. The atlas for the 1920 census contains similar maps for 1910 and 1920 only.

[2] Estimates of total up to 1820.



OUTLYING POSSESSIONS (*not shown on map*)

Territory	When Acquired	Population (1920)	Area (sq m)
Alaska	1867	55,036	590,884
Hawaii	1898	255,912	6,449
Philippine Islands	1898	10,314,310	115,026
Porto Rico	1898	1,299,809	3,435
Guam	1898	13,275	210
American Samoa	1899	8,056	77
Virgin Islands	1917	26,051	132

Except for the isolated military or trading posts, which always preceded the settlement frontier, the latter advanced across the prairie region of the Mid-West with a practically solid front until halted for a time at the eastern edge of the Great Plains. The North and the South sections of the country started out with population growths in the decade 1790–1800 very nearly equal (36·5 and 33·7%); but in every succeeding decade before the Civil War the rate of growth of the North was greater, and that of the South less, than its increment in the initial decade In 1790 the two sections were almost of equal population; by 1890, the population of the North was practically double that of the South. In the decade 1890–1900 the increase of the South exceeded slightly that of the North owing to the rapid development of the Southern States west of the Mississippi, but in general the increase of the two sections since has been nearly equal.

The temporary halt in the western advance at the edge of the Great Plains was due to the comparative aridity of this region and the discovery of more desirable agricultural valleys and mineral wealth in the mountainous sections and Pacific coast States of the farther west Population, therefore, leaped over these more barren regions and formed in isolated islands beyond The first of these overland migrations, which were to become a feature of American life in that generation, was the migration over the Oregon trail to the Oregon country (beginning 1842), the Mormon emigration to Utah (beginning 1847) and the gold rush to California, by sea and the Overland trail (beginning 1848) By the treaty of 1848, ending the war with Mexico, a number of old Spanish settlements in the south-west were added to the population Discoveries of mineral wealth between 1858 and 1880 in Colorado, Nevada, Idaho, Montana and Wyoming created other isolated areas of settlement in these States which spread gradually into the more attractive agricultural valleys of the mountains Between 1880 and 1890 a large part of the Great Plains was taken up But a small portion of this region was used for farming purposes until after 1900 when the system of dry land farming became generally known Settlement was then rapid up to the entrance of the United States into the World War, more land being settled than could be held during the period of agricultural depression which followed Similarly the population of the mountain States has to a large degree followed the rise or fall of prosperity in the mining industries, but the growth of agriculture in these States is proving a stabilizing factor.

In 1920 the centre of population was located 1 8 m. W. of Whitehall in Owen county, Indiana In 130 years the centre moved 567 m westward almost exactly along the 39th parallel of latitude, the extreme north and south variation amounting to only 21·4 miles Between 1910 and 1920 the westward movement of the centre, amounting to but 9·8 m, was less than in any previous decade See diagram page 737.

Growth of the Nation in Population.—From 1790 to 1920 the population increased in numbers from 3,929,881 to 105,710,620. The official estimate of the Census Bureau for July 1, 1928 was 120,013,000 In 1800 every important European country, even including Spain and Turkey, exceeded the United States in numbers; in 1925 only the Union of Soviet Republics had a larger population (135,755,000 by 1925 official census) From 1800 to 1900 the increase in the United States was 1,331·6% as compared with 204·3% in Belgium, then the fastest growing of European countries, and 155 9% in the United Kingdom. Natural or genetic growth, which in Europe is the only important source of population increase, is but one of several factors in the United States. There must also be considered the extraordinary additions to the population through immigration, and the less important additions through the annexation of territory.

In 1790 there were about 600,000 white families in the United States. Speaking broadly there were few very rich and few very poor. Food was abundant. Both social traditions and the religious beliefs of the people encouraged fecundity. The land was but partially settled. Mechanical labour was scarce, and even upon the farm it was difficult to command hired service. Yet only an increased supply of labour made more land or more capital of any practical value, and consequently large families possessed a direct economic advantage It is estimated that the total immigration from 1790 to 1830 amounted to but 378,000 persons, but in the same period the native white population increased 237%—a doubling every 22 or 23 years—a rate of genetic increase almost unprecedented in the history of civilized man

From 1830 to the Civil War the rate of increase in the total population of the country continued at the same rate as in the preceding 40 years, the decennial increase for the entire 70 years averaging 34·6% and in no case falling below 32·7%. But after 1830 an increasing proportion of this increase was due to immigration, the accessions, especially in the decade 1840–50 from Ireland and Germany, being enormous, and the total immigration in that decade rising to 1,427,337 as compared with 538,381 during the preceding decade This showed that the natural increase of the native population was slowing up, though the heavy immigration concealed this from view at the time In the decade 1850–60 almost one-seventh of the population consisted of persons born abroad.

The ten years from 1860 to 1870 witnessed the operation of the first great factor which reduced the rate of national increase, namely the Civil War The superintendent of the ninth census, 1870, computed the effects of this cause—first, through direct losses, by wounds or disease, either in actual service of the army or navy, or in a brief term following discharge; secondly, through the retardation of the rate of increase in the coloured element due to the privations, exposures and excesses attendant upon emancipation, thirdly, through the check given to immigration by the existence of the war; and finally, through the temporary reduction of the birth-rate, due to the withdrawal of perhaps one-fourth of the national militia during four years—to be a loss to the population of 1870 of approximately 2,515,000.

The rate of population increase declined steadily from 30·1% in the decade 1870–80 to 20 7% in the last decade of the century. From 1900 to 1910 there was a slight rise to 21%, due chiefly to a tremendous immigration of 8,202,388 in that decade, but in 1910–20 occurred an abrupt drop to 14 9%, the lowest rate of increase in the nation's history This decline in rate of increase in the face of heavy immigration is explained chiefly by a decline in the rate of natural increase of native-born, a decline so great that immigration could not wholly substitute for it This decline was continuous and uniform from 31·8% for the decade 1820–30 to 10 9% for the decade ending in 1920, the latter rate being approximately the rate of European increase.

The causes of the decline in rate of natural increase have been the subject of much speculation by sociologists It was not to be expected that the rate established from 1790 to 1830 by a virile and fertile race in a virgin land would continue Gen Francis A. Walker, superintendent of the 1870 and 1880 censuses, upon noticing, that in spite of increased immigration, the population in 1860 was but 10,000 more than if the rate of natural increase of 1830 had been maintained, ventured that the decline was due to the "competitive shock" of immigration, and that therefore immigration actually contributed little to the final total of population but instead merely substituted foreign for native stock It was no mere coincidence in his opinion that the birth-rate began to decline just as immigration began to increase, and that the decline was greatest in those regions, States "and in the very counties" where immigration was heaviest Walker's explanation, with modifications, has been adopted by most subsequent publicists who have written on immigration, notably Hall, Commons, Ross and Fairchild In 1920 the conditions upon which his conclusions were based were still in evidence The comparative natural increase of native whites was far below that of foreign-born whites, the ratio of infants to females among the latter being 78% greater than among the former. Furthermore the ratio ranged from only 14% greater in the East South-Central section where there are few foreign-born to over 120% in the New England and Middle Atlantic sections where the foreign-born are most numerous. All of which strongly suggests that the presence of the foreign-born acts as a deterrent.

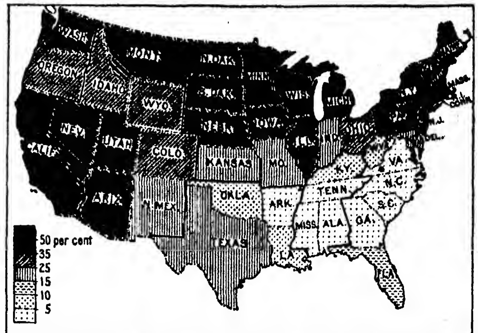
This explanation, however, has not gone unchallenged Goldenweiser and Billings have maintained that the decrease is due to

industrial development and urbanization and the complex forces attendant upon these two. The fact that immigration increased at the same time, is explained by representing this increase and the decline in rate of natural increase as two effects of the same cause. Rural life is still to some extent favourable to the development of large families but city life is not. Cities brought an increased cost of living and at the same time increased standards of living. They made possible increased opportunities for personal gratification along other lines and introduced other interests to compete with home and family. After 1900 the spread of contraceptive knowledge doubtless had an increasing effect. Another factor is the increasing late marriage among the more ambitious and intellectual classes. Finally to be considered is the growing independence of women, the widening of their interests and their entrance into business pursuits. Since the World War the latter considerations have operated to a much greater extent than formerly and their effect was by no means fully registered in the 1920 Census.

Despite the notable decrease in rate of growth, 1910–20, the actual numerical increase of 13,738,354 was greater than in any decade except 1900–10. Population increases showed a less definite geographical trend than ever before, the western movement having slackened decidedly, and seemed dependent instead upon industrial development. Immigration distribution, for instance, has become more and more a matter of labour opportunities. The mountain and Pacific sections continued to have the highest rate of growth, but the percentages, when compared with those of the preceding decade, showed a sharp reduction. The only section showing a higher rate of increase than during the previous decade was the East North-Central division, comprising the states of Ohio, Indiana, Illinois, Michigan and Wisconsin, a section where also occurred the most noticeable industrial expansion. The lowest rate of increase was reported in the East South-Central section. The South suffered from a considerable northward migration of negroes during the World War. Of the States east of the Mississippi, Michigan was the only one to report an increase over 30%, as against five States west of the Mississippi, namely Arizona, California, Idaho, Montana and Wyoming. Connecticut, New Jersey, Ohio, Florida and Oklahoma reported increases over 20%. A percentage basis gives little intimation of the actual numerical increase however. In this respect New York, Pennsylvania and California were the leading States, each with an increase of more than 1,000,000. Ohio, Michigan, Illinois, Texas and New Jersey reported between 500,000 and 1,000,000. Three States only, Nevada, Vermont and Mississippi, declined in numbers.

Racial Composition.—Under the classification "foreign stock" the Census Bureau includes both foreign-born inhabitants and native inhabitants who have one or both parents foreign-born. This classification in 1920 included slightly more than one-third the entire population, the number having increased from 32,243,382 in 1910 to 36,398,958. The rate of increase for the decade was 12·9%—slightly less than the rate for the population as a whole. The rate of increase for the foreign-born only was but 2·8%, so that most of the gain was contributed by the children of foreign-born. In 1920 the total foreign stock consisted of 13,712,754 foreign-born, 15,694,539 native-born with both parents foreign-born, and 6,991,665 with one parent foreign-born.

There have been many attempts to estimate the contribution of immigrants since 1790 to the present population as compared with the contribution of the original stock of 1790. The difficulty is that no record of immigrant stock beyond the second generation is kept. However, a number of estimates by the Census Bureau, arrived at by entirely different methods, closely agree in results. The average of these results places the numerical equivalent of the native white stock descended from the population of 1790 at 37,290,000 in 1900 and 47,330,000 in 1920. These figures do not represent so many persons of pure native blood, but the approximate sum of all fractional proportions of native blood in all individuals. Only in the Southern States is there a large percentage of comparatively pure-blooded descendants of the original inhabitants. Of the 10,040,000 increase between 1900 and 1920 in the calculated descendants of the 1790 population 3,360,694 or 35% was in nine Southern States. There has long been an impression that the original element of the population was slackening in growth to the point where it was doubtful if any increase was occurring, but these estimations indicate that it is increasing 11 or 20% per decade, a rate which closely approximates the average increase shown by European countries.



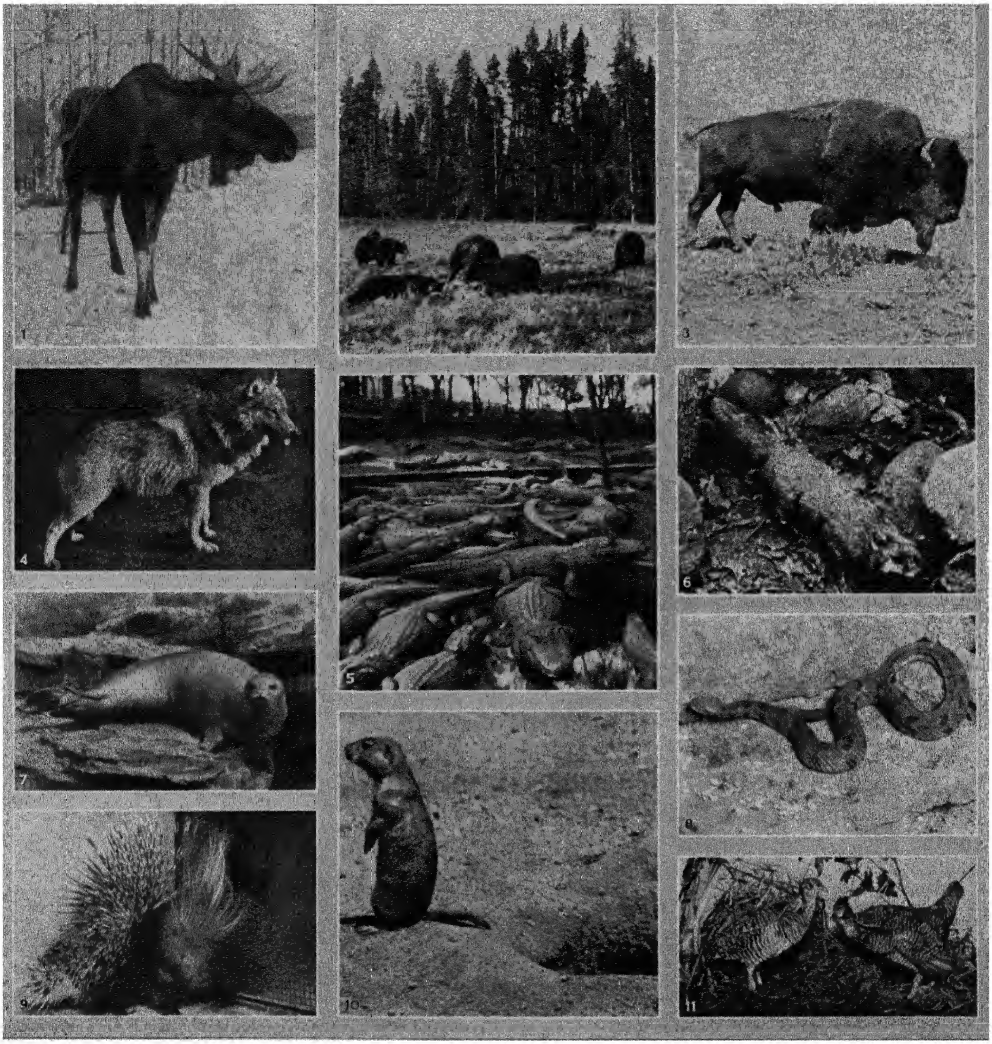
MAP SHOWING PERCENTAGE OF FOREIGN-BORN WHITE AND NATIVE WHITE OF FOREIGN OR MIXED PARENTAGE COMBINED IN TOTAL POPULATION BY STATES IN 1920

The increase was greatest in the south, and practically stationary, or even on the decline, in New England.

In 1920 the foreign-born represented 14·5% of the total population. This element becomes more significant, however, when it is considered that of the male population over 21 years of age it formed in 1910 24·6% and in 1920 22·1%. In certain sections of the country this percentage rises very high, as in the New England section where it amounts to 38·2% and in New York, Pennsylvania and New Jersey (considered as a unit) where it was 35·4%. In Boston it amounted in 1920 to 46·3%; in New York city to 53·4%.

In the decade 1910–20 the West North-Central section showed an important decline in its proportion of foreign-born, due largely to the mortality among its older pioneer immigrants, and to its inability to compete with the industrial areas for the new immigrants. The main increases in the percentage of foreign-born occurred in the industrial areas along the Atlantic coast and Great Lakes, in Montana and Washington in the far North-west, and in the States along the Mexican border. The percentage of city-dwellers among the foreign-born increased from 61·8% in 1890 to 75·5% in 1920. In the decade 1910–20 the number of foreign-born whites in rural districts decreased 12%. It is not believed that this decrease so much represented an actual migration to the cities, as a replacement of the earlier agricultural immigrants, whose mortality rate is now high, by later races which prefer the cities. In 1910, for example, it was shown that the urban proportion of Scandinavians was 53%, of Germans 67%, Austrians and Hungarians 74%, Italians 78% and Russian Jews 87%.

The shares of different nationalities in the aggregate mass of foreigners have varied greatly. The family names on the registers of the first census show that more than 90% of the white population was then of British stock, and more than 80% was English. The Germans were already near 6%. The entry of the Irish began on so great a scale in 1840 that by 1850 they formed nearly half the foreign-born. In that year 85·6% of the total foreign-born was made up by natives of Great Britain and Germany. The latter element took first place in 1880. In 1900 these two countries represented only 52·7% of the total; add the Dutch, Danes, Swedes, Norwegians and Swiss and the share was 65·1%. A majority of all these elements, except the British, settled in states added to the original Union, many of them being original homesteaders on the frontier. Since 1880 Italians, Russians, Poles, Austrians, Bohemians and Hungarians have enormously increased



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FAUNA OF THE UNITED STATES

1. A moose, a large mammal of the deer family, found in forests along the northern border from Maine to the Rocky Mountains
2. Black bears in Yellowstone Park, Wyoming, eating their evening meal. Black bears are widely distributed throughout the wooded parts of the United States
3. A buffalo bull, near Mammoth Hot Springs, Yellowstone Park. This animal, more properly called the American bison, formerly immensely abundant from the Rocky Mountains eastward to Pennsylvania, now survives only in protected reserves
4. The American grey wolf or timber wolf (*Canis nubilis*), found in the Great Lakes region and westward to Wyoming
5. Alligator farm on Anastasia Island, Florida, where more than 6,000 alligators are kept. The North American alligator is native to a narrow strip along the Atlantic coast from North Carolina southward and the Gulf coast from Florida to Texas
6. Grey fox (*Urocyon cinereoargenteus*). This fox, which is widely distributed in North America, prefers wooded country and usually lives in hollow logs, rarely in burrows
7. The common seal (*Phoca vitulina*), found on both the Atlantic and the Pacific shores, is abundant along the New England coast, often ascending rivers
8. Northern banded rattlesnake (*Crotalus horridus*), found from Maine and Northern Florida westward to the Rocky Mountains
9. Porcupine. This woodland animal is native to most forest areas in the United States north of lat. 40° and southward in Rocky Mountains to New Mexico and Arizona
10. Prairie dog, a gregarious rodent found in the more arid districts of the Great Plains region
11. Prairie hen (pinnated grouse). This game bird was formerly abundant in the prairies of the Mississippi valley

the immigrant population. In 1920 Germany, Russia (including Lithuania and Finland), Italy, Austria and Hungary, Poland, Canada and Ireland, in order of importance, were the chief countries of origin, each being represented by between one and two million foreign-born. Between 1910 and 1920 the following European nationalities decreased in number in the United States: English, Scotch, Welsh, Irish, Norwegians, Swedes, Swiss and Germans; the following were represented by an increase: Danes, Dutch and Belgians, French, Austrians, Hungarians, Poles, Russians, Finns, Rumanians, Bulgarians, Greeks, Italians, Spanish, Portuguese and some smaller nationalities. Canadians decreased by 78,192, Mexicans increased by 258,581 and Asiatics increased by 46,136.

With the disappearance of the frontier of free land, agitation for a restriction of immigration began to appear. The newer immigrants crowded in the cities, creating vast problems of assimilation and housing, and their competition with the native labourer was more keenly felt, now that the latter had no frontier to which to escape. The problem was brought to a crisis after the World War, when the United States, faced with the reabsorption into an ebbing industrial life of its own war veterans, realized that unless some barrier were erected it would be swamped by immigrants fleeing from the burdens of war-torn Europe. Immigration increased from 141,132 in 1919 to 805,228 in 1921. For restriction since 1921 *see* MIGRATION.

Immigration decreased under the Immigration Act of 1924, from 706,896 to 294,314 in 1925, 304,488 in 1926 and 335,175 in 1927. In 1927 Canada with 81,506 and Mexico with 67,721 supplied together nearly 45% of the total number of immigrants. Europe sent 168,368 immigrants, Germany with 48,513 leading, followed by the Irish Free State with 28,054, Great Britain 23,669, Italy 17,297 and the Scandinavian countries 16,860. All other European countries combined sent 33,975. Though the State of New York continues to lead all others as the settling ground of immigrants there has been, since the new law, a marked drift to the Central West and to the States beyond. Departures of emigrant aliens have decreased greatly since 1920, the proportion in 1927 being but 33 for every 100 arrivals. For Finland, Greece, Hungary, Italy, Portugal, Spain and Yugoslavia, considered as a separate group, however, the departures were greater by 5,879 than the immigration from these countries. It seems certain that the Immigration Law of 1924 is an epochal event in American history, marking a turning point as full of economic and social significance as was the disappearance of the frontier about 1890.

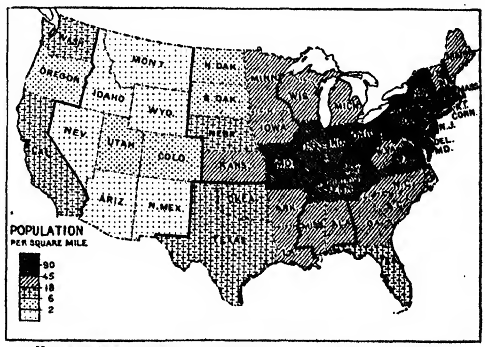
Numerically the Chinese and Japanese are not an important element of the population, but because of their concentration in the States of the Pacific slope, chiefly California, they have presented a problem to those particular States, and consequently to the National Government, far out of proportion to their numbers. The Chinese problem came first when between 1860 and 1880 they were imported at the rate of nearly 20,000 per year chiefly for labour purposes. Because of their serious competition with American labour, and because they were socially unassimilable, opposition to them reached a riot stage in many places, and in 1882 Congress, in contravention of existing treaties with China, passed an exclusion act, which with small changes has remained in force since. Since then the number of Chinese has steadily fallen and between 1910 and 1920 the decrease was from 71,531 to 61,638. Each year between 1920 and 1927 the departures were greater in number than the Chinese admitted. Furthermore the proportion of Chinese women in the United States is so low that the natural increase is slight.

Japanese immigration was not an important problem until after the Chinese Exclusion Act was passed. The cessation of Chinese immigration created a demand for cheap labour, and it was generally felt that the Japanese were cleaner and more attractive than the lower classes of Chinese which formerly arrived. But they were also more ambitious and aggressive economically and the Californians grew increasingly critical. Between 1900 and 1920 they came in greatly augmented numbers, averaging more than 10,000 annually. In 1920 there were 111,010 Japanese in the United States compared with 72,157 in 1910. Of the 1920 total 71,952 were located in California and 17,387 in Washington. As a result of the Immigration Act of 1924 Japanese admissions declined from 8,481 in 1924 to 682 in 1925 and 598 in 1926.

Of the entire population in 1920, 10,463,131, or 9·9% were negroes. This represented an increase of 635,000, or 6·5%, over 1910, the lowest increase of negroes in any decade. The proportion to whites in 1920 was about half of that in 1790 when they represented 19·3% of the population. This decline in proportion is due chiefly to the fact that, unlike the white, the negro race has not been augmented by immigration. Numerically their increase has been steady, ranging from 765,000 to double that number each decade from 1850 to 1910. Their increases were greater for the two decades before emancipation than for any decade since. As compared with 92·2% in 1860 there were resident in the Southern States 89·0% in 1910 and 85·2% in 1920 of the negro population. As compared with their 6·5% increase for the entire United States their increase in the Southern section was but 1·9%, and in the East South-Central section there was an actual decrease. (For more details *see* NEGROES.)

The American Indian numbered 244,437 in 1920 as against 265,683 in 1910 and 237,196 in 1900. The Census Bureau reports that the decrease between 1910 and 1920 may be more apparent than real, because of many with but a slight percentage of Indian blood being counted as whites. In the South-west, and especially in Oklahoma, intermarriage between the Indian and negro has been frequent, increasing the difficulty of enumeration. The number of Indians of pure blood has undoubtedly seen a material decrease. On the other hand the extinction of the Indian has probably been averted by increasing intermarriage so that a considerable strain of Indian blood will remain.

Urban and Rural Population.—In 1790 the population of the United States was almost entirely rural and supported directly from the soil. There were no large cities and no industry of importance other than agriculture. There were but six cities with more than 8,000 inhabitants. By 1920 cities having a population of 8,000, or more, had increased in number to 924, and more than one-half the total population lived in cities numbering over 2,500 inhabitants. The proportion of the population living in cities seems to have been practically constant throughout the 18th century and up to 1820. The great growth of urban centres has been a result of industrial expansion since that time, these centres gathering momentum from decade to decade, drawing man power



MAP SHOWING DENSITY OF POPULATION IN THE UNITED STATES

both from the rural areas and from the great numbers of immigrants. On an average throughout the 130 years the population in cities of 8,000 considerably more than doubled every twenty years. With a much slower rate of increase the rural areas, aided by the constant development of agricultural machinery, have maintained a food supply adequate for the increasing urban inhabitants. In 1880 only 28·6% of the nation's population was urban; in 1910, 45·8% and in 1920, 51·4% was urban.

Of the 13,738,354 inhabitants who represented the national

population increase for 1910–20, 12,138,483 were added to the urban and but 1,599,871 to the rural population Though there was a decline in the percentage of increase for both classes during the decade (which is natural in view of the decline in the rate of national growth from 21% to 14·9%) that for the urban dweller fell from 38 8% to 28·8% Of the urban increase of 28·8% during the decade it is estimated that about 10% was due to the natural increase from excess of births over deaths and the remainder about equally due to immigration of foreign-born and to domestic migration from rural to urban communities Negroes formed about one-fifth of the domestic migrants during the period

Of the migrants from the country to the city four-fifths were between the ages of 10 and 30 The movement from rural to urban continued to be greatest in the areas in which it began—the industrial North-eastern and North-Central States In this region from 1900 to 1910 the rural population was stationary and from 1910 to 1920 it showed a slight decrease. The movement was also very great in the West North-Central States, usually considered the agricultural stronghold of the nation. Here the additions to the rural population were but slight, and almost all the increase was confined to the cities In the Southern States where the proportion of rural population is highest, the rural increase for the decade 1910–20 was but 1,400,000, approximately, and the urban increase 2,300,000. In the Pacific States, where the urban element predominated in 1910, the urban growth continued to be at a much higher rate than rural increase. Only in the Rocky Mountain States was the exception found, the rural element showing a decidedly greater increase from 1910 to 1920 than the urban.

Rhode Island and Massachusetts possess the highest proportion of city dwellers, 97·5% and 94 8%, respectively, living in cities of over 2,500 inhabitants Except for Maine all other Atlantic States south to Virginia have a predominating urban element and similarly all Northern States east of the Mississippi river, except Wisconsin The only other States in which the urban element is highest are California and Washington on the Pacific coast The lowest proportions of city dwellers are found in Mississippi (13·4%) and North Dakota (13 6%), with South Dakota, Arkansas, South Carolina and New Mexico not far behind In 1920 cities with a population over 250,000 numbered 25, over 100,000, 68, and over 25,000, 287 Cities with a population of 100,000, or more on July 1, 1928, as estimated by the Census Bureau, follow:—

Cities with 100,000 Inhabitants or More

Rank in 1920		1920	1910	Per-cent-age in-crease	1928 estimate
1	New York, N.Y.	5,620,048	4,766,883	17 9	6,017,500
2	Chicago, Ill.	2,701,705	2,185,283	23·6	3,157,400
3	Philadelphia, Pa.	1,823,779	1,549,008	17·7	2,064,200
4	Detroit, Mich.	993,678	465,766	113·3	1,378,900
5	Cleveland, O.	796,841	560,663	42·1	1,010,300
6	St Louis, Mo.	772,897	687,029	12·5	848,100
7	Boston, Mass.	748,060	670,585	11·6	799,290
8	Baltimore, Md.	733,826	558,485	31·4	830,400
9	Pittsburgh, Pa	588,343	533,905	10·2	673,800
10	Los Angeles, Calif.	576,673	319,198	80·7	1,367,000*
11	Buffalo, N Y	506,775	423,715	19·6	555,800
12	San Francisco, Calif	506,676	416,912	21 5	585,300
13	Milwaukee, Wis	457,147	373,857	22·3	544,200
14	Washington, D C	437,571	331,069	32·2	557,000
15	Newark, N.J.	414,524	347,469	19·3	473,600
16	Cincinnati, O.	401,247	363,591	10·4	413,700
17	New Orleans, La	387,219	339,075	14·2	429,400
18	Minneapolis, Minn	380,582	301,408	26·3	455,900
19	Kansas City, Mo.	324,410	248,381	30·6	391,000
20	Seattle, Wash.	315,312	237,194	32·9	383,200
21	Indianapolis, Ind.	314,194	233,650	34·5	382,100
22	Jersey City, N J.	298,103	267,779	11·3	324,700
23	Rochester, N.Y.	295,750	218,149	35·6	328,200
24	Portland, Ore.	258,288	207,214	24·6	354,000*
25	Denver, Colo.	256,491	213,381	20·2	294,200

Cities with 100,000 Inhabitants or more—Cont'd

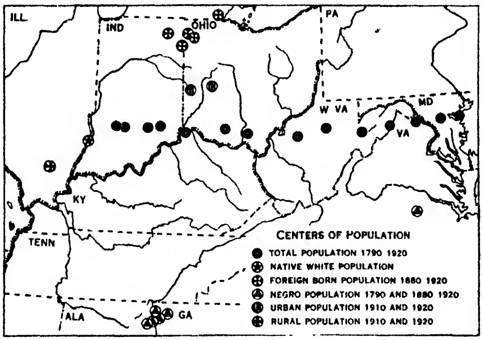
Rank in 1920		1920	1910	Per-cent-age in-crease	1928 estimate
26	Toledo, O.	243,164	168,497	44·3	313,200
27	Providence, R.I.	237,595	224,326	5·9	286,300
28	Columbus, O.	237,031	181,511	30·6	299,000
29	Louisville, Ky.	234,891	223,928	4·9	329,400
30	St Paul, Minn.	234,698	214,744	9·3	313,000*
31	Oakland, Calif.	216,261	150,174	44·0	274,100
32	Akron, O	208,435	69,067	201·8	210,000*
33	Atlanta, Ga	200,616	154,839	29·6	255,100
34	Omaha, Neb.	191,601	124,096	54 4	222,700
35	Worcester, Mass.	179,754	145,986	23·1	197,600
36	Birmingham, Ala	178,806	132,685	34·8	222,400
37	Syracuse, N Y.	171,717	137,249	25·1	199,300
38	Richmond, Va	171,667	127,628	34·5	194,400
39	New Haven, Conn	162,537	133,605	21·7	187,900
40	Memphis, Tenn.	162,351	131,105	23·8	190,200
41	San Antonio, Tex.	161,379	96,614	67·0	218,000
42	Dallas, Tex	158,976	92,104	72·6	217,800
43	Dayton, Ohio	152,559	116,577	30·9	184,500
44	Bridgeport, Conn.	143,555	102,054	40·7	170,000*
45	Houston, Tex	138,276	78,800	75·5	300,000*
46	Hartford, Conn	138,036	98,915	39·6	172,300
47	Scranton, Pa	137,783	129,867	6·1	144,700
48	Grand Rapids, Mich	137,634	112,571	22 3	164,200
49	Paterson, N J	135,875	125,600	8·2	144,800
50	Youngstown, O	132,358	79,066	67·4	174,200
51	Springfield, Mass.	129,614	88,926	45·8	149,800
52	Des Moines, Ia.	126,468	86,368	46 4	151,900
53	New Bedford, Mass	121,217	96,652	25·4	126,000*
54	Fall River, Mass	120,485	119,295	1·0	134,300
55	Trenton, N J	119,289	96,815	23·2	139,000
56	Nashville, Tenn.	118,342	110,364	7·2	139,600
57	Salt Lake City, Utah	118,100	92,777	27 3	138,000
58	Camden, N J	116,309	94,538	23 0	135,400
59	Norfolk, Va	115,777	67,452	71·6	184,200
60	Albany, N.Y.	113,344	100,253	13·1	120,400
61	Lowell, Mass	112,759	106,294	6 1	115,000*
62	Wilmington, Del	110,168	87,411	26 0	128,500
63	Cambridge, Mass	109,694	104,839	4·6	125,800
64	Reading, Pa	107,784	96,071	12·2	115,400
65	Fort Worth, Tex	106,482	73,312	45·2	170,600
66	Spokane, Wash	104,437	104,402		109,100
67	Kansas City, Kan	101,177	82,331	22·9	118,300
68	Yonkers, N Y.	100,176	79,803	25 5	121,300
69	Lynn, Mass.	99,148	89,336	11·0	105,500
70	Duluth, Minn.	98,917	78,466	26·1	116,800
71	Tacoma, Wash	96,965	83,743	15·8	110,500
72	Utica, N.Y.	94,156	74,419	26·5	104,200
73	Somerville, Mass.	93,091	77,236	20·5	102,700
74	Flint, Mich.	91,599	38,550	137·6	148,800
75	Jacksonville, Fla	91,558	57,699	58·7	140,700
76	Canton, O.	87,091	50,217	73·4	116,800
77	Fort Wayne, Ind.	86,594	65,933	35·4	105,300
78	Knoxville, Tenn	77,818	36,346	114·1	105,400
79	El Paso, Tex.	77,560	39,279	97·5	117,800
80	San Diego, Calif.	74,683	39,578	88·7	119,700
81	Tulsa, Okla	72,075	18,182	296 4	170,500
82	Tampa, Fla	51,608	37,782	36·6	113,000
83	Miami, Fla	29,571	4,571	647·0	156,700

*No estimate made by Census Bureau. Figures are local estimates.

Interstate Migration is an interesting element in American national life. In 1920 19·2% of the native-born population, as compared with 18·4% in 1910, were living in States other than those in which they were born. Formerly the migration of the native element was chiefly westward, but the increased migration from 1910 to 1920 in the face of a slackened westward movement of the centre of the population indicates the increasing movement in other directions. There was an increased movement of whites from the North to the Southern States of Florida, Texas and California, for instance, but the north to south movement was

balanced to a large extent by the northward negro migration. The most stationary population is in the south, the South Atlantic and East South-Central States showing over 90% of their population born in the State of residence. In Oklahoma, Wyoming, Colorado, Idaho and Montana, on the other hand, more than 50% of the population was born outside the State, and the proportion is about 40% for the entire mountain and Pacific divisions.

Sexes.—The percentages of males and females of all ages in the aggregate population of 1920 were 51·0 and 49·0 respectively



BY COURTESY OF BUREAU OF CENSUS

The corresponding figures for the main elements of the population were as follows for native whites, 50·4 and 49·6; foreign-born whites, 54·9 and 45·1; negroes 49·8 and 50·2. In the proportions of the sexes in the aggregate population there has been almost no change since 1820 In the immigration since the restrictions of 1924 there has been an increasing proportion of women which presumably indicates a more stable class of immigrants. In densely settled regions females are proportionally more numerous as a general rule In Massachusetts, Rhode Island, New York and the Southern States of North Carolina, South Carolina, Georgia and Alabama there are more females than males In the more thinly settled western States males predominate, there being in the mountain States 115·7 males, in the Pacific States 113·9 males for every hundred females In 1920 there were in every 1,000 urban inhabitants 38 (in 1900 only 23) more females than in 1,000 rural inhabitants In no State did the females exceed the males in rural districts.

Vital Statistics.—The median age of the aggregate population —that is, the age which divides the population into two equal groups, one younger and the other older—has shown an increase each decade from 1800, when it was 15·97 years, to 1920 when it was 25·2 years, the median ages for 1900 and 1910 being 22·9 and 24 years, respectively The increase has been due chiefly to two causes: first, an increase in the average length of life; second, a reduction in the birth rate, which results in a decrease of the proportion of young persons in the population. Also an increase in immigration tended to raise the median age since most immigrants come as mature persons. The median age of the foreign-born in 1920 was 40. The median age of whites alone was 25·6; of negroes 22·3, of American Indians 19·7 The United States has a larger proportion (60·7% in 1920) within the "productive" age limits of 15 and 60 years than most European countries, due to the immigration of foreign adults.

Statistics of births and deaths in the United States are collected from a registration area which consists of all States wherein at least 90% of the births or deaths are correctly reported In 1920 this area for deaths consisted of 34 States comprising 82·8% of the population; in 1927 it had increased to 42 States with 91% of the population. For births the area increased from 26 States with 65·1% of the population in 1920 to 37 States with 81% of the population in 1927.

The death-rate of the registration area per 1,000 living was 17·6 in 1900, 15 in 1910, 13·6 in 1915, 13·1 in 1920 and 11·8 in 1925. There was considerable variation between 1915 and 1920, the death-rate rising as high as 18·3 per 1,000 in 1918 due to war casualties and to the even more disastrous epidemic of influenza that swept the country in that year. In 1925 the mortality among whites was 11·2 while that among negroes was 18·2 per 1,000 Mortality in the rural districts (10·7 per 1,000) was less than in cities (13 per 1,000) In 1900 the deaths under 1 year of age formed 20·7%, and those under 5 years 30·4%, of the total deaths of all ages, but in 1924 the corresponding percentages were 13·7 and 18·7. In 1924 the death-rate in the United States was lower than in any other important nation except Australia and New Zealand, though the rates for England and Wales, Germany and Sweden were but slightly higher The leading causes of deaths in 1924 were as follows. diseases of the heart, 15%; cancer and other malignant tumours, 7·8%; cerebral hemorrhage and softening, 7·8%; acute and chronic nephritis, 7·6%; violent deaths (except suicide), 7·2%; tuberculosis of respiratory system, 6·7%; congenital debility and malformations, 6·2%; pneumonia, 4·8%

The birth-rate appears to have been declining gradually for a considerable period, but the reductions in infant mortality have, to some degree, offset the effect Only since 1915 has the Census Bureau collected birth statistics systematically For the years 1917–25 the results follow —

Year	Births per 1,000 population*	Deaths per 1,000 population*	Excess of births over deaths	Deaths under 1 yr of age per 1,000 births*
1917	24·7	14·3	10·4	94
1918	24·6	18·1	6·5	101
1919	22·3	12·9	9·4	87
1920	23·7	13·1	10·6	86
1921	24·3	11·9	12·6	76
1922	22·5	11·9	10·6	76
1923	22·4	12·4	10·0	77
1924	22·6	11·8	10·8	71
1925	21·4	11·8	9·6	72

*Stillbirths not counted.

For every 1,000 births in 1917 there were but 868 in 1925, a decrease of 132 The decline in infant mortality, though marked, amounted to but 22 per 1,000 and so fell short 110 per 1,000 in affecting the decline in birth-rate In 1925 the birth-rate of the white population was 21·1 per 1,000 white, that among the coloured population was 26·7 per 1,000 The excess of births over deaths was 9·8 for whites and 8·1 for negroes In every State of the union the birth-rate exceeded the death-rate for whites, but in many Northern States the death-rate was higher than the birth-rate for negroes The birth-rate in the urban area was 21·9% in contrast to 20·9% in rural districts.

Of females above 15 years of age in 1920 35·1% were single, 59·2% married, 4·8% widowed, 0·5% divorced, 0·4% unknown In 1900 the figures were respectively 31·2%, 56·9%, 11·2%, 0·5%, 0·2% Among males above 15 years of age in 1920 27·3% were single, 60·6% married, 11·1% widowed, and 0·8% divorced The corresponding figures for 1900 were 40·2%, 54·5%, 4·6% and 0·3% In 1926 the number of marriages per 1,000 population varied from 7·66 in New England to 12·90 in the East South-Central section The number was high in the remainder of the South and in the Pacific States; the rest of the country was about midway between The number of divorces has shown an increase each year since 1887 when statistics were first taken In proportion to every 100 marriages performed divorces numbered 7·9 in 1900, 8·8 in 1910, 13·4 in 1920 and 15 in 1926. The number of divorces per 1,000 population for the years 1922–26 was lowest in the Middle Atlantic and next lowest in the South Atlantic divisions; it was highest in the Pacific and next highest in the mountain States Of those in 1926 57·3% reported no children In 1850 there were 5·6 persons (excluding the slave population) in an average American family; 50 years later there were only 4·7. The rate of decline has since continued, the average family numbering 4·5 in 1910 and but 4·3 in 1920. The largest families are in the Southern and the smallest in the Western States

Education.—In the article EDUCATION: *United States*, and in the articles on the several States, details are given generally of

the conditions of American education Here the statistics of literacy need only be considered. In 1920 illiterates (that is persons unable to write, the majority of these being also unable to read) constituted 6% of the population at least ten years of age; but the greatest part of this illiteracy was due to the negroes and the foreign immigrants. Since 1880 the percentage has steadily declined for all classes save the foreign-born, for which it increased between 1880 and 1890 and again between 1910 and 1920, due, probably, to the large scale immigration from southern Europe where the percentage of illiteracy is high Illiteracy also is less among young persons of all classes than in the older age-groups, in which the foreign-born largely fall. Between 1900 and 1920 the reduction of illiterates was from 10·7% to 6%. In 1920 classification by races shows that the percentage of illiteracy among negroes was 22 9 (in 1900, 44 5%), foreign-born whites, 13·1 (in 1900, 13%), native whites of native parentage, 2 5% (in 1900, 5·7%), and native whites of foreign or mixed parentage, 0·8% (in 1900, 1 6%) In all classes but the foreign-born, therefore, the figures show a reduction of about half in the two decades Illiteracy is greatest in the East South-Central (12·7%), South Atlantic (11·5%) and West South-Central (10%) sections, and least in the West North-Central (2%), Pacific (2·7%) and East North-Central (2 9%) sections. All differences between sections are lessened if the comparison is limited to children, and still farther lessened if also limited to cities. Increasing literacy in the lower age-groups directly reflects the extension of educational facilities from decade to decade.

Similarly the decrease in illiteracy among women over 10 years of age from 20·3% in 1890 to 5 9% in 1920 reflects the increasing educational opportunities that have been opened to them In the decade 1910–20 for the first time their percentage of illiteracy (5·9%) was less than that for men (6%) In the total population of voting age women were still behind men in illiteracy, the percentages being 7 3 to 7; but within the age group 10 to 24 years the reverse was true. For the ages 25 to 34 years, inclusive, the sexes are even, with an illiteracy of 5 6% each. In 1920 64·3% of the total population 5 to 20 years of age was in attendance at some school, compared to 61·6 in 1910. In 1910 the percentage of males in attendance (62%) slightly exceeded that of females (61·3), but in 1920 the proportions were reversed (male 64·1%, female 64·5%).

Religious Bodies.—According to the census of religious bodies taken by the Federal Census Bureau in 1926 there were in the United States 213 religious denominations, represented by 231,983 organizations with 54,624,976 members. Compared with the religious census of 1916 this represents an increase of 13 denominations, 5,265 organizations and 12,698,122 members. Whereas in 1910 about 46% of the total population was identified with some religious body, by 1920 that proportion had increased to 51%.

While statistics of membership may be used in a very general way for comparison of denominational strength, it must be remembered that membership is counted very differently in different denominations, the membership of children especially differing between Roman Catholic and most Protestant bodies. Though Protestants as a group outnumbered Roman Catholics almost 2 to 1, the Roman Catholic church was far ahead of any other single denomination For membership of each denomination *see* separate articles on the various denominations. The trend toward fewer organizations in spite of increased membership is noticed in the Disciples of Christ, Methodist, Presbyterian and in many lesser Protestant denominations Nineteen of the denominations reported in 1916 were not included in the 1926 census, having either dropped out of existence or joined other organizations. Thirty-two new denominations were reported for the first time in 1926, some being created by divisions within the old churches, others being original organizations. The immigration from south-eastern Europe gave great strength to some sects which had no existence in the religious census of 1890, notably those of the Eastern Orthodox churches (Russian, Serbian, Syrian and Greek)

The Roman Catholic was the leading denomination in membership in every one of the northern and western States, except in Idaho and Utah where the Latter Day Saints (Mormons) predominated by a large margin In the Southern States the leading denominations were either Baptist or Methodist. The Lutherans are relatively strongest in the North-Central division of the country, their members consisting chiefly of Germans and Scandinavians. The other important Protestant bodies are widely and fairly evenly distributed over the country

At the census of 1926 the total annual expenditure of religious bodies was $814,371,529 as compared with $328,809,999 in 1916. The value of church property was $3,842,577,133 as against $1,676,600,582 in 1916.

Occupations.—Of persons 10 years or more of age 41,614,248 —nearly two-fifths (39 2%) of the country's total population—were gainfully employed in 1920 In 1900 the percentage was 38 3 In 1910 and 1920 ten main occupational groups were listed by the Census Bureau, in which the number of wage-earners, male and female, were as follows —

Class of occupation	Both sexes		Males		Females	
	1910	1920	1910	1920	1910	1920
All occupations	38,167,336	41,614,248	30,091,564	33,064,737	8,075,772	8,549,511
Manufacturing and mechanical industries	10,628,731	12,818,524	8,808,161	10,888,183	1,820,570	1,930,341
Agriculture, forestry, and animal husbandry	12,659,082	10,953,158	10,851,581	9,869,030	1,807,501	1,084,128
Trade	3,614,670	4,242,979	3,146,582	3,575,187	468,088	667,792
Domestic and personal service	3,772,559	3,404,892	1,241,338	1,217,968	2,531,221	2,186,924
Clerical occupations	1,737,053	3,126,541	1,143,829	1,700,425	593,224	1,426,116
Transportation	2,637,420	3,063,582	2,530,795	2,850,528	106,625	213,054
Professional service	1,693,361	2,143,889	959,470	1,127,391	733,891	1,016,498
Extraction of minerals	965,169	1,090,223	964,075	1,087,359	1,094	2,864
Public service (not elsewhere classified)	459,291	770,460	445,733	748,666	13,558	21,794

Perhaps the most interesting change occurring during the decade 1910–20 was the advance to first place of manufacturing and mechanical industries over agriculture, forestry and animal husbandry in the number of workers employed. Agriculture, forestry and animal husbandry had previously held the lead ever since 1790. Another exchange which registered the changing social and economic life of the nation was the decrease of workers in domestic and personal service, and the increase in clerical occupations.

The total number of gainfully employed in 1920 included 78·2% of the males and 21·4% of the females over 10 years of age resident in the country. In 1900 the corresponding percentages were 80·8 and 18·8; in 1880 they were 78·7 and 14·7. The proportion of women workers is greatest in New England, New York and New Jersey, where they are engaged in manufacturing, and in the Southern States where the negro women are engaged in agricultural operations. The decreased number of agricultural workers among women in 1920 was due chiefly to a change in census instructions which resulted in a lower number being reported. The most important increase of women in any field was in that of clerical occupations. In the manufacturing industries women are employed chiefly in the dress and millinery trades and

in the cotton factories. Of the women in professional service nearly two-thirds were school teachers, and close to half the remainder were registered nurses. The number of women in trade increased 42·7% from 1910 to 1920, and in many occupations, mainly those of a proprietary nature, enormous increases are shown. Of the total in trade 82·4% were saleswomen and store clerks In 1920 23% of the women in industry were married.

From 1910 to 1920, despite their increase in total numbers, children from 10 to 15 years of age in industry, decreased from 1,990,225 to 1,060,858 The proportion which children of this age engaged in gainful occupations bore to the whole number of such children was in 1900, 26·1% for males and 10 2% for females, in 1910, 24 7% for males and 11 8% for females, in 1920, 11·3% for males and 05·5% for females Over one-half the employment of children was in agricultural pursuits, which are exempt from the restrictions of child labour regulation. About one-sixth of the boys and one-fifth of the girls employed were in manufacturing and mechanical industries, which are usually the first to be brought under legal control Geographically the proportion of children employed ranged from 3% in the Pacific coast States to 17% in the East South-Central States, comprising Kentucky, Tennessee, Alabama and Mississippi When all occupations are taken into account the proportion was much larger in the South than in any other section, but when non-agricultural occupations alone are considered, the proportion was considerably larger in New England and the Middle Atlantic States and slightly larger in the East North-Central States.

National Wealth.—Mulhall has estimated the aggregate wealth of the United States in 1790 at $620,000,000, assigning of this value $479,000,000 to lands and $141,000,000 to buildings and improvements It is probable that this estimate is generous according to the values of that time But even supposing $1,000,000,000 a juster estimate, the increase in wealth from 1790 to 1920 was more than three-hundredfold, or three times as great as the growth in population The estimate of the national wealth of 1850 was $7,135,780,228, since which the increase has been more than fortyfold The Census Bureau estimated the national wealth in 1900 at $88,517,000,000, in 1912 at $186 300,000,000, and in 1922 at $320,804,000,000 The estimated per caput wealth has increased from an average of $308 in 1850 to $1,165 in 1900 and $2,918 in 1922

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VI. NATIONAL FINANCE

Establishing the Financial System.—The complete financial collapse of the Confederation government in 1786 was the primary motivating factor in the establishment of a new Government. The country itself was economically sound and its resources were inexhaustible, yet attempts to collect sufficient revenue from the States had failed as also had attempts to levy national taxes. The interest on the public debt had gone unpaid and was increasing at a rapid rate. With no income all other governmental functions were faced with extinction. It was this situation which led statesmen to meet to remodel the government in the direction of giving increased power to the central administration. The Constitution which resulted gave the national Congress the power to levy and collect taxes, duties, imports and excises, to coin money and to regulate its value, to pay debts, to borrow money upon the credit of the United States and to provide for the common defense and general welfare of the country. Taxes, duties, imposts and excises were to be uniform throughout the land and could not be levied on commerce between the States. The individual States were forbidden to levy duties or imposts on imports and exports but retained the power of taxation They were also forbidden to coin money, emit bills of credit, or make anything but gold and silver legal-tender in payment of debts Money was to be drawn from the public treasury only according to appropriations voted in Congress Thus the Constitution laid down the broad principles upon which the income and expenditures of the nation are based Of the amendments since added only one, the 16th, ratified in 1913 and allowing a graduated income tax to be levied, relates to finances.

The new Congress met a month before Washington's inauguration to provide revenue by a Tariff Act levying customs duties on imported goods. Differences of opinion over details of the schedule developed and the debate lasted seven weeks Opposition also developed between those who wanted a tariff for revenue only and those who hoped that the duties might be made high enough to protect manufactures also This conflict was also destined to be permanent in American financial history With the Revenue Bill passed the House began to consider the establishment of a Treasury Department, the chief matter of discussion being whether it should be under a commission or a single head The latter was decided upon and Washington appointed Alexander Hamilton (*q.v.*) to the post Hamilton immediately tackled the third problem, the funding of the public debt Obligations to foreign countries, to individuals at home, and the debts of the various States were fixed and funded through loans Hamilton was also convinced that a Government bank would be an important aid in the handling of public credit and Congress by a sectional vote chartered such an institution for 20 years He also recommended that the monetary unit be a coin corresponding as closely as possible to the Spanish dollar and that it be expressed in both gold and silver in the proportion of 1 to 15. In the Coinage Act of 1792 provision for the coinage of this dollar and other coins was made and a mint was established at Philadelphia Thus with the power to tax in its hands, with its financial machinery established, and with rich resources in wealth behind it, the new Government became at once stable and effective

Historical Survey.—The growth of the Government's financial operations falls quite definitely into four periods. Before the War of 1812 Treasury receipts and expenditures were with few exceptions less than $10,000,000 annually Between the War of 1812 and the Civil War they could be expressed in tens of millions, from the Civil War to the World War in hundreds of millions and after the World War only in thousands of millions. For revenue reliance down to the Civil War was chiefly on customs duties. The first internal revenue tax was an excise tax on whiskey levied in Washington's administration, but it proved so unpopular that an armed insurrection broke out, and though defiance quieted down the tax never yielded well The Jeffersonian Democrats abolished internal revenue taxes on principle and, except during the War of 1812, they were not re-established until the financial strain of the Civil War made them necessary They were afterwards continued and became increasingly important until after 1900 they rivalled the customs in amount After the passing of the income tax in 1913 they began to surpass the customs. At the time of the founding of the Government it was hoped that income from the sales of public lands would pay off the national debt but this hope was never realized, and it was finally abandoned.

The government has been in an extremely critical situation, financially, only twice, during the War of 1812 and during the Civil War. The Mexican War and the Spanish-American War were financed without interrupting the nation's stride The War of 1812 was mishandled financially nor did it command the support of the middle and New England States, where the money

power was concentrated The Civil War, disrupting as it did the nation itself, created an even more precarious situation and the years 1862–63 were, doubtless, the darkest in the nation's history. The years 1865–80 were devoted to paying off the war debts or refunding them by long-term loans and to resuming specie payments. New complications, lasting until 1900, came into existence due to the declining price of silver bullion, which disturbed the 1 to 16 silver-gold ratio established in 1835 Owing to the political power of the debtor West the Treasury was obliged to maintain the coinage of this inferior bullion on a parity with gold. The years from 1900 to 1913 were occupied chiefly by attempts to increase the effectiveness of the national banks in meeting the rapidly growing business demands of the country. The solution finally arrived at was the establishment in 1913 of the Federal Reserve System (*q v.*). (X)

PUBLIC FINANCES SINCE 1913

The dominating feature in Federal public finance since 1913 has been the financing of American participation in the World War with the subsequent readjustments necessary for returning to peace conditions Although several significant alterations and innovations in the fiscal system had their origin in the pre-War period, 1910–6, it was the necessity for war expansion and for post-War contraction that made most of these changes important. For example, income taxation had its beginnings in the tariff Acts of 1909 and 1913, but it was due primarily to war experience that it rose to its present pre-eminent position in the revenue system Similarly, the Federal Reserve System had begun operation in 1914, but the use of the Federal reserve banks as fiscal agents of the Government was a war development And it was the need for retrenchment after the War that brought about the adoption of the executive budget, a measure which had been steadily advocated by successive administrations since about 1910.

Public Debt—Although taxation was used to an unprecedented extent in financing the participation of the United States in the World War, it was necessary to borrow the greater portion of the required revenues Four classes of interest-bearing obligations were authorised and issued. (1) Treasury certificates of indebtedness, with maturities not exceeding one year, (2) Treasury notes, with maturities from one to five years; (3) bonds, with maturities exceeding five years; and (4) war savings certificates, with maturities not exceeding five years. All were issued at not less than par except war savings certificates, on which interest was discounted in advance.

The Treasury was placed in funds through the issue of short term Treasury certificates of indebtedness, and from time to time outstanding certificates were funded into loans, discharged from tax receipts or replaced by new issues. Five war loans were issued during the War and post-Armistice periods The War Loan Organisation, directed from the Treasury and centred at the Federal Reserve Banks, with associated Liberty Loan Committees formed in every part of the country, conducted the selling campaigns. The results are shown in the table below.

Issue	Amount subscribed	Amount allotted and issued	Number of subscribers (estimated)
First Liberty Loan, 3½ per cent, June 15, 1917	$3,035,226,850	$1,989,455,550	4,000,000
Second Liberty Loan, 4 per cent, November 15, 1917	4,617,532,300	3,807,865,000	9,400,000
Third Liberty Loan, 4¼ per cent, May 9, 1918	4,176,516,850	4,175,650,050	18,308,325
Fourth Liberty Loan, 4¼ per cent, October 24, 1918	6,992,927,100	6,964,581,100	22,777,680
Victory Liberty Loan, 3¾–4¾ per cent, May 20, 1919	5,249,908,300	4,495,373,000	11,803,895
Total	$24,072,111,400	$21,432,924,700	

The peak of the War debt was reached on Aug 31, 1919, when the gross amount outstanding stood at $26,594,267,878. Congress, in the Victory Liberty Loan Act (March 3, 1919), provided for definite and systematic discharge of the permanent debt through provision for the cumulative sinking fund, effective on July 1, 1920, and through reaffirmation of directions to apply to domestic debt reduction any repayments of loans to foreign governments. The Federal budget is balanced annually on such basis. There remained the problem of the temporary or short-dated debt. Many of the maturities came at inconvenient times and in inconvenient amounts. In order to render this short-dated debt more manageable and to arrange maturities on dates and in amounts that could be discharged without undue strain the Treasury entered on a refunding programme. It resorted to issues of Treasury notes in moderate amounts from time to time, with maturities not exceeding five years The first issue was made on June 15, 1921. Other issues followed. On Oct. 16, 1922, the programme was varied and a series of Treasury bonds was issued with further issues of bonds on Dec. 15, 1924, March 15, 1926, and June 15, 1927. Each year since the War the volume of maturities has been considerably larger than the amount that could be retired, so that refunding operations have been continuously necessary The maturities of all refunding issues are arranged for tax payment dates, and with respect to the bonds provision was made for call before maturity. Sixteen refunding issues aggregating $9,635,899,850 have been made to June 30, 1928.

Included in the short-dated debt to be discharged or refunded were the outstanding Victory notes maturing in 1922 and 1923. Approximately $1,200,000,000 were retired through purchase for the sinking fund and other accounts, approximately $1,500,000,000 were exchanged for other issues, and approximately $1,800,000,000 were paid on call date or at maturity The second liberty loan 4 per cent bonds and converted 4¼ per cent bonds, redeemable on or after Nov. 15, 1927, and payable June 15, 1947, were called on Nov 15, 1927 Approximately $1,300,000,000 were retired through purchase for the sinking fund and other accounts, approximately $2,000,000,000 were exchanged for other issues and about $500,000,000 were paid on the call date Of the third Liberty 4¼ per cent bonds payable on Sept 15, 1928, approximately $2,600,000,000 were retired through purchase for the sinking fund and other accounts, approximately $900,000,000 were exchanged for other issues, and approximately $600,000,000 were paid at maturity.

On June 30, 1928 the outstanding debt was as follows.—

Interest-bearing debt—	
Bonds:	
Pre-War issues	$ 768,132,510 00
Liberty Loans	9,462,046,350 00
Post-War issues	2,790,638,650 00
Treasury notes	2,900,000,500 00
Certificates of indebtedness	1,252,408,000 00
Treasury Savings certificates	144,469,036 45
Total interest-bearing debt outstanding	$17,317,695,096 45
Matured debt on which interest has ceased	45,331,660 26
Outstanding debt bearing no interest	241,263,806 22
Total gross debt	$17,604,290,562 93
Net debt, after adjustments for matured interest obligations, balance held by Treasurer of the United States, etc.	$17,467,605,507 06

Taxation—There were three notable features in the history of Federal taxation in the period 1910–28 The first was the adoption of an income tax with progressive rates and its rapid growth to a position of pre-eminence in the revenue system. The second was the unprecedented expansion of taxation during the War, which made it possible to pay nearly one-third of the War costs, including loans to the Allies, from current revenues The third feature was the post-War reduction in taxation, made possible by an aggressive campaign for economy in public expenditures and by the adoption of an executive budget.

Until 1913 practically all the Federal revenue had been de-

rived from customs and internal excise duties on alcoholic beverages and tobacco In 1910, customs duties were furnishing 50% of the total ordinary receipts of the Federal Govt., while 40% came from internal taxes on tobacco and alcoholic beverages. The ratification of the 16th Amendment in 1913 permitted the Federal Govt. to "lay and collect taxes on incomes from whatever source derived," a privilege that was immediately made use of by a provision in the Tariff Act of Oct. 3, 1913 With the War came an expansion in all taxes, but the new income and excess profits taxes supplied the major portion of the increased revenues By 1928, after three reductions had taken place in the maximum rates, income and profits taxes yielded more than all of the other sources of ordinary revenue combined, while customs duties provided only about one-seventh, and tobacco taxes about one-tenth of the total ordinary receipts. The following table shows the growth in importance of the income tax from 1910 to 1928

Relative Importance of Principal Federal Taxes 1910–28

Fiscal year ending June 30	Income and profits*	Customs*	Tobacco†	Spirits and liquors†	Total ordinary receipts
(In millions of dollars)					
1910	21‡	334	58	209	676
1915	80	210	80	224	678
1920	3,057	324	296	140	6,704
1925	1,762	549	345	26	3,608
1928	2,175	568	306	15	3,864
(In percentages of ordinary receipts)					
1910	3·1	49·4	8·6	30·9	
1915	11·5	30·1	11·5	32·1	
1920	59·0	4·8	4·4	2·1	
1925	48·8	15·2	9·6	0·7	
1928	56·3	14·7	10·2	0·4	

*On warrant basis
†On basis of reports of collections Includes special taxes relating to manufacture and sale
‡From a 1% "excise tax" on corporation incomes Adopted 1909.
Source: Annual Report of the Secretary of the Treasury, 1928.

Under the stimulation of War necessity, not only were former taxes increased to maximum rates, but a multitude of new and temporary taxes came into being In each successive Revenue Act from 1914 to 1918, both of these tendencies were illustrated The climax came in the Revenue Act of 1918, approved Feb 24, 1919, which constituted the high water mark for tax levies in American history Under this law, rates on individual incomes for 1918 began with 6% on the smallest incomes and rose to 77% (65% surtax) on net incomes of over $1,000,000 For years subsequent to 1918, a small reduction in the normal tax was provided, which reduced the rate applicable to the highest incomes to 73%. Corporations were taxed 12% on their net incomes, 1% on their capital stock, and, under a combined War-profits and excess-profits tax, an additional amount up to 80% of the profits in excess of certain credits for the taxable year 1918, and 10% on their net incomes, 1% on their capital stock, and, under an excess-profits tax, an additional amount up to 40% of the profits in excess of certain credits (including 8% of invested capital) for the taxable years 1919, 1920 and 1921. Estates of decedents were made taxable at rates reaching a maximum of 25%. Excise and occupation taxes were increased from the already high rates of 1917, and many new levies were made on transactions and articles of consumption

The new Republican administration upon coming into office in 1921 began an aggressive campaign to decrease expenditures and effect a cut in the high taxes. The success of this economy programme was greatly enhanced by the establishment in 1921 of an executive budget system, which permitted, for the first time, the formulation of a comprehensive fiscal programme by the administration. In spite of the increased cost of government and continued war liabilities for the public debt, disabled veterans and unliquidated War-time agencies, it was found possible to reduce taxes to some extent immediately. Accordingly, the Revenue Act of 1921 repealed the excess-profits tax on corporations (although the corporation income tax was increased as a partial offset), and the maximum rate on individual incomes was reduced from 73% (65% surtax) to 58% (50% surtax). Several of the more unpopular excise taxes were also repealed, such as duties on transportation, toilet and medicinal preparations and clothing

By 1924 the reduction in expenditures had made considerable progress, resulting in a surplus of about $500,000,000 in ordinary receipts over expenditures chargeable against ordinary receipts Congress found it possible, therefore, to make more extensive tax reductions in the Revenue Act of 1924 The maximum rate on individual incomes was reduced from 58% to 46% (40% surtax), while the smallest taxable incomes paid only 2% Numerous excise duties, including taxes on telegraph and telephone messages, manufacturers' sales, drafts and checks, and admissions, were repealed in whole or in part

Two further tax revisions in 1926 and in 1928 were undertaken in an attempt to devise a more scientific system It was felt that some of the taxes, especially the excessive surtaxes on individual incomes and the corporation taxes, had a depressing effect on industry, and, furthermore, were fiscally unnecessary Accordingly, in 1926, the maximum rate on individual incomes was fixed at 25% (20% surtax), while corresponding reductions were made in the lower brackets The corporation capital stock tax was repealed in 1926 and the rate on corporation incomes was fixed at 12% in 1928 (after having been increased to 13½% in 1926) Several taxes including the gift tax and the automobile taxes were repealed and reductions made in many other taxes

Tariff—Two thorough revisions of the tariff have taken place since 1910 In 1913, the new Democratic administration supplanted the "cost of production" duties of the 1909 law with schedules designed to secure "effective competition" between American and foreign producers There was a reduction in rates on many manufactured products, notably textiles, and the free list was extended to include some important raw materials and foodstuffs, as well as a few manufactures A Tariff Commission was created to make researches into comparative costs of production, upon which future tariff rates could be based

With the return of the Republican party to power in 1921, an emergency Act was immediately provided to be effective until a comprehensive tariff revision could be undertaken There was a general increase in rates, and duties were imposed on many articles which had been on the free list The new Tariff Act of 1922, as finally framed, reinforced and extended this upward revision of rates A "flexible" provision was included which gave the President power to increase or decrease rates by not more than 50% of the statutory amount, as occasion demanded, but this privilege has been rarely used

Loans to Foreign Governments—The total principal amount of obligations of foreign governments originally held by the Treasury was $10,338,058,352 20 Such obligations were acquired by the United States (1) under the authority of the Liberty bond acts which authorised the Secretary of the Treasury, with the approval of the President, to establish credits in favour of foreign governments engaged in war with enemies of the United States against which cash advances were made for the general purpose of enabling those governments to meet commitments made in the United States in connection with the prosecution of the War; (2) under the authority of the Act of July 9, 1918, which authorized the President, through the head of any executive department, to sell any surplus war supplies on such terms as the head of such department deemed expedient, (3) under the authority of the Act of Feb 25, 1919, appropriating $100 000,000 as a revolving fund for the participation by the United States, in the discretion of the President, in the furnishing of foodstuffs and other urgent supplies to certain populations in Europe and countries contiguous thereto; and (4) under the authority of the Act of March 30, 1920, which authorized the U.S Grain Corporation, with the approval of the Secretary of the Treasury, to sell or dispose of the flour in its possession, not to exceed 5,000,000 bbl at such prices and on such terms or conditions as might be necessary to relieve populations in the countries of Europe or countries contiguous thereto, suffering for the want of food.

Principal Amounts of Obligations of Other Countries to the United States and Payments Received Thereon, to June 30, 1928

Country	Total principal amount of obligations received under Liberty Bond Acts	Total principal amount of obligations received for surplus supplies sold on credit under Act of July 9, 1918	Total principal amount of obligations received for relief supplies furnished on credit under Acts of Feb. 25, 1919, and March 30, 1920	Payments on account of principal of obligations so received	Total net principal amount of obligations held by Treasury prior to funding or on June 30, 1928
Armenia			$ 11,959,917.49		$ 11,959,917.49
Austria	.		24,055,708 92	.	24,055,708.92*
Belgium	$ 349,214,467 89	$ 29,872,732 54		$ 2,057,630.37	377,029,570.06
Cuba	10,000,000.00	..	.	10,000,000.00	
Czechoslovakia	61,974,041 10	20,604,302.49	9,301,327.44	..	91,879,671.03
Estonia	.	12,213,377.88	1,785,767.72	..	13,999,145 60†
Finland			8,281,926.17	..	8,281,926.17
France	2,997,477,800 00	407,341,145 01		85,969,895.91‡	3,318,849,049 10
Great Britain	4,277,000,000 00			202,181,641 56	4,074,818,358 44
Greece	15,000,000.00				15,000,000 00
Hungary			1,685,835 61		1,685,835.61
Italy	1,648,034,050.90			164,852 0	1,647,869,197 96
Latvia		2,521,869.32	2,610,417 82		5,132,287.14
Liberia	26,000.00			26,000 00	
Lithuania		4,159,491.96	822,136 07		4,981,628 03
Nicaragua	.	431,849.14		141,221 15	290,627.99
Poland	.	83,682,708.66	75,984,263.73		159,666,972.39
Rumania	25,000,000 00	12,922,675.42		1,794,180 48	36,128,494.94
Russia	187,729,750 00	406,082.30	4,465,465 07		192,601,297 37
Yugoslavia	26,780,465 56	24,978,020.99		720,600 16	51,037,886 39
Total	$9,598,236,575.45	$599,134,255.71	$140,952,766.04	$303,056,022 57	$10,035,267,574 63

*Time of payment of principal and interest extended to June 1, 1943, by authority of joint resolution of Congress approved Aug. 6, 1922.
†Credit of $1,932,923 45 allowed by funding agreement on account of loss of cargo on ship sunk by mines
‡Upon ratification of the funding agreement, $21,280,307 73 of this sum will be applied towards payment of the first annuities due thereunder

Debt-funding agreements executed pursuant to the authority of the Act of Feb 9, 1922, as amended, providing for the funding of $9,811,094,094 03, principal amount of obligations of foreign governments held by the Treasury, have been concluded with the Govts of Belgium, Czechoslovakia, Estonia, Finland, France, Great Britain, Hungary, Italy, Latvia, Lithuania, Poland, Rumania and Yugoslavia Below is a statement showing by countries the principal amount of obligations funded and the amount of accrued interest thereon included in the principal of the debt as funded --

Country	Date of agreement	Principal of obligations funded	Accrued interest funded	Funded bonds received or to be received
Belgium	Aug. 18, 1925	$ 377,029,570 06	$ 40,750,420 94	$ 417,780,000 00
Czechoslovakia	Oct. 13, 1925	91,879,671 03	23,120,328 97	115,000,000 00
Estonia	Oct 28, 1925	12,066,222.15*	1,763,777 85	13,830,000 00
Finland	May 1, 1923	8,281,926 17	718,073.83	9,000,000 00
France	April 29, 1926	3,340,516,043 72	684,483,956 28	4,025,000,000 00†
Great Britain	June 19, 1923	4,074,818,358 44	525,181,641 56	4,600,000,000 00
Hungary	April 25, 1924	1,685,835 61	253,164 39	1,939,000.00
Italy	Nov. 14, 1925	1,647,869,197 96	394,130,802 04	2,042,000,000 00
Latvia	Sept. 24, 1925	5,132,287 14	642,712 86	5,775,000 00
Lithuania	Sept. 22, 1924	4,981,628 03	1,048,371 97	6,030,000.00
Poland	Nov. 14, 1924	150,666,972.39	18,893,027.61	178,560,000 00
Rumania	Dec. 4, 1925	36,128,494 94	8,461,505 06	44,590,000 00
Yugoslavia	May 3, 1926	51,037,886 39	11,812,113 61	62,850,000.00
Total		$9,811,094,094 03	$1,711,259,905.97	$11,522,354,000 00

*Credit of $1,932,923 45 allowed for loss of cargo on ship sunk by mine deducted. †Agreement with France not yet (June, 1929) ratified by the United States or France.

The tables above show by countries the total principal amount of such obligations received by the United States and payments on account of principal thereof.

The Budget.—The Budget and Accounting Act of June 10, 1921, directed the President to submit annually to Congress a budget prepared by a Bureau of the Budget in the Treasury Department, whose duties were to be performed directly under the President. By this means it is possible for the President to exercise an effective control over the estimates of appropriations submitted by the executive departments and officers. The first budget was submitted in 1921, for the fiscal year ending June 30, 1923. By that same law, the General Accounting Office was established under the Comptroller-General of the United States and independent of the executive departments

The Federal Reserve Banks as Fiscal Agents.—The organisation of the Federal Reserve System has made a fundamental change with respect to the conduct of the fiscal business of the Government. The Secretary of the Treasury may require the Federal Reserve banks to act as fiscal agents of the United States and as depositaries of public moneys. They have been utilised in both capacities, and since the discontinuance of the independent Treasury system on July 1, 1921 they have been the principal agents for the administration of receipts and expenditures, the depositary system, the public debt and paper currency changes

Other Agencies.—During the War period and subsequently the operations of many governmental agencies created by Congress had more or less connection with and influence on national finance. Mention may be made of the Federal control of railways and the post-War assistance given the carriers under the Transportation Act of Feb. 28, 1920 and of the several War emergency corporations, the capital stocks of which were subscribed for by the Treasury and served as revolving funds, such as the Emergency Fleet Corp., the U.S. Housing Corp., the U.S. Sugar Equalisation Board, the U.S. Spruce Products Corp., the War Finance Corp., and the U.S. Grain Corporation. The United States subscribed to the capital stock of the Federal Land Banks, now repaid for the most part, furnished the capital for the Intermediate Credit Banks, and purchased Federal farm loan bonds when their public sale at par was impossible at statutory coupon rates. In 1910 a Postal Savings System was established that has received deposits aggregating $1,586,498,397, while withdrawals have amounted to $1,434,355,048. Deposits bear interest at 2%.

TABLE I. *Receipts and Expenditures of the United States Government by Fiscal Years from 1911 to 1928*
(On basis of warrants issued)

Fiscal year	Ordinary receipts: Customs	Internal revenue: Income and profits tax	Internal revenue: Miscellaneous	Sales of public lands	Surplus postal receipts covered into the Treasury	Miscellaneous receipts	Total ordinary receipts	Postal revenues[1] exclusive of surplus postal receipts covered into the Treasury	Total ordinary receipts and postal revenues	Surplus (+) or deficit (−) ordinary receipts covered into the Treasury compared with expenditures chargeable against ordinary receipts(2)
1911	$314,497,071	$33,516,977	$289,012,224	$5,731,637		$59,075,002	$701,832,911	$237,870,824	$939,712,735	+$10,631,399
1912	311,321,672	28,583,304	293,028,896	5,392,797		54,282,535	692,609,204	246,744,016	939,353,220	+2,727,870
1913	318,891,396	35,006,300	309,410,666	2,910,205		57,892,663	724,111,230	266,619,526	990,730,756	−400,733
1914	292,320,014	71,381,275	308,659,733	2,571,775	$3,800,000	55,940,370	734,673,167	284,134,566	1,018,807,733	−408,264
1915	200,786,672	80,201,759	335,467,887	2,167,136	3,500,000	66,787,373	697,910,827	283,748,165	981,658,992	−62,675,975
1916	213,185,846	124,937,253	387,764,776	1,887,662		54,759,011	782,534,548	312,057,689	1,094,592,237	+40,537,821
1917	225,962,393	359,681,228	449,684,080	1,892,893	5,200,000	81,903,301	1,124,324,795	324,526,116	1,448,850,911	−961,717,309
1918	182,758,989	2,838,999,894	857,043,591	1,969,455	48,630,701	[8]251,022,526	4,180,425,156	340,345,261	4,520,770,417	−9,611,482,739
1919	183,428,625	2,600,762,735	1,239,468,260	1,404,705	89,906,000	[8]539,410,574	4,654,380,809	346,333,126	5,000,714,025	−14,297,760,281
1920	323,536,559	3,956,936,004	1,442,213,241	1,910,140	5,213,000	[8]974,695,493	6,704,414,437	431,937,212	7,136,351,649	+562,669,197
1921	308,025,102	3,228,137,674	1,351,835,935	1,530,439		694,087,895	5,584,517,045	463,491,275	6,048,008,320	+693,241,726
1922	357,544,713	2,086,918,465	1,121,239,843	895,391	81,494	536,916,625	4,103,596,531	484,772,047	4,588,368,578	+485,558,734
1923	562,189,039	1,691,089,535	935,699,504	656,508		657,411,097	3,847,945,683	532,827,925	4,379,873,608	+199,370,900
1924	545,012,115	1,841,759,317	952,530,768	522,223		544,216,719	3,884,041,142	572,948,778	4,456,989,920	+479,746,015
1925	548,521,795	1,761,659,049	827,786,838	623,534		469,052,948	3,607,644,164	599,591,478	4,207,235,642	+676,936,988
1926	579,716,611	1,974,104,141	862,667,640	754,253		491,214,930	3,908,457,575	659,819,801	4,568,277,376	+390,694,362
1927	605,672,465	2,219,952,444	648,732,440	621,187		548,743,140	4,023,721,676	683,121,989	4,706,843,665	+607,022,408
1928	568,156,593	2,174,573,103	617,620,008	384,651		[10]503,194,266	[10]3,863,928,621	693,633,921	4,557,562,542	+426,539,706

Fiscal year	Expenditures chargeable against ordinary receipts: Civil and miscellaneous[3]	War Department (including rivers and harbors and Panama Canal)[4]	Navy Department[4]	Indians ($)	Pensions[5] ($)	Postal deficiencies[6]	Interest on the public debt	Total ordinary expenditures	Public debt retirements chargeable against ordinary receipts[7]	Total expenditures chargeable against ordinary receipts	Postal expenditures[1] exclusive of postal deficiencies ($)	Total ordinary and postal expenditures
1911	$173,838,599	$197,199,491	$119,937,644	20,933,869	157,980,575		$21,311,334	$691,201,512		$691,201,512	237,660,705	$928,862,217
1912	172,256,794	184,122,793	135,591,956	20,134,840	153,590,456	$1,568,105	22,616,300	689,881,334		689,881,334	246,961,344	936,842,678
1913	169,802,304	202,128,711	133,262,862	20,306,159	175,085,450	1,027,369	22,899,108	724,511,963		724,511,963	261,081,506	985,593,469
1914	170,530,235	208,349,746	139,682,186	20,215,076	173,440,231		22,863,957	735,081,431		735,081,431	283,558,103	1,018,639,534
1915	200,533,231	202,160,134	141,835,654	22,130,351	164,387,942	6,636,593	22,902,897	760,586,802		760,586,802	291,944,881	1,052,531,683
1916	199,555,048	182,139,305	155,029,426	17,570,284	159,302,351	5,500,000	22,900,313	741,996,727		741,996,727	300,728,453	1,042,725,180
1917	1,153,677,360	459,539,078	257,166,437	30,598,093	160,318,406		24,742,129	2,086,042,104		2,086,042,104	319,889,904	2,405,932,008
1918	6,306,354,095	5,705,136,249	1,368,642,794	30,888,400	181,137,754	2,221,095	197,526,608	13,791,907,895		13,791,907,895	322,628,093	14,114,535,988
1919	6,805,124,736	9,265,325,159	2,009,272,389	34,593,257	221,614,781	343,511	615,867,337	18,952,141,180		18,952,141,180	362,160,763	19,314,301,943
1920	[9]3,097,287,728	1,100,865,666	629,893,116	40,516,832	213,344,204	35,813,254	1,024,024,440	6,141,745,240		6,141,745,240	418,607,441	6,560,352,681
1921	[9]1,800,786,432	580,704,891	647,870,645	41,470,808	260,611,416	131,502,473	996,676,804	4,468,713,469	$422,561,850	4,891,275,319	489,506,490	5,380,781,809
1922	[9]989,915,977	402,058,450	458,704,813	38,500,413	252,576,848	64,352,936	989,485,410	3,195,684,847	422,352,950	3,618,037,797	481,316,005	4,099,353,802
1923	1,169,555,294	355,722,856	372,532,000	45,142,763	264,147,869	32,526,915	1,055,088,486	3,244,717,092	402,957,691	3,647,674,783	524,366,214	4,172,040,997
1924	1,047,269,579	348,606,247	324,129,998	46,754,026	228,261,555	12,638,850	938,740,772	2,946,401,027	457,894,100	3,404,295,127	574,773,905	3,979,069,032
1925	617,537,560	357,957,420	320,365,467	38,755,457	218,321,424	23,216,784	882,014,950	2,464,169,062	466,538,114	2,930,707,176	616,119,721	3,546,826,897
1926	1,233,838,954	358,329,076	311,611,694	48,442,120	207,189,622	39,506,400	831,469,206	3,030,387,162	487,376,051	3,517,763,213	640,285,691	4,158,048,904
1927	1,130,122,874	361,987,157	322,620,723	36,701,649	230,556,065	27,263,191	787,793,761	2,897,135,423	519,563,845	3,416,699,268	687,364,998	4,104,064,266
1928	[10]1,128,826,151	400,345,210	337,608,080	36,990,808	229,401,461	32,080,202	731,850,074	[10]2,897,102,001	540,246,020	3,437,348,021	693,674,815	4,131,022,836

Fiscal year	Public debt expenditures chargeable against public debt receipts and surplus revenue: Public debt retirements, exclusive of retirements chargeable against ordinary receipts	Redemption of national bank and Federal reserve bank notes	Total public debt retirements chargeable against public debt receipts and surplus revenue	Public debt receipts: Public debt receipts, proceeds of bonds, and other securities	Deposits to retire national bank and Federal reserve bank notes	Total public debt receipts	Surplus (+) or deficit (−) public debt receipts compared with public debt expenditures (exclusive of public debt expenditures chargeable against ordinary receipts)	Recapitulation of all receipts and expenditures: Total of all receipts	Total of all expenditures	Surplus (+) or deficit (−) of all receipts as compared with all expenditures
1911	$236,306	$31,976,840	$35,223,336	$17,641,634	$4,232,555	$57,873,189	+$22,650,853	$997,586,924	$964,085,553	+$33,501,371
1912	120,616	28,527,712	28,648,328	32,817,646	20,078,365	52,896,011	+24,247,683	992,240,231	965,491,006	+26,758,225
1913	102,575	24,089,036	24,191,611	1,929,840	21,471,010	23,400,850	−790,761	1,014,131,606	1,009,785,080	+4,346,526
1914	109,127	26,852,200	26,961,327	3,118,940	19,902,283	23,021,223	−3,940,104	1,041,828,956	1,045,600,861	−3,771,905
1915	47,533	17,205,958	17,253,491	933,540	21,553,415	22,486,955	+5,233,464	1,004,145,947	1,069,785,174	−65,639,227
1916	35,903	24,633,011	24,668,914	1,803,500	56,648,903	58,452,403	+33,783,489	1,153,044,640	1,067,393,094	+85,650,546
1917	636,980,667	40,564,116	677,544,783	2,390,724,755	37,293,045	2,428,017,800	+1,750,473,017	3,876,868,711	3,083,476,791	+793,391,920
1918	7,685,267,850	21,611,225	7,706,879,075	16,964,609,560	10,279,650	16,974,880,210	+9,268,010,135	21,495,659,627	21,821,415,063	−325,755,436
1919	15,813,848,117	23,717,803	15,837,566,010	29,053,331,758	22,644,758	29,075,976,516	+13,238,410,506	34,076,690,541	35,151,867,953	−1,075,177,412
1920	17,013,020,107	23,424,165	17,036,444,272	15,835,273,962	17,071,988	15,852,345,950	−1,184,098,322	22,988,697,590	23,596,796,953	−608,099,354
1921	8,721,751,533	37,460,631	8,759,212,164	8,824,738,839	40,186,945	8,864,925,784	+105,713,620	14,912,034,104	14,139,093,973	+772,940,131
1922	6,500,584,643	107,251,870	6,607,836,513	5,910,931,276	107,086,627	6,018,017,903	−589,818,610	10,606,386,481	10,707,190,315	−100,803,834
1923	7,486,747,506	74,414,564	7,561,162,070	7,259,180,899	90,547,571	7,349,728,470	−211,433,600	11,729,602,078	11,733,203,067	−3,600,989
1924	2,814,718,038	33,084,377	2,847,802,415	2,178,675,627	28,453,557	2,207,129,184	−640,673,231	6,664,119,104	6,826,871,447	−162,752,343
1925	3,351,708,909	68,974,392	3,420,773,301	3,047,015,791	105,447,372	3,152,463,163	−268,310,138	7,359,698,805	6,967,600,198	+392,098,607
1926	3,339,670,284	54,400,183	3,394,070,467	2,986,133,047	22,223,475	3,008,357,422	−385,713,045	7,576,634,798	7,552,119,371	+24,515,427
1927	5,770,467,337	28,060,775	5,798,528,112	5,157,255,005	27,828,138	5,185,083,143	−613,444,969	9,891,926,808	9,902,592,378	−10,665,570
1928	7,193,291,479	27,686,920	7,220,978,399	6,830,219,119	25,121,597	6,855,340,716	−365,637,683	11,412,903,258	11,352,001,235	+60,902,023

1. Postal revenues and expenditures, except surplus postal receipts covered into the Treasury and postal deficiencies paid out of the general fund of the Treasury, are based upon reports of the Post Office Department. Postal expenditures include adjusted losses, etc —postal funds—and expenditures from postal balances but are exclusive of departmental expenditures in Washington, D C , to the close of fiscal year 1922, and amounts transferred to the civil service retirement and disability fund, fiscal years 1921 to 1926, inclusive For the years 1927 and 1928 the 3½ per cent salary deductions are included in "Postal expenditures," the said deductions having been paid to and deposited by the disbursing clerk of the Pension Bureau for credit of the retirement fund.

2. Beginning with 1921, the surplus or deficit takes into account public-debt expenditures chargeable against ordinary receipts.

3 Includes civil expenditures under War and Navy Departments in Washington, to and including fiscal year 1920, and unavailable funds charged off under act of June 3, 1922. (42 Stat. 1502.)

4. Exclusive of civil expenditures under War Department and Navy Department in Washington to and including fiscal year 1920

5. Includes only Army and Navy pensions for service prior to World War, and fees of examining surgeons in Pension Bureau, and is exclusive of payments made by the War Risk Insurance Bureau and Veterans' Bureau to veterans of the World War, and salaries under Bureau of Pensions, which are included in civil and miscellaneous expenditures

6 Exclusive of amounts transferred to the civil service retirement and disability fund (Interior Department) under act of May 22, 1920 (41 Stat. 614), on account of salary deductions of 2½ per cent, as follows: 1921, $6,519,683 50, 1922, $7,899,006 28, 1923, $8,284,081; 1924, $8,679,658.60; 1925, $10,266,977.47, and 1926, $10,472,-289.59 *See* Note 1

7 At par

8. Exclusive of estimated increased postage under act of Oct. 3, 1917 (40 Stat 327), which is included in "Surplus postal receipts," as follows 1918, $39,073,000, 1919, $71,906,000; 1920, $4,013,000

9 Exclusive of additional compensation, Postal Service, under joint resolution of Nov. 8, 1919 (41 Stat. 350), which is included in "Postal deficiencies," as follows, 1920, $35,698,400, 1921, $1,374,014 56, 1922, $22,397 37.

10 Exclusive of $11,268,183 62 transferred on July 1, 1927, from the checking account of the U S Shipping Board on the books of the Treasurer of the United States to the warrant account on the books of the Secretary of the Treasury, and covered into the Treasury by miscellaneous receipt covering warrant under the title, "Funds deposited for construction loan under section 11, merchant marine act, 1920, special fund" This transfer of funds checking account to warrant account is merely an adjustment between accounts in this fiscal year of cash transactions occurring in prior fiscal years Accordingly, the item has not been included in either the receipts or expenditures of this report, inasmuch as it did not affect the cash in the Treasury during the current fiscal year

Adherence to the gold standard has been one of the important factors contributing to the stability of the American financial structure During the War actual payments in gold, though discouraged, were never suspended, and in 1922 the unrestricted payment of gold in the ordinary course of business was reinaugurated.

Table I sets forth the receipts and expenditures of the U S Govt on a warrant basis during the period July 1, 1910 to June 30, 1928 by fiscal years, classified as to ordinary receipts and expenditures, postal revenues and expenditures, and public debt receipts and expenditures. The surplus or deficit of ordinary receipts and of total receipts is also shown for each year. Table II. summarizes the history of the public debt since 1917 Table III. is a statement of ordinary receipts, and expenditures against such receipts, together with the surplus or deficit, stated on a current cash basis, by fiscal years from 1917 to 1926.

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TABLL II *Transactions in the Public Debt of the United States Government from July 1, 1916, to June 30, 1928*

(In thousands of dollars—000's omitted)

Detail	Fiscal year ended June 30, 1917	Fiscal year ended June 30, 1918	Fiscal year ended June 30, 1919	Fiscal year ended June 30, 1920	Fiscal year ended June 30, 1921	Fiscal year ended June 30, 1922	Fiscal year ended June 30, 1923	Fiscal year ended June 30, 1924	Fiscal year ended June 30, 1925	Fiscal year ended June 30, 1926	Fiscal year ended June 30, 1927	Fiscal year ended June 30, 1928
Total gross debt outstanding (from previous year)	$1,225,146	$2,075,619	$12,243,629	$25,482,034	$24,297,918	$23,976,250	$22,964,079	$22,349,688	$21,251,120	$20,516,272	$19,643,183	$18,510,174
Public debt issues												
Pre-War issues	52,151	20,171	289	189	179	112	30	33	102	544	690	1,583
Certificates of indebtedness	918,205	9,017,648	16,955,328	14,728,726	8,486,965	3,905,090	4,292,259	2,014,802	1,926,578	2,355,515	3,145,735	5,419,284
First Liberty Loan	1,466,335	523,112	8									
Second Liberty Loan		3,807,864	1	1								
Third Liberty Loan		3,213,045	932,104	501								
Fourth Liberty Loan			6,959,504	5,071	5							
Victory Liberty Loan			3,467,845	1,027,527	2	1*						
Treasury notes					311,192	1,035,404	2,000,938	210	50,000	123,500	1,529,456	1,365,247
Treasury bonds							763,962		1,047,089	494,898	467,802	27,053
Treasury (War) savings securities		352,769	738,248	73,241	26,418	70,326	201,091	163,540	23,217	11,677	13,572	17,052
National bank notes, retirements	37,293	10,280	22,645	17,072	40,187	107,087	90,548	28,453	105,447	22,223	27,828	25,122
Total issues	$2,473,984	$16,974,889	$29,075,972	$15,852,328	$8,864,048	$6,018,018	$7,349,728	$2,207,129	$3,152,463	$3,008,357	$5,185,083	$6,855,341
Public debt redemptions												
Pre-War issues	50,373	27,381	82,245	441	152	57	245	43	117,075	640	213	88
Certificates of indebtedness	632,572	7,578,272	15,046,533	15,588,704	8,552,217	4,775,874	5,096,403	2,238,167	2,157,551	2,440,742	2,027,251	4,867,363
First Liberty Loan		656	4,003	32,338	200	415	80	240	5	12,307	54	4
Second Liberty Loan		61,050	180,357	241,150	8,770	5,039	111,560	93,450	28	31	1,798,148	1,273,632
Third Liberty Loan		13,935	201,660	296,338	51,156	137,772	66,001	410,587	111,823	397,105	340,608	918,816
Fourth Liberty Loan			165,000	405,222	39,499	9,477	16,818	4,070	14	9	27,560	2,863
Victory Liberty Loan				249,007	332,587	1,997,086	1,911,442	80,640	6,912	2,307	1,282	960
Treasury notes							143,340	356,073	1,373,392	930,485	1,119,512	490,215
Treasury bonds							8	6		1	10,000	150
Treasury (War) savings securities		2,072	134,048	190,819	159,732	85,416	543,808	87,433	50,861	33,850	64,162	178,827
Miscellaneous	40,566	21,013	23,720	23,425	42,303	107,253	74,415	33,086	69,617	54,969	29,293	28,306
Total redemption	$723,511	$7,706,879	$15,837,566	$17,036,444	$9,186 616	$7,030,189	$7,964,120	$3,305,697	$3,887,311	$3,881,446	$6,318,092	$7,761,224
Gross debt outstanding												
Interest-bearing debt	2,712,550	11,985,882	25,234,496	24,061,095	23,737,352	22,711,035	22,007,591	20,981,586	20,210,906	19,383,771	18,250,944	17,317,695
Matured debt on which interest has ceased	14,232	20,243	11,110	6,748	10,940	25,251	98,172	30,241	30,243	13,328	14,707	45,332
Debt bearing no interest (less gold reserve)	248,837	287,504	236,429	230,075	227,959	227,793	243,925	239,293	275,123	246,084	241,523	241,264
Total gross debt	2,975,610	12,243,629	25,482,035	24,297,918	23,976,251	22,964,079	22,349,688	21,251,120	20,516,272	19,643,183	18,510,174	17,604,291
Deduct.												
Net balance (adjusted) held by Treasurer U.S	1,066,984	1,310,348	1,002,733	32,971†	162,703	32,337†	193,801	73,075	77,038	70,478	87,886	136,685
Net debt	$1,908,635	$10,024,281	$24,470,302	$24,330,889	$23,813,547	$22,996,416	$22,155,887	$21,178,045	$20,439,234	$19,572,705	$18,422,288	$17,467,606
Net debt increased	902,354	9,015,646	13,555,021									
Net debt decreased				148,413	517,342	817,131	840,530	977,841	738,811	866,530	1,150,416	954,683

*Adjustment—deduct. †Adjustment—add.

TABLE III. *Ordinary Receipts, and Expenditures Chargeable Against Such Receipts, Together with the Surplus or Deficit, on a Current Cash Basis, by Fiscal Years from 1917 to 1928* (In thousands of dollars—000's omitted)

Fiscal year	Total ordinary receipts	Expenditures chargeable against ordinary receipts			+ Surplus or − deficit	Fiscal year	Total ordinary receipts	Expenditures chargeable against ordinary receipts			+ Surplus or − deficit
		Ordinary	Public debt	Total				Ordinary	Public debt	Total	
1917	$1,124,325	$ 1,977,682	$	$ 1,977,682	−$ 853,357	1923	$4,007,135	$3,294,628	$402,850	$3,697,478	$+309,657
1918	3,664,583	12,696,702	1,134	12,697,837	−9,033,253	1924	4,012,045	3,048,678	458,000	3,506,678	+505,367
1919	5,152,257	18,514,880	8,015	18,522,895	−13,370,638	1925	3,780,149	3,063,105	466,538	3,529,643	+250,505
1920	6,694,565	6,403,344	78,746	6,482,090	+212,475	1926	3,962,756	3,097,612	487,376	3,584,988	+377,768
1921	5,624,933	5,115,928	422,282	5,538,209	+86,724	1927	4,129,394	2,974,030	519,555	3,493,585	+635,810
1922	4,109,104	3,372,608	422,695	3,795,302	+313,802	1928	4,042,348	3,103,265	540,255	3,643,520	+398,828

States transmitting the Budget (annual, 1924–27); The Bureau of the Census, *Wealth, Debt and Taxation*, 1913, 1922, *Financial Statistics of States* (annual); *Financial Statistics of Cities Having a Population of over 30,000* (annual), The National Tax Association, *Proceedings* (annual); D R Dewey, *Financial History of the United States* (10 ed, 1928); A. S Bolles, *Financial History of the United States* (2 ed, 1884–86); A D Noyes, *Forty Years of American Finance* (1909), covers period 1865–1907, C J Bullock, *Finances of the United States, 1775–1789* (1895); A. B. Hepburn, *History of Coinage and Currency in the United States* (1903), F W Taussig, *The Tariff History of the United States* (7 ed, 1923), E R A Seligman, "The Federal Income Tax," *Political Science Quarterly, XXIX* (1914), and "The Cost of the War and How It Was Met," *American Economic Review, IX.* (1919). (A. W. ME)

VII. INDUSTRY AND COMMERCE

MANUFACTURES

During the colonial period there was very little manufacturing in the American Colonies, for the population was occupied largely in the raising of foods and other agricultural products Then, also, there was the competition of the English manufacturers, with their relatively cheap labour, larger capital, and more skill, fostered by the British Government, who regarded the American Colonies first as sources of raw materials, and secondly as markets for their manufactured goods What manufacturing was carried on, was devoted mostly to such products as crude textiles, shipbuilding, naval stores, candles and brick

There was a period of transition from colonial to national economy beginning about 1790 and continuing down to about 1820 or 1825 Manufacturing during this time, while hampered occasionally, made progress.

It represented, however, such a small portion of the endeavours of the population that no attempt was made at the first decennial census of 1790 or that of 1800 to collect statistics regarding it. Congress did provide for such enumerations beginning in 1810 but the results of the 1810 census were so unsatisfactory they were not published, nor were the results of the 1820 census of much value. Practically all manufacturing was done either in local shops or in the home.

Unification.—Beginning about 1820 and continuing down to 1860 might be termed a period of unification Wealth increased, markets widened, inventions of apparatus greatly increased, the manufacturing processes gradually became more complex, and more capital eventually found its way to manufacturing industries, which made for the production of a larger variety of goods The cotton gin patented in 1794, the introduction of the use of power in 1832 and the invention of the ring spinner a little later were destined to transform the textile industry from one of the home to one of the factory. The substitution in 1840 of anthracite coal for charcoal in the smelting of pig iron revolutionized the iron trade and made it possible for American iron manufacturers to compete successfully with the English who had begun the use of bituminous coal for this purpose a few years before. The invention in 1846 of the sewing machine revolutionized the shoe industry and also gave great impetus to the manufacture of ready-made clothing. Other factors which aided in the development during the period of 1825–60 were the growth of population, the extension of railways, the development of natural resources and the taking up of western lands. The north and east were the principal manufacturing sections, while the south and west were largely agricultural.

Rise of Modern Era.—From 1860–99 was a period of industrial revolution. The opening of the west, the increasing means of transportation, growth of inventions, and imposition of heavy tariffs on all imported manufactured goods had an immediate effect upon production. According to an official report in 1869 more cotton spindles were put into operation, more iron furnaces erected, more iron smelted, more steel made, more lumber sawed and more manufactories of different kinds started in 1864–68 than in any previous equal period in the history of the country. Between 1870 and 1899 the production of manufactured goods continued to expand The manufacture of iron and steel, railway equipment, agricultural implements and other machinery, boots and shoes, textiles, paper and printing, and food products grew rapidly Much of the expansion in the production of manufactured goods was due to the continued increase in national income, the growth in population, the consequent widening of home markets, and the continued development of natural resources.

Not only did the volume and value of manufactured products grow rapidly during the period of 1860 to 1899 but at the same time there took place an increase in the size of manufacturing establishments This was particularly pronounced in the manufacture of iron and steel and their products, of cottons and of leather goods, and only less so in all industries except those essentially of a local nature During this period the system of interchangeable machine parts was introduced into manufacturing industries Toward the close of the nineteenth century there was some tendency toward standardization, but there was no great progress at that time The use of mechanical power was increasing rapidly, and though still small compared with the present, its progress between 1870 and 1899 made the United States the leading manufacturing nation of the world.

Before the World War.—Inventions, the growth of population, the development of natural resources and the increasing wealth of the latter part of the nineteenth century set the stage for rapid industrial progress between 1899 and 1914. Value added to cost of raw materials by process of manufacture which in 1899 amounted to $4,800,000,000 had more than doubled by 1914, amounting to $9,900,000,000. In this great growth the production of automobiles began to play an important part The further perfection of motor vehicles was destined to transform many industries, and to affect greatly the whole system of distribution and, indeed of the social fabric of the nation It had a direct beneficial effect on the iron and steel and rubber industries, and many vocations not usually classed as manufacturing.

Apart from the increased demand for steel brought about by the development of the automobile, the resultant increased use of all kinds of machinery—notably agricultural implements, electrical equipment and machine tools—had an important bearing on the rapid growth of the iron and steel industry Indeed there is scarcely an industry of any kind whose development does not affect that of iron and steel, whose output (less the cost of its raw materials) rose in value from $302,000,000 in 1899 to $822,000,000 in 1914, an increase of 172 per cent During the same time a corresponding increase was naturally recorded in the case of rubber tires, the output of which (less raw materials) increased in value from 40 million dollars in 1899 to 138 million dollars in 1914, or 245 per cent. There was also a large growth in the manufacture of textiles, food and kindred products, and in paper and printing, the latter of which was directly due to a large extent to the marked increase in education, and to the rising standards of living

TABLE I. *Value (in Dollars) Added to Cost of Raw Materials by Process of Manufacture*
(000,000's omitted)

Industry group	1914	1919	1925	Per cent change 1914 to 1919	Per cent change 1919 to 1925
Food and kindred products	1,036	2,435	2,670	135	10
Textiles and their products	1,431	3,832	3,775	168	−1
Iron and steel and their products	822	2,466	2,727	200	11
Lumber and allied products	850	1,745	1,964	105	12
Leather and its finished products	351	896	752	155	−16
Rubber products	138	543	537	293	−1
Paper, printing and related industries	876	1,707	2,529	95	48
Chemicals, and allied products, ex alcohols	715	1,880	2,232	163	19
Stone, clay and glass products	378	689	1,037	82	51
Metals and metal products other than iron and steel	364	780	887	114	14
Tobacco manufactures	283	529	665	87	26
Machinery, exclusive of transportation equipment	919	2,795	3,035	204	9
Musical instruments and gramophones	70	183	133	161	−27
Transportation equipment, air, land and water	408	2,427	2,063	387	−15
Railroad repair shops	291	807	769	177	5
Miscellaneous industries	315	822	982	161	19
Total United States	9,823	24,844	26,778	153	8

The increase in output per worker of about 10% between 1899 and 1910 was due in part to improvement in methods, better management, larger use of capital, more automatic machinery and much freer use of mechanical power No small part of this increase in output per worker, however, was due to changes in the worker himself His alertness, increasing intelligence, and adaptability, aided by improvements in education, made him quick to pick up new ideas and eager to apply them

The installed horsepower in manufacturing establishments multiplied 2·23 times between 1899 and 1914, increasing from 10,100,000 to 22,500,000 between these dates This increase in the use of mechanical power was more rapid in some sections of the country than in others The use of mechanical power in manufacturing establishments increased 304% in the Pacific States, 276% in the Mountain States, 157% in the South Atlantic States, 154% in the West Central States, and about 127% in the East South Central and East North Central States, while the growth in all other sections was less than the average for the whole country The New England States, whose industries were already largely developed naturally showed the smallest relative growth. The use of mechanical power increased, however, much more rapidly in all groups of States than did the number of factory wage earners. New York, Pennsylvania, Illinois, Ohio and Massachusetts with about one-third of the population produced in 1914 about one-half of the value of all manufactures and employed about one-half of the wage earners in manufacturing industries.

The War Period.—Manufacturing activity increased rapidly between 1914 and 1919 The World War caused an overwhelming demand for all kinds of manufactured goods, especially those of a basic nature—food products, chemicals, iron and steel, textiles, and transportation equipment. The value of manufactured products increased from $24,100,000,000 in 1914 to $61,900,000,000 in 1919, and the value added to the cost of raw materials by the process of manufacture increased from $9,800,000,000 to $24,800,000,000, or 153%, the greatest percentage of increase being in transportation equipment, rubber products and machinery (Table I.)

The first effect on American manufacturing of the outbreak of the war in 1914 was one of mild depression caused by the sale of foreign-held United States securities. Then came a period of revival, followed by great activity A loan of $500,000,000 made by American bankers to Great Britain and France, followed by subsequent advances, all of which was to be spent in America, inaugurated several years of tremendous activity in American manufacturing, including steel products, explosives, lubricants, woollen goods, boots and shoes, meat products, automobiles, lumber, agricultural machinery and ships. With the entry of the United States into the World War in the spring of 1917 the demands upon industries were of formidable proportions and required widespread co-ordination. The War Industries Board was therefore created, with which most manufacturers co-operated Certain non-essential industries were cut down considerably, while those required for the successful prosecution of the war were run at top speed.

The expansion of manufacturing plants from 1914 to 1919 caused a large increase in the number of factory workers, wages and the use of mechanical power The number of workers increased from 6,900,000 to 9,000,000, 30%; wages from $4,100,000,000 to $10,500,000,000, 156%; and the use of mechanical power from 22·3 million horsepower to 29 3 million, 31 per cent

Recent Years.—Barring the readjustment of industries to a peace time basis and the depression of 1921, from about 1919 down to about 1929 there has been a marked development in the industries of the country It has been characterized by (1) elimination of waste, (2) standardization of many products, (3) mass (repetitive) production, (4) increasing size of industrial units, (5) larger use of capital, (6) increasing use of mechanical power, (7) more automatic machinery, (8) increased research into methods and processes, (9) increasing output per worker, and (10) steadier employment

Much of the progress of industry, especially since 1921, has been owing to the fact that problems of production and distribution have been systematically studied The result has been to render discovery, invention, economy of material and labour, and improvement of methods in general largely an organized and continuous process rather than a haphazard one This movement has come to be commonly designated as "elimination of waste" or "simplified practice." These systematic movements are conducted by individual corporations, by associations of producers, dealers and consumers, by special research organizations, by universities, and by the Federal and State Governments There is a growing practice of co-operation among all the interests involved to this end

Simplification.—One of the important efforts of recent years has been concerted agreement for the simplification of products. In scores of branches of industry, producers, dealers and consumers have agreed to eliminate unnecessary sizes, shapes and varieties of products, concentrating production on a limited number of standard forms, with a consequent marked reduction in average unit cost. The Federal Department of Commerce has played a large part in this movement. For instance during 1927 there were 17 simplified practice recommendations for as many groups of commodities completed under the auspices of the Department of Commerce, bringing the total of completed recommendations at the end of the year to 80. Some of the reductions in variety of products made as a result of these recommendations of 1927 were as follows:

Commodity	Reductions in varieties From	Reductions in varieties To	Per cent reduction
Flashlight cases	25	14	44
Razor blades (system of packing)	2	1	50
Salt packages	35	19	46
Turnbuckles	248	115	54
Solid section steel sash	42,877	2,244	95
One-piece porcelain insulators	272	249	9
Hospital and institutional textiles	575	26	95
Composition blackboard:			
Colours	3	1	66
Widths	18	8	55
Lengths	54	13	76

It has been the past experience that a simplified line of products makes the cost less to the ultimate consumer and makes for improved quality as well. If a distributor can reduce his inventory by 75% as has been reported in some instances, and obtain better, quicker delivery from the producer, his gains are passed on to the consumer in the form of improved service, immediate replacement of items, and gradual reduction in cost of the commodity.

Large-scale Production.—American industry in 1929 was characterized by large-scale production, and increasing size of industrial units. In 1925 there were about 10,600 manufacturing establishments with an output each exceeding a million dollars in value, and these together contributed over two-thirds of the value of all factory products. There were in 1923 (the latest year for which these data are available) nearly a thousand factories each employing more than 1,000 wage earners and these reported 2·1 million employees out of an aggregate of 8·8 million in all plants. The relative importance of large plants has increased materially; in 1909 (the first year for which comparable statistics are available) 43% of all factory wage earners were in plants with more than 250 employees, whereas in 1923 considerably more than half of the total number of factory workers were in such plants. Larger-scale production is, of course, particularly conducive to low costs where processes are repetitive—that is, where large quantities of the same product are turned out. The big plant can in such cases introduce highly specialized machinery adapted to its various tasks, whereas the smaller plant must often use machines intended for more general purposes.

Another factor in the progress of American industry is the increasing use of capital per plant The combined assets of corporations in manufacturing industries in 1924 were reported at more than $49,000,000,000, of which about $24,000,000,000 was in the form of current assets—inventory, accounts receivable, and cash—and the remainder in fixed assets—plant and equipment.

A rough measure of the use of machinery is furnished by the statistics of the capacity of mechanical power. In manufacturing industries each American wage earner on the average was in 1927 aided by mechanical power of a capacity of 4 7 horsepower; in 1919 the average was 3 3 The power employed on American railways has similarly increased The average capacity of the individual locomotive has doubled since 1900 but it requires no more men to operate a locomotive than before

A still broader view of the use of power is gained from the data of the production of mineral fuels and of water power Their output, reduced to the terms of equivalent of coal, has averaged during recent years about 7½ tons per capita of the entire population, a figure four or five times greater than half a century ago, and about twice as great as in 1900 Moreover the heat and energy derived have increased much more by reason of the growing efficiency with which fuels are utilized

One important lesson learned by American industries during the World War was the great value of industrial research as a tool in peace time operation of industry To-day it is one of the basic factors in the nation's industrial progress and it has made great progress within the last few years. According to a survey made by the National Research Council in 1921 five hundred and seventy-eight industrial research laboratories, exclusive of those attached to the Government's bureaux and the universities, were at that time making studies of the processes and possibilities of industrial improvement. Another survey made by the same organization in 1927 showed that this number had grown to 1,000, an increase of nearly 75% within six years There is hardly an industry to-day that does not owe much of its progress to research, and this has been particularly true during the past seven years.

Wages are higher in the United States than in most other countries and have advanced steadily in recent years. The average annual wage in manufacturing industries for workers of all degrees of skill in 1927 was $1,310. Adjusted by the buying power of money, this was over 40% higher than in 1919, in spite of a considerable shortening of the working day This increase in real wages has served to advance efficiency of industry and to widen markets, which in turn has tended to lower unit costs. Factory workers have come to recognize that large production tends to high wages and have shown little tendency to restrict output or to oppose labour-saving machinery Factory wages in 1927 amounted to $10,849,000,000, which was equal to about 12 5% of the total national income as estimated by the National Bureau of Economic Research. The per cent distribution of factory wages in 1925 by groups of States was as follows. New England, 12·5%; Middle Atlantic, 32%; East North Central, 31·2%; West North Central, 5·2%; South Atlantic, 7%; East South Central, 3%; West South Central, 2·5%; Mountain, 1·2%; Pacific, 5·4 per cent.

To 1919 the number of workers in manufacturing plants had increased from decade to decade, but since that time has shown a declining tendency, and in 1927 there were probably nearly three-fourths of a million fewer factory workers in the United States than in 1919. This decrease in the number of factory workers, however, resulted in no general unemployment, even though the population had increased The increase in output per worker in manufacturing industries and the wider distribution of wealth have created thousands of new positions in the "servicing industries" For example, recent reports show that more than 1·2 million have found employment since 1919 in driving and ministering to motor vehicles About 150,000 in 1927 were engaged in selling and servicing radios; in 1919 such employment scarcely existed The hotel, restaurant and allied industries were in 1927 employing over 500,000 more people than in 1919; those employed in the motion picture industry (exclusive of production) increased about 150,000, those engaged in teaching in schools and colleges increased about 185,000, and so on down a long list.

Some of the outstanding developments in the manufacturing industry since 1919 have been the production of commodities that tend to increase the comforts of life and to save hand labour—such as automobiles, radio, vacuum cleaners, washing machines.

Output and Value.—The volume of production of all manufacturing industries was 9% larger in 1927 than it was in the year 1920, the increase in iron and steel industries being 5%, lumber and allied products 31%, metals and metal products, other than iron and steel, 26%, chemicals 66%, paper and printing 40%, textiles and their products 17%, food products 27%, and stone, clay and glass products 67 per cent The decline in the vehicle (land, air and water) group of industries was due to the great decline in shipbuilding The large increase (105%) in the output of rubber products between 1921 and 1927 was due to the increased production of tires Indexes of the principal individual manufacturing commodities are shown in Table II.

According to the latest complete census the mechanical power in manufacturing establishments increased 33% between 1919 and 1927, increasing from 29·3 million horsepower to 39 0 million horsepower From 1919 to 1925 the increase by groups of industries was as follows Rubber products 53%, stone, clay and glass products 48%, railroad repair shops 46%, the transportation equipment group, the machinery group, and the paper, printing and related industries groups each about 23 per cent

Three groups of industries—textiles and their products, machinery, exclusive of transportation equipment, and iron, steel and their products—employed in 1927 about 40% of the wage earners, paid about 41% of the wages, and represented about 37% of the value added to the cost of raw materials by the process of manufacture in all United States manufacturing establishments. The increase in output per person made possible a decrease in the number of wage earners in manufacturing establishments between 1919 and 1927, the number of wage earners decreasing about 7 per cent. While this condition prevailed in most industries, four of the sixteen groups showed an increase from 1919 to 1925; the textiles and their products increasing slightly, the lumber and allied products increasing 7%, the paper, printing and related industries 5%, and the stone, clay and glass products group 17% (Table III) This was not due so much to a lack of efficiency in these industries as it was to an increased volume of output.

The middle Atlantic group of States (New York, New Jersey, Pennsylvania) was the largest as measured in value of products, value added to cost of raw material by process of manufacture, and number of wage earners employed, but was followed rather closely by the East North Central group of States (Ohio, Indiana,

TABLE II. *Manufacturing Production—Indexes for Groups of Industries*

NOTE.—Monthly average 1923-25 = 100. These index numbers are not adjusted for length of month or seasonal variations.

Period	All commodities	Foodstuffs	Textiles	Iron and steel	Lumber	Leather	Paper and printing	Chemicals and oils	Stone, clay, and glass products	Metals, non-ferrous	Tobacco	Rubber products	Vehicles	Miscellaneous
1920	96	82	94	96	73	108	81	75	67	87	87		161	102
1921	73	84	90	47	64	95	72	63	66	38	85	55	90	68
1922	86	92	101	80	87	101	88	75	77	66	89	79	72	90
1923	102	100	106	105	98	109	95	93	96	93	96	87	111	97
1924	95	101	92	90	96	94	99	95	96	100	99	98	89	95
1925	104	100	102	105	107	97	105	112	109	107	105	115	101	108
1926	107	104	101	109	103	97	112	123	109	112	112	112	106	116
1927	105	104	110	101	96	103	114	125	111	110	116	116	88	115

Illinois, Michigan, Wisconsin). As measured on the basis of value added in factories per square mile of land area the middle Atlantic group of States far exceeded all others (Table IV)

TABLE III *Number of Wage Earners in Manufacturing Establishments*

(000's omitted)

Industry	1914	1919	1925	Per cent change 1914 to 1919	Per cent change 1919 to 1925
Food and kindred products	528	723	665	37	− 8
Textiles and their products	1,506	1,610	1,627	07	1
Iron and steel and their products	618	859	851	39	− 1
Lumber and allied products	865	864	921	0	7
Leather and its finished products	307	349	315	14	−10
Rubber products	74	159	141	115	−11
Paper, printing and related industries	453	510	537	13	5
Chemicals and allied products, ex alcohol	278	424	379	53	−11
Stone, clay and glass products	336	303	353	− 10	17
Metals and metal products other than iron and steel	238	304	275	28	−10
Tobacco manufactures	179	157	132	− 12	−16
Machinery, exclusive of transportation equipment	619	998	859	61	−14
Musical instruments and phonographs	49	69	47	41	−32
Transportation equipment, air, land and water	313	859	560	174	−35
Railroad repair shops	366	516	458	41	−11
Miscellaneous industries*	216	291	262	35	−10
Total United States	7,015	9,031	8,384	29	− 7

*Include also alcohols omitted from chemicals, and allied products group

TABLE IV *Density of Manufacturing in United States, 1925*

State group	Land area, 1925 (sq miles)	Value added to cost of raw material by process of manufacture: Total	Value added to cost of raw material by process of manufacture: Per square mile of land area
New England	61,976	$ 2,936,153,000	$47,376
Middle Atlantic	100,000	8,727,133,000	87,271
East North Central	245,564	8,261,929,000	33,645
West North Central	510,804	1,507,795,000	2,952
South Atlantic	269,071	1,982,754,000	7,369
East South Central	179,509	766,224,000	4,268
West South Central	429,746	824,124,000	1,918
Mountain	859,009	357,968,000	417
Pacific	318,095	1,413,986,000	4,445
Total United States	2,973,774	$26,778,066,000	$9,005

The proportion of population working in factories is largest in the New England States In 1925 for every 100 people in New England 14·1 were factory wage earners, in the Middle Atlantic States 10 3, in the East North Central states 9 9, in the Pacific States 6·3, in the South Atlantic States 5·4, while in the balance of the States less than 4 persons of each 100 were factory wage earners. For further details of the progress of manufacturing between 1919 and 1927, the reader is referred to the *Abstract of the Census of Manufactures* published biennially by the United States Department of Commerce

MINERALS

The mineral resources of the United States may be said to form the corner stone upon which its industrial structure has been reared In the steady growth of its manufactures and the increased utilization of its coal, petroleum, iron, copper and other minerals, a definite correlation is evident. The growth of the mineral industry and its present magnitude is indicated by the following table:

Total Value of Mineral Products of the United States

1909	$1,887,107,000	1923	$5,986,500,000
1910	1,987,844,000	1924	5,305,800,000
1911	1,924,081,000	1925	5,677,630,000
1912	2,237,794,000	1926	6,212,700,000
1913	2,433,545,000	1927	5,520,000,000

Iron.—In 1925 the United States contributed 55% to the world's total production of iron and steel Only 3% of this production was exported, the remainder being consumed within the country. The one outstanding factor that has advanced the American iron industry is the demand of the railways which have been the greatest consumers of iron

Production of Iron Ore in the United States, 1923-1927

(In long tons)

1923	69,351,000	1926	67,623,000
1924	54,267,000	1927	61,744,000
1925	61,908,000		

The following figures taken from the *Annual Statistical Report of the American Iron and Steel Institute* for 1927 show the quantities of materials produced and used in the iron industry of the United States in 1927

Pig iron manufactured	35,858,232 gross tons
Iron ore, mill cinder, scale, etc., consumed	69,714,806 gross tons
Coke consumed in the manufacture of pig iron only	37,375,473 bushels
Limestone consumed in the manufacture of pig iron only	14,102,028 gross tons
Total steel produced	44,935,185 gross tons

The United States is far better supplied with developed resources of iron ore than any other country, although Brazil probably ranks first in undeveloped resources. The major deposits of the United States are found in the Lake Superior region and along the Appalachian system. Of the total production of 61·7 million gross tons in 1927, 52·3 million tons were shipped from the Lake Superior district, while Alabama and Pennsylvania, next in importance, produced 6·4 million and 1·2 million gross tons, respectively.

Coal.—The growth of the bituminous coal industry during the present century up to the period of the World War, in spite of ups and downs, was relatively steady

Production of Bituminous Coal in the United States
(Million of short tons)

1909	380	1921	416
1910	417	1922	422
1911	406	1923	565
1912	450	1924	484
1913	478	1925	520
1919	466	1926	573
1920	569	1927	520

The post World War developments in the coal industry have not kept pace with the earlier part of the century, largely for two reasons First, great economies, precipitated by the war, in the use of coal have reduced the quantity required for a given unit of power. For example, the electric utilities cut their unit consumption of coal per kilowatt hour from 3 2 pounds in 1919 to 2 1 in 1925, a reduction of 34% in six years Secondly, there has been a considerable substitution by the use of petroleum, gas and water power Coal still remains the principal source of energy in the United States but in 1927 the relative use of energy sources was bituminous coal 54·8%, anthracite 8 8%, oil and gas 29 6%, and water power 6 8%, whereas in 1913, anthracite constituted 14 4% and bituminous 72 7 per cent

Although coal is produced in commercial quantities in twenty-seven States, in 1925 seven States produced over 450 million tons of the 520 million total output for the bituminous industry These seven States produced in round numbers (in millions of tons) as follows: Pennsylvania 137, West Virginia 122, Illinois 67, Kentucky 55, Ohio 28, Indiana 21 and Alabama 20

Petroleum.—Production of petroleum in America dates back to 1859 and from that date the United States has supplied the bulk of the world's output Before the general introduction of electricity, kerosene gave the world light as the successor of whale oil, lubricating oil derived from petroleum made possible the age of machinery By 1910 the automobile was creating a new demand for gasolene which has been the predominant urge in the world's petroleum development and has revolutionized the American industry

The United States is by a large margin the greatest oil consuming country in the world The annual per capita consumption

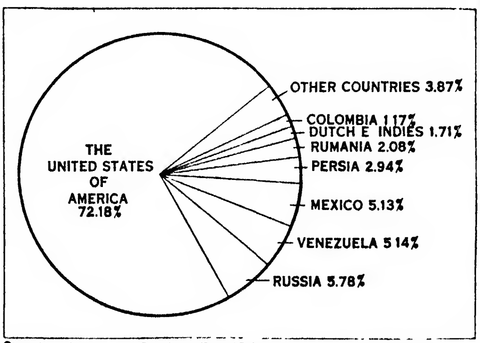


CHART SHOWING SOURCES OF THE CRUDE PETROLEUM PRODUCED IN THE WORLD IN 1927 (1,252,145,000 BARRELS, PRELIMINARY FIGURES)

in 1927 was 6 81 barrels; in 1870 it was 0·14 barrels, and as late as 1900 it was only 0·84. As has been indicated, the large increases in consumption followed 1910 in which year the consumption was 2·08 barrels for each person.

Production of Crude Oil by Decades 1860 to 1910
(In thousands of barrels of 42 gallons each)

1860	500	1890	45,824
1870	5,261	1900	63,621
1880	26,286	1910	209,557

Since the close of the World War, the production of petroleum in the United States has doubled, amounting in 1927 to 894 4 million barrels There are over 300,000 producing oil wells in the United States but less than 3% of them produce half of the oil.

Production of Crude Oil by Major Divisions—1927
(In thousands of barrels of 42 gallons each)

Eastern	Appalachian	30,458
	Lima, Indiana	1,833
	Illinois and South-west Indiana	7,751
	Mid-continent	543,343
	Gulf Coast	49,679
	Rocky Mountain	30,184
	California	230,752

As to resources, the survey of the American Association of Petroleum Geologists made at the end of 1921, gave 9,150,000,000 barrels

A comparison of the rate of growth of coal and its principal competitors, oil, gas and water power, has been made by F G

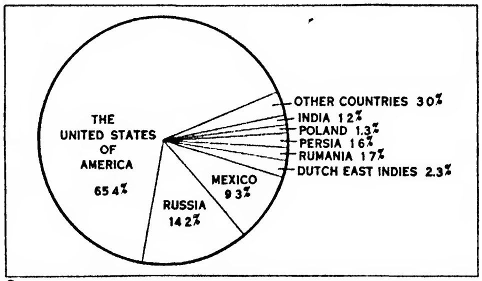


CHART SHOWING SOURCES OF THE CRUDE PETROLEUM PRODUCED IN THE WORLD 1857–1927 (15,811,437,000 BARRELS, INCLUDING PRELIMINARY FIGURES FOR 1927)

Tryon of the U S Bureau of Mines This shows that the energy derived from coal has decreased while that derived from oil and natural gas has increased Fuel oil has made its greatest gains as an energy resource in the marine world Since 1914, the tonnage of the world's oil burning merchant marine has increased from 1 7 million tons to 20 8 million tons

Copper.—The United States is by far the most important producer of copper in the world, winning its leading position in 1872 when it passed Chile From 1880 to 1900 there was an average annual increase of more than 24,000,000 pounds The output in 1900 was 606,100,000 pounds which was almost doubled by 1913

Copper Statistics (in millions of pounds)

	1923	1924	1925	1926
Copper smelter output	1,434	1,634	1,674	1,739
Electrolytic production of new copper	1,302	1,499	1,533	1,533
Metallic copper export	828	1,116	1,082	960

During recent years the United States has supplied more than one-half of the world's total production. In 1926 Arizona produced in round numbers copper ore with an equivalent of 365,000 short tons, Utah 130,000 and Montana 129,000 out of a United States total of 870,000 for that year. Low grade deposits have become the largest source of American copper.

Lead.—The United States is the largest producer as well as the largest consumer of lead in the world. The two principal lead ore producing States are Missouri and Idaho, followed by Utah, Colorado and Oklahoma. These five States account for approximately 90% of the production The technical advances which have been made in the processing of the complex lead-zinc-silver ores of the Rocky Mountain district have opened up relatively larger reserves of lead heretofore unavailable to commerce From 1909 to 1913 the annual yield was from 350,000 to a little over 400,000 tons. In 1927 the output was 668,000.

Zinc.—The United States is the largest producer as well as consumer of zinc in the world, producing almost one-half of the world's output in 1927. The outstanding deposits are situated in what is known as the Joplin District, which includes adjacent parts of the States of Missouri, Oklahoma and Kansas Other important producing states are New Jersey, Montana, Utah, Idaho and Colorado. The present potential production of zinc from the complex sulphide ores in the Rocky Mountain area, through improved processes, bids fair not only to replace the older areas, which are being depleted, but to add materially to the world's production. The position occupied by zinc during the past five years differs greatly from that of copper and lead, particularly lead, as zinc is not as essential industrially as the other metals The peak year of zinc production was 1926 with 611,000 tons In 1927 the production was 577,000 tons The outstanding development since the World War is the increase in the production of electrolytic zinc

Other Metals.—Bauxite, the ore from which aluminium is made, is produced in the United States mainly in Arkansas, with Georgia, Tennessee and Alabama in a secondary position. In 1927 the total production of the United States was 320,900 long tons of which Arkansas produced 303,800 tons During the past few years the United States produced between one-fourth and one-third of the total world output.

In 1927 the United States imported 20,200 flasks (75 pounds to the flask) of mercury and produced 11,300, the largest quantity produced in the country since 1920 when the output was 13,400 flasks. The largest part of the domestic requirements, approximately two-thirds, is met by importations. For many years the United States has required more than one-fourth of the world's total productions.

Other Non-metals.—The United States possesses about 60% of the world's high-grade deposits of phosphate rock and in 1927 produced 3,100,000 long tons. In sulphur, the reserves of the United States exceed those of the rest of the world The American sulphur deposits, situated mostly in the State of Texas, contribute the larger part of the world's production. In 1927, 2,100,000 short tons were produced in the United States Natural gas, an accompaniment of the oil industry, was produced and delivered to consumers to the extent of 1 4 trillion cubic feet in the United States in 1927. Production of gasolene from natural gas has increased greatly since the World War. In 1928 the output of this commodity was 282,000,000 gallons, in 1927 it was 1,628,000,000 gallons.

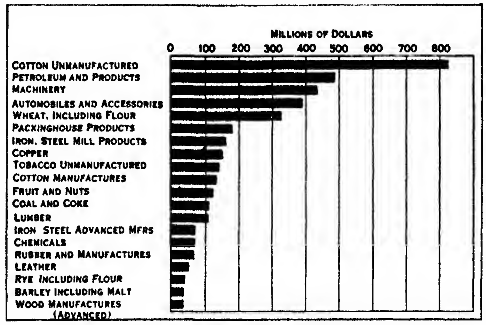
FOREIGN TRADE OF THE UNITED STATES

While the export trade of the United States accounts for only a small proportion of domestic production, it is of extreme importance to the economic well-being of the country, because of the fact that it acts as a general stabilizer of industry Each year from one-seventh to one-eighth of the total farm production is marketed abroad, representing the output of a million and a quarter persons. Of the production of United States factories, from 8 to 9% is exported, representing the output of a million industrial workers. In the case of certain commodities the export demand exceeds that within the country. In 1927, for instance, 60·6% of the total cotton crop went into overseas trade as did more than half the production of rosin, rye, motor cycles, and turpentine. Other commodities in which the proportion exported is high include copper, lard, kerosene and lubricating oil In 1927, which was a normal year, 40·2% of the total production of typewriters and parts was exported, 25·2% of the sewing machines and nearly 20% of the agricultural machinery. The ratio of finished manufactures to the total exports of the United States has been rising steadily in recent years, amounting to 44·9% in 1928, as compared with 31 9% in 1913.

In the matter of imports, the growth of American industries has been reflected in the steadily rising proportion of raw materials brought into the country as compared with finished manufactures. The bulk of imports into the United States in 1928 was made up of silk, rubber, coffee and sugar.

Early History.—During the Colonial period export trade was the chief commercial activity of the American Colonies. To Europe they shipped tobacco, furs, indigo, rice, naval stores and lumber and to the West Indies fish, lumber, agricultural products and candles. From European countries, chiefly Great Britain, they obtained manufactured goods, while the West Indies furnished a source of supply for slaves, sugar and gold.

From 1790 to 1820, as a result of extended European wars, the foreign commerce of the United States was to a large extent



VALUE OF LEADING EXPORTS FROM UNITED STATES, 1927

concerned with re-exports to Europe of foreign products which American-owned vessels gathered from the West Indies, South America, and the Orient From 1814 to 1818 there was an abnormal advance in exports, which rose from 6·9 million dollars to 93 3 million dollars, most of which rise was due to the increased shipments of agricultural products. Imports during this period showed an even greater advance than exports, rising from 13 million dollars in 1814 to 122 million in 1816 This more than nine-fold increase in imports was due in part to the receipt of surplus stocks of goods which had accumulated in Europe during the frequent wars which had occurred there from 1800–16.

This situation resulted in extreme hardship to American enterprise and in 1818 caused a general panic For the ensuing ten years American citizens found it more profitable to concentrate their energies upon the development and protection of the home market, and as a result the foreign trade of the country declined markedly This decrease involved practically every important commodity entering the country's export trade with the exception of raw cotton Partly as a result of commercial treaties between the United States and foreign countries and partly because of the development of new industries and resources, after 1830 American foreign trade began to grow The spread of agriculture in the central states and its increasing surpluses caused a demand for more oversea outlets for American products Exports of domestic merchandise increased from 59 5 million dollars in 1830 to 106 9 million dollars in 1836. From 1846 to 1860 also they grew considerably, rising from 101·7 million dollars to 316·2 million dollars.

This development was due to (*a*) the rapid increase in production of agricultural products coincident with the opening of the Mississippi Valley, whose surplus sought foreign markets; (*b*) construction of railways, affording better and quicker means of transportation; (*c*) discovery of gold, which raised prices and stimulated production; (*d*) removal of many tariff barriers in Europe; and (*e*) a reciprocity treaty with Canada. The lower tariff schedules of the United States and the rise in prices caused the imports into the country to increase in value about as rapidly as did the exports. In 1846 the imports of merchandise were 117·9 million dollars; in 1860 they were 353·6 million dollars.

During this period the character of the export trade of the United States was radically altered. Commodities such as tobacco, fish, naval stores, indigo, furs and rice, lost definitely their relative importance. The South was centering its activities upon cotton and the North was turning from fish and furs to manufacturing. The outstanding feature of the country's foreign trade during this period, however, was that its export trade was becoming a

TABLE I. *Exports and Imports of Merchandise*

NOTE.—All figures in thousands of dollars. Figures are for fiscal years ended Sept. 30, 1790 to 1842, and June 30, 1843 to 1915, subsequently for calendar years

Yearly average or year	Exports			Imports			Total exports and imports	Excess of exports (+) or imports (−)
	Total	Domestic	Foreign	Total	Free	Dutiable		
1790–1800	44,359			55,805			100,254	−11,536
1801–1810	74,532			92,766			167,298	−18,234
1811–20	58,980			80,812			139,801	−21,823
1821–30	69,421	53,221	16,200	72,949	4,215	68,734	142,370	−3,528
1831–40	103,550	88,168	15,382	119,520	45,478	74,042	223,070	−15,970
1841–50*	122,620	114,894	7,727	121,123	23,246	97,877	243,743	+1,498
1851–60	248,887	232,283	16,604	284,475	44,730	239,745	533,362	−35,588
1861–65	187,811	170,198	17,613	255,439	48,948	206,491	443,250	−67,628
1866–70	320,842	307,696	13,146	408,295	27,828	380,467	729,137	−87,453
1871–75	501,841	486,128	15,713	577,873	105,286	472,587	1,079,714	−76,032
1876–80	676,761	663,650	13,111	492,570	154,683	337,887	1,169,331	+184,191
1881–85	791,892	774,607	17,285	667,142	204,735	462,407	1,459,034	+124,750
1886–90	738,370	725,685	12,604	717,231	242,521	474,710	1,455,610	+21,148
1891–95	892,421	876,326	16,095	785,137	402,363	382,774	1,677,558	+107,284
1896–1900	1,157,318	1,136,039	21,279	741,519	342,125	399,394	1,898,837	+415,799
1901–05	1,453,803	1,427,020	26,783	972,162	426,836	545,326	2,425,965	+481,641
1906–10	1,778,697	1,750,980	27,717	1,344,838	614,825	730,013	3,123,535	+433,859
1911–15	2,370,539	2,331,648	38,891	1,712,319	961,439	750,880	4,082,858	+658,220
1915–20†	6,521,190	6,416,513	104,677	3,358,354	2,258,608	1,099,747	9,879,545	+3,162,836
1921–25	4,397,026	4,310,221	86,805	3,450,103	2,060,303	1,389,800	7,847,129	+946,924
1921	4,485,031	4,378,928	106,103	2,509,148	1,562,202	946,856	6,994,179	+1,975,883
1922	3,831,777	3,765,091	66,686	3,112,747	1,871,917	1,240,830	6,944,524	+719,030
1923	4,167,493	4,090,715	76,778	3,792,066	2,135,942	1,656,124	7,959,559	+375,427
1924	4,590,984	4,497,649	93,335	3,609,963	2,080,096	1,529,867	8,200,947	+981,021
1925	4,909,848	4,818,722	91,125	4,226,589	2,651,266	1,575,323	9,136,437	+683,258
1926	4,808,660	4,711,721	96,939	4,430,888	2,853,411	1,577,477	9,239,548	+377,772
1927	4,865,375	4,758,864	106,512	4,184,742	2,621,874	1,562,869	9,050,117	+680,633

*Period beginning Oct. 1, 1841, and ending June 30, 1850. †Period July 1, 1915, to Dec. 31, 1920.

relatively minor adjunct to the enormous expansion of internal commerce.

The Civil War and After.—The Civil War caused a temporary lull in the country's export trade, due to the serious embarrassments of the leading southern agricultural export commodities (notably cotton and tobacco) as well as the war-time pre-occupations of many northern industries, the general destruction of ships by the southern raiders and the transfer of American ships to foreign registry. In 1860 more than 66% of the country's foreign trade was carried in American ships, but by 1870 the proportion had dropped to about 35 per cent. These circumstances account in part for the fact that the exports of domestic merchandise rose only from 316.2 million dollars in 1860 to 376.6 million dollars in 1870. With appropriate allowance for price advance there was an actual decline in the volume of goods shipped.

Beginning in 1870 and continuing down to the end of the nineteenth century, there was a pronounced, though at times irregular, growth in foreign trade. This upward trend was the result of the further necessity of foreign markets to absorb surpluses of war-born industries. In 1870 the exports amounted to 376.6 million dollars, by 1900 they had increased to 1.4 thousand million dollars, multiplying almost fourfold, while the imports, which in 1870 amounted to 436 million dollars, had risen only to 850 million dollars. It should be noted further that there was a general downward trend of prices during most of the last quarter of the 19th century and consequently the actual growth in the volume of commerce was even greater than the above figures would indicate. Almost uniformly the exports exceeded the imports (Table I.) Considerably over one-half of the exports were made up of only seven commodities with cotton heading the list. In spite of the large exports of farm products the proportion of these as compared with the total volume of trade steadily declined. In 1860 about 80% of the total value of exports consisted of agricultural products, but by 1900 the proportion had declined to about 60 per cent. During this period, mineral and forest products and manufactures were increasing conspicuously.

This transformation is best indicated by the fact that whereas the foodstuffs exports rose only from a yearly average of 321 million dollars in 1876–80 to 488 million in 1896–1900, the value of manufactured exports grew during the same period from 128.8 million dollars to 351.8 million. The proportion furnished by the foodstuffs declined from 48 to 43%, whereas finished manufactures advanced from 19 to 31 per cent. An interesting and important phase of the exports of the manufactures was the rapid growth in the shipment of specialties to an increasing number of foreign lands. As the 19th century drew to a close the country's diversified manufactures were moving to markets abroad in rapidly increasing volume. The exports of copper increased from a yearly average of $749,000 in 1871–1875 to 36.7 million dollars in 1896–1900. Certain shifts in the agricultural commodities exported were of importance. The great increase in the value of provisions, comprising meat and dairy products is a notable example. These rose from about 30 million in the 1860's to 136 million dollars in 1890.

The leading group of imports and the one which advanced with greatest rapidity was that comprising crude materials for use in American industries, such as India rubber, wool, hides and skins, and raw silk. Before the Civil War the chief source of domestic exports and the leading markets for imports were the regions along the Atlantic and Gulf coasts, and the eastern part of the Mississippi valley.

The Pre-War Years.—Beginning with the turn of the century and continuing down to 1913 the foreign trade of the United States increased rapidly and underwent considerable change in character. The continued shift in exports from foodstuffs to manufactures was noteworthy. While the value of domestic exports grew from $1,400,000,000 in 1900 to $2,400,000,000 in 1913, increasing 71%, the value of foodstuffs exports declined from $545,000 to $503,000, decreasing 7 per cent.

Finished manufactures made up 32% of the total exports in 1913, as compared with 24% in 1900, while the proportion repre-

TABLE II.: *Foreign Trade by Continents and Great Trade Regions*
(Values in millions of dollars)

Yearly average or year	Total	North America				South America		Europe		Asia		Oceania		Africa	
		Northern		Southern											
		Value	Per cent	Value	Per cent	Value	Per cent	Value	Per cent	Value	Per cent	Value	Per cent	Value	Per cent
Exports															
1876–80	677	34	5·0	36	5·4	22	3·3	562	83·1	11	1·7	7	1·1	4	0·6
1881–85	792	43	5·4	45	5·7	28	3·6	642	81·0	18	2·2	13	1·6	4	·5
1886–90	738	39	5·2	43	5·8	32	4·3	586	79·3	20	2·8	15	2·0	3	·5
1891–95	892	49	5·5	61	6·8	33	3·7	709	79·5	21	2·3	14	1·6	5	·6
1896–1900	1,157	80	6·9	65	5·6	36	3·1	887	76·7	45	3·9	26	2·3	17	1·5
1901–05	1,454	125	8·6	98	6·7	46	3·2	1,061	72·3	77	5·3	30	2·0	28	1·9
1906–10	1,779	181	10·2	155	8·7	82	4·6	1,213	68·2	97	5·5	32	1·8	18	1·0
1911–15	2,371	337	14·2	182	7·7	122	5·2	1,517	64·0	133	5·6	52	2·2	27	1·1
1915–20*	6,521	780	12·0	503	7·7	361	5·5	4,124	63·2	562	8·6	109	1·7	82	1·3
1921–25	4,397	627	14·3	445	10·1	297	6·8	2,318	52·7	499	11·3	141	3·2	70	1·6
1921	4,485	600	13·4	529	11·8	273	6·1	2,364	52·7	533	11·9	113	2·5	73	1·6
1922	3,832	583	15·2	332	8·7	226	5·9	2,083	54·4	449	11·7	102	2·7	56	1·5
1923	4,167	661	15·8	426	10·2	269	6·5	2,093	50·2	511	12·3	146	3·5	61	1·5
1924	4,591	634	13·8	456	9·9	314	6·8	2,445	53·3	515	11·2	157	3·4	70	1·5
1925	4,910	659	13·4	480	9·8	403	8·2	2,604	43·0	487	9·9	189	3·9	80	1·8
1926	4,809	748	15·5	429	8·9	444	9·2	2,310	48·0	565	11·7	213	4·4	101	2·1
1927	4,865	845	17·4	408	8·4	438	9·0	2,314	47·6	560	11·5	194	4·0	107	2·2
Imports															
1876–80	493	28	5·6	87	17·6	68	13·8	248	50·3	56	11·3	5	·9	2	·5
1881–85	667	42	6·3	96	14·4	76	11·4	368	55·1	70	10·5	11	1·7	4	·6
1886–90	717	40	5·6	99	13·8	82	11·5	402	56·0	74	10·4	16	2·3	3	·5
1891–95	785	36	4·6	128	16·3	117	14·9	398	50·6	85	10·8	16	2·1	5	·6
1896–1900	742	37	5·0	76	10·3	98	13·2	390	52·6	108	14·6	23	3·1	10	1·3
1901–05	972	53	5·4	130	13·3	122	12·5	498	51·3	150	15·4	9	·9	11	1·1
1906–10	1,345	80	5·9	180	13·4	157	11·7	690	51·3	205	15·2	17	1·2	17	1·2
1911–15	1,712	131	7·7	240	14·5	220	12·8	708	46·6	271	15·8	19	1·1	24	1·4
1915–20*	2,358	425	12·7	588	17·5	591	17·6	682	20·3	910	27·1	70	2·1	91	2·7
1921–25	3,450	397	11·5	514	14·9	421	12·2	1,049	30·4	943	27·3	54	1·6	71	2·1
1921	2,509	338	13·5	417	16·6	296	11·8	765	30·5	618	24·6	35	1·4	40	1·6
1922	3,113	367	11·8	456	14·6	359	11·5	991	31·8	827	26·6	49	1·6	65	2·1
1923	3,792	418	11·0	583	15·4	467	12·3	1,157	30·5	1,020	26·9	59	1·6	87	2·3
1924	3,610	402	11·1	593	16·4	466	12·9	1,096	30·4	931	25·8	49	1·4	73	2·0
1925	4,227	459	10·9	522	12·3	519	12·3	1,238	29·3	1,319	21·2	78	1·8	92	2·2
1926	4,431	486	11·0	526	11·9	568	12·8	1,286	29·0	1,401	31·6	68	1·5	96	2·2
1927	4,184	485	11·6	501	12·0	518	12·4	1,276	30·5	1,257	30·0	55	1·3	93	2·2

*Period July 1, 1915, to Dec. 31, 1920.

sented by foodstuffs declined to 21% from 39% at the turn of the century. Of the manufactures shipped abroad the most important products were those of iron and steel, copper and its manufactures, machinery, lumber and its re-manufactures, cotton manufactures, leather and automobiles. All of these showed outstanding growth, that of iron and steel from $38,500,000 in 1900 to $124,200,000 in 1913; copper and its manufactures from 58·9 to 143·1 million dollars; lumber and its re-manufactures from 45·1 to 107·8; machinery from 78·0 to 194·7; cotton manufactures from 24·0 to 51·5, and that of leather from 21·8 million dollars to 42·4 million dollars. One of the remarkable growths in exports was shown in the shipments of automobiles, including engines and parts, which amounted to $33,000,000 in 1913.

Europe has always taken the greatest share of American exports but since 1900 the proportion going to this continent has been declining. (Table II.) In 1913 it took only 60% of United States exports as compared with 74·6% in 1900. The markets of the rest of the world, especially those of the two American continents, took a much larger proportion in 1913 than in 1900. The proportion going to Asia, Oceania and Africa did not increase much until after the beginning of the World War.

Imports increased from $849,900,000 in 1900 to $1,813,000,000 in 1913, a rise of 113 per cent. The greatest shift in the character of imports during this period was in the proportional increase of crude materials, which amounted to $649,400,000 in 1913, and represented 36% of the total value of all imports as compared with 33% in 1900. Ten commodities made up 42% of all imports, namely, coffee, $119,000,000; hides and skins, $117,400,000; sugar, $103,600,000; crude rubber $90,200,000; silk, $82,100,000; cotton manufactures, $66,100,000, copper and tin, including ore and manufactures of each, $59,600,000 and $53,100,000 respectively, fertilizer and its materials $41,400,000; and fruits and nuts, $41,000,000.

The War Years.—The foreign trade of the United States from 1914 to 1919 was necessarily distorted. It is possible only to make the most general observations as to the commercial development of this period. The United States naturally was the major source of supply, not only for the markets of the European contestants but also for those in Latin America and Asia. The export of munitions was extremely large, but a careful examination of the data reveals the fact that much of the increase in the volume of exports was in commodities which had hitherto been unknown quantities in international trade, for example, automobiles, motion picture films, labour-saving machinery, ready-made clothing and similar American specialties. Though the exports of these commodities in large quantities date largely from about the beginning of the World War, they were really the reflex of the enormous expansion of those industries in the United States in their efforts to supply the domestic demand, rather than the attempt to take over the export trade of the preoccupied European powers. Heavy gains were made by the United States in many once exclusive trade preserves of Europe, but these gains were largely in the shipment of new and improved products which had never been supplied by Europe.

The exports of the United States rose from $2,300,000,000 in 1914 to $6,200,000,000 in 1917, and to $7,800,000,000 in 1919. The share of wholly and partly fabricated wares reached the record mark of 65% in 1917. Europe naturally provided much the

TABLE III: *Exports (Domestic) of Leading Commodities*
(Values in millions and tenths of millions of dollars)

Commodity		Quantity				Value			
		*1910–14	1921–25	1926	1927	*1910–14	1921–25	1926	1927
Cotton, unmanufactured	million lbs	4,420	3,420	4,692	4,897	551·9	805·0	814·4	826·3
Petroleum and products						127·7	405·1	554·5	486·1
Refined oils	million bbls	37	76	108	116	110·5	363·6	497·2	429·9
Crude oil	,,	4	13	15	16	6·4	22·5	28·5	25·9
Machinery†						158·2	320·8	399·9	435·5
Electrical, and apparatus						20·0	69·1	84·2	84·6
Agricultural, and implements						40·5	51·9	85·5	90·1
Industrial						78·6	166·7	179·6	201·5
Automobiles, parts and accessories‡	thousands	19	150	306	384	24·1	177·2	320·2	388·3
Wheat, including flour	million bu	105	227	194	229	106·2	321·9	284·9	324·8
Wheat, grain	,,	57	159	138	168	55·1	228·3	201·7	239·5
Packing house products	million lbs	1,220	1,036	1,416	263	146·5	279·6	234·8	180·9
Meats	,,	485	809	481	356	62·7	133·2	98·7	64·2
Fats and oils	,,	735	1,126	935	907	83·8	146·4	136·1	116·8
Lard	,,	474	861	699	681	52·1	115·6	108·6	92·0
Iron and steel-mill products	thousand tons	2,180	1,953	2,166	2,182	91·3	166·8	174·1	160·6
Copper, including manufactures	million lbs	828	877	966	1,077	121·2	129·8	141·2	150·2
Tobacco, unmanufactured	,,	392	503	487	512	44·8	164·6	136·9	139·7
Cotton manufactures, including yarns, etc				.		45·2	133·1	128·9	133·1
Cloths, duck, tire fabric	million sq yd	399	525	513	562	27·1	79·9	74·6	76·5
Fruits and nuts			..			28·7	82·9	111·8	121·7
Coal and coke	million tons	18	21	36	20	55·7	131·1	203·9	109·7
Sawmill products						66·0	85·1	97·4	107·6
Boards and timber	million bd ft	2,704	2,145	2,694	2,951	61·5	83·9	96·6	106·9
Iron and steel, advanced manufactures				.		45·0	68·6	75·9	73·3
Chemicals (coal tar, medicinal, industrial)		..	.		..	21·8	56·2	64·9	72·9
Rubber and manufactures						12·4	38·5	59·2	68·7
Automobile casings	thousands		§1,392	1,407	2,631		16·3	24·4	33·8
Leather						39·1	44·3	49·8	54·0
Rye, including flour	million bu	1	35	12	36	·6	39·5	12·4	39·9
Barley and malt	,,	8	26	17	41	5·3	24·4	13·8	38·5
Wood manufactures (advanced)						25·7	30·8	37·9	38·1
Naval stores, gums and resins			.			23·4	22·4	36·9	34·3
Furs and manufactures						14·7	22·5	23·2	30·9
Oilcake and meal	million lbs	1,668	1,166	1,450	1,570	23·6	24·7	26·5	30·2
Paper and manufactures						10·7	24·6	26·8	27·0
Books and printed matter						9·2	19·9	21·9	24·2
Pigments, paints and varnishes						6·8	14·6	18·9	20·9
Photographic goods						8·0	17·4	18·6	18·7
Leather manufactures						19·0	21·8	18·5	18·4
Fish		.				9·7	18·0	19·9	18·3
Dairy products		.				3·3	30·1	19·0	17·4

*Fiscal years ended June 30 †Includes office appliances and printing machinery
‡The number is automobiles only, the value includes parts and accessories §Average for years 1922–25.

larger market, taking 63·2% of the United States exports from 1915 to 1920

Imports were correspondingly stimulated and rose in value from less than two thousand millions just before the war to three thousand millions in 1917 and to almost four thousand millions in 1919 Although many lines of once highly valued European luxuries disappeared from United States trade, these were more than compensated for by the enormous increase of raw materials imported directly from Latin America and the Far East This development was one of the outstanding phenomena of American foreign trade Many trade routes were so completely altered that, whereas the United States before the war received a large portion of its imports of raw materials through European markets—such commodities as rubber, vegetable oils, tin, wool, cacao, furs and dye-wood—during and since the war these commodities were and are being received direct from the production areas in the Far East and Latin America Such changes in trade routes account in part for the enormous increase in United States imports from Asia and Latin America.

The efficiency of American production methods, the vigorous efforts of American business men in finding markets, and the active aid of the government in promoting foreign trade are factors which have brought about a marked increase in the volume of export trade since 1919 At the same time the rising standards of living of the American people have necessitated an increased volume of imports of a number of important commodities and a number of minor ones which the country cannot at present produce economically, or can produce only in part, such as silk, rubber, jute, sisal, wool and hides and skins

One of the leading features of the country's trade position since the World War has been the profound influence of the change of the United States from a debtor to a creditor nation in world finance Another factor in the country's foreign trade has been the revival of American shipping available for overseas trade, the tonnage of which multiplied nearly ten times between 1914 and 1920 These ships have in recent years been carrying about 35% of American export trade, a figure considerably higher than in any time since 1870.

After the World War.—The readjustment in American foreign trade from a war-time to a peace-time basis naturally resulted in a decline in the value of both exports and imports because of the increased buying power of money The volume, however, gradually increased and in 1928 that of exports was 20% higher than in 1920 and that of imports 31% higher. As

TABLE IV.: *Imports of Leading Commodities*
(Values in millions and tenths of millions of dollars)

Commodity	Unit	Quantity 1910–14*	Quantity 1921–25	Quantity 1926	Quantity 1927	Value 1910–14*	Value 1921–25	Value 1926	Value 1927
Silk, raw	million lbs.	24	52	66	74	77·1	348·1	392·8	390·4
Rubber, crude	„	106	681	926	955	86·3	192·9	505·8	339·9
Coffee	„	899	1,340	1,493	1,433	101·5	205·8	322·7	264·3
Sugar, cane	„	4,341	8,118	9,420	8,431	103·5	295·4	232·5	258·2
Paper and manufactures						10·7	105·2	139·5	149·4
Newsprint	million lbs	238	2,375	3,701	3,974	4·8	90·9	124·0	131·5
Furs and manufactures						22·6	79·8	117·4	135·6
Paper base stocks						27·5	94·2	121·5	113·6
Wood pulp	thousand tons	472	1,165	1,546	1,406	14·6	67·0	91·2	85·8
Petroleum and products						6·3	90·8	124·6	113·4
Crude oil	million bbls	7	95	60	58	5·9	68·0	79·3	78·6
Refined oils	„		13	21	13		22·2	44·6	33·6
Hides and skins	million lbs	531	430	369	447	104·6	93·1	96·8	112·8
Tin: Bars, blocks, pigs	„	106	132	173	159	41·5	56·5	104·8	100·9
Copper, including manufactures	„	369	598	779	718	47·8	77·8	99·7	85·0
Fruits and nuts						42·3	75·5	87·3	84·5
Wool and mohair	million lbs	208	340	310	267	30·3	102·4	106·7	82·9
Wool manufactures, including yarn, etc						21·5	64·6	70·7	78·8
Vegetable oils, expressed	million lbs	267	613	780	773	20·5	59·7	79·1	78·7
Tobacco, unmanufactured	„	56	67	68	103	31·7	64·8	60·6	74·6
Burlaps	„	421	559	599	570	29·4	60·4	82·2	67·2
Cotton manufactures, including yarn, etc						67·4	86·6	67·2	66·2
Oilseeds	million lbs	491	1,393	1,906	1,832	15·1	51·2	70·5	64·3
Flaxseed	thousand bu	7,258	16,934	22,550	21,821	12·3	34·0	41·4	37·8
Sawmill products						22·1	68·4	74·6	64·0
Boards, planks, deals	million bd ft.	971	1,593	1,899	1,745	17·6	49·8	55·4	49·5
Art works						35·0	31·2	53·5	60·4
Fertilizers	thousand tons	1,488	1,609	2,083	1,819	40·7	50·9	69·2	58·8
Chemicals (coal-tar, industrial, medicinal)						41·6	44·2	54·0	57·8
Cocoa or cacao beans	million lbs	142	365	426	425	16·0	31·3	42·7	56·8
Diamonds	thousand carats		639	834	717	34·7	52·6	66·4	54·4
Flax, hemp, ramie manufactures						31·8	44·8	48·5	52·4
Cotton, unmanufactured	million lbs	111	166	181	206	20·7	46·3	46·2	45·7
Silk manufactures						29·9	40·9	40·0	42·2
Vegetables and preparations						14·4	26·2	38·4	38·4
Tea	million lbs	95	94	96	89	16·7	25·3	31·3	28·2

*Fiscal years ended June 30

compared with the pre-war period of 1910–14, not only the value but also the volume showed remarkable growth Exports increased from $2,400,000,000 to $5,000,000,000 in 1928, or 100%, while the imports increased from $1,800,000,000 to $4,800,000,000 or 128 per cent Allowing for the decrease in the buying power of money, the volume of exports increased 65% between 1913 and 1928, and the imports 81 per cent

The recent gains in exports as compared with 1913 have been most conspicuous in the shipment of fabricated wares. This is but natural in a country that is shifting rapidly from agriculture to manufactures. The demand for foodstuffs and other agricultural products in the world as a whole is limited and expands only about as fast as the population increases Farm products are for the most part necessities, and the consumption of them does not grow as rapidly as does those of fabricated products. But an increase in manufacturing means fuller employment for American workers, and a larger domestic demand for the country's products.

The example set by American industry in its rapid adoption of machinery has created an enormous expansion of demand from abroad for American products of this nature The value of machinery exports in 1927 was 175% higher than during the five-year pre-war average, increasing from an average per year of $158,200,000 in 1910–1914 to $435,500,000 in 1927 (Table III.). The aid given to foreign industrial growth is greater than these data indicate. The machinery exported in 1927 was considerably better and capable of a much larger output per dollar value than before the World War. Industrial machinery exports increased from a pre-war average of 78·6 to 201·5 million dollars in 1927, electrical machinery and apparatus from 20·9 to 84·6, and agricultural machinery and implements from 40·5 million dollars to 90·1 million dollars

Another large increase in the country's exports was in the shipments of automobiles and automobile parts and accessories, whose value rose from an average of 24·1 million dollars in 1910–1914 to 388·3 million dollars in 1927 If allowance is made for the decline in price of motor cars, the volume increase is even greater Despite the decline in the price levels of motor cars the growth as shown in the export figures would be even more outstanding, were it not for the fact that a large portion of those made in Canada and produced by branches of American plants are not included in the table.

Changes in Destination.—There have been a number of striking changes in the geographic distribution of the United States foreign trade in recent years. Before the World War the country's exports were highly concentrated in a few European countries, whereas imports were widely diversified The situation since the war has been materially modified and exports are becoming more widely scattered. Europe, which with the adjoining territory of the Near East, was taking about 63% of the country's pre-war exports, is (1928) absorbing less than 48 per cent. Latin America is gradually increasing its share, taking about 18% today, as compared with about 14% during 1910–1914, while the Far East now supplies a market for about 16% of the United States exports, as compared with about 8% during 1910 to 1914.

In the matter of imports the geographic change has been more striking. In pre-war days Europe furnished about 50% of the United States imports, while during the last few years that con-

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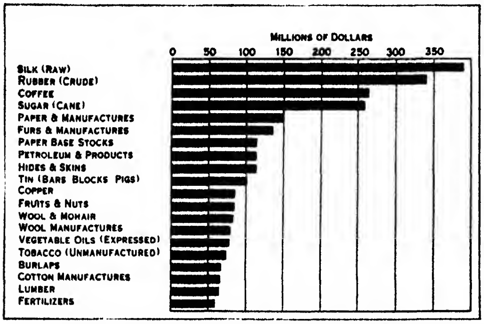
VIEWS OF COMMERCIAL ACTIVITIES IN THE UNITED STATES

1. Orange grove of California. Horticulture is one of the principal industries of this State and the orange is one of the most important of the fruits produced. The citrus industry has contributed largely to the development of the State
2. Air view of the Standard Oil Company Sugar Creek refinery at Independence, Missouri. Production of petroleum in America dates back to 1859 and from that date the United States has supplied the bulk of the world's output
3. The Homestake gold mine at Lead, S.D., in the Black Hills region. Gold is an important mineral in this part of the State and is found in a section covering about 3,500 sq.m.
4. An air view of the manufacturing plant of the National Enameling and Stamping Company, East St. Louis, Illinois. This city is across the river from St. Louis, Missouri, with which it is connected by bridges and ferries. It is an important manufacturing centre
5. The stockyards at Kansas City, Kansas. With the exception of Chicago this is the largest livestock centre in the United States. Kansas City draws largely from the south-west markets of the United States
6. Airview of "Ford City," Detroit, Michigan, principal manufacturing unit of the Ford Motor Company. This plant is operated five days a week on eight hour shifts. It is one of the 36 branches of the company in the United States, at 33 of which Ford cars are assembled

tinent has furnished only about 30%, a striking example of the discontinuance of much of the pre-war triangular trade wherein the United States received many of its imports originating in non-European countries via European markets. Latin America, meanwhile, has about maintained its position, contributing about 25% of the United States imports On the other hand, the East



VALUE OF LEADING IMPORTS INTO UNITED STATES, 1927

has double its shares and has become one of the leading suppliers of American requirements from overseas

INTERNAL COMMERCE

Large and important as has become the foreign trade of the United States it is small compared with the internal commerce For every dollar's worth of goods exported about ten dollars' worth is sold to consumers within the country. The internal trade of the country is larger than the combined export trade of the entire world.

The basis of this internal trade lies in adequate transportation facilities furnished by rail, highway, water and air, in means of rapid communication, in a large and growing national income, and in an adequate financing system In 1927 the railway lines in the United States totaled 249,000 miles; the navigable water ways, excluding 2,760 miles of the Great Lakes, 27,460 miles; the highway system 288,000 miles; motor trucks and road tractors in use numbered almost 2·9 million; the number of miles of telephone wire totaled more than 56 5 million connecting over 18 million telephones. America's national income during 1927 was estimated at approximately 90 thousand million dollars. Her Federal Reserve System established primarily for the financing of trade is serving its purpose admirably.

That the volume of the country's internal commerce has grown tremendously in recent years is indicated by the volume of freight traffic handled by the railway and internal waterways. The amount of revenue freight carried 1 mile by the railways totaled 432 thousand million tons in 1927, an increase of 405% over the yearly average of 1891–95, while volume of freight traffic handled on the internal waterways and in the coastwise trade, excluding duplication, totaled 219 million tons.

Some of the most pressing problems of American industry are those relating to domestic distribution. Unfortunately no important field of economic statistics until recently has been so sadly neglected as that of internal commerce. Many data indirectly indicative of its volume have long been collected but not until after the World War was the value in measuring the economic progress of the country of precise facts on distribution fully recognized by the business community or by the Federal Government. Recently much progress has been made in collecting this material.

The United States Department of Commerce recently undertook a series of surveys, to determine the basic business characteristics, the factors affecting distribution, and the actual status of the buying power of the various economic areas of the country in an attempt to evaluate the actual consuming capacity of the various regions and of particular trading areas within each region of the United States. The Department is also to make a census of distribution in 1930, probably the first complete tabulation of this sort ever made by any major commercial nation on a large scale.

Diverse tendencies are apparent in the United States internal trade—and some of them are strikingly at variance with the practice of the past. The lessons of mass production are being applied with increasing intensity to mass distribution. The increase in the sales of mail order houses and department stores has been remarkable. The growth of the chainstore system has been notable especially in such fields as foodstuffs and shoes In the latter line it is estimated that only 40% of the retailing is now dependent upon jobbers; in the remainder of this business the services of the middlemen have been dispensed with as the result of mass retail selling by producers.

The spread of automobiles has also reacted upon the trade in farm equipment, which since 1921 has very noticeably gravitated toward more tractors and better farming machinery of all sorts. The element of post-war style changes is apparent in several industries; for example the textile trade has felt its effect to an unusual degree This is shown by the growth of rayon yarn production in the United States from 1 6 million pounds in 1913 to nearly 75 6 million pounds in 1927 At the same time the United States silk imports increased from about 26 million pounds in 1913 to 74 million pounds in 1927. Naturally, the cotton-goods trade has been particularly affected by this shift, but even in that line there have been many plants which have readjusted their output so as to take advantage of new industrial uses for their products instead of relying solely on the apparel trade.

The distribution of electrical goods has afforded another illustration of striking changes since the World War The great increase in the use of combustion engines, both for transportation and industrial purposes, has stimulated the electrical industry to keener efforts toward better merchandising, one notable feature of which has been a remarkable development in aggressive advertising, evidently with satisfactory results

In spite of the efforts that have been made to meet these rapidly changing conditions and the salutary results obtained, trading continues to be very complex. Simplification is needed in the terms and practices of business endeavours because the absence of a uniform understanding of their meaning is costing the consumers millions of dollars a year. Neither railway, steamship bills of lading, insurance certificates, nor banking terms are properly understood or uniformly interpreted among large numbers of business men Guarantees made by many producers are indefinite and susceptible to a variety of meanings; for instance, a guarantee of "fast colors" in fabrics, and a guaranty of "15,000 miles" on automobile tires should have a more definite meaning than they have at present. Lack of standardization of such trade terms as these, and the lack of generally accepted, authoritative definitions of trade documents, terms and practices cause constant interruption to business, entail expensive arbitration and law suits, and leads to strained commercial relations Efforts are being made to simplify these trade practices and to promote internal trade, by both governmental and private organizations, and if these efforts continue valuable results may be expected. For articles giving full particulars on transportation facilities *see* RAILWAYS: *United States;* HIGHWAYS: *United States,* and CANALS AND CANALIZED RIVERS. (J. KLE.)

INLAND WATERWAYS

The development of inland waterways in America began immediately after the war of the Revolution, and by 1830 there was an extensive net work of water communication through the New England and Middle States, Virginia and Ohio.

The first canals were small affairs and were the result of private initiative, but as larger ones were undertaken state aid was sought, which in some instances was granted The introduction of railways in 1828 and their subsequent rapid growth put out of business the small canals, except the Erie, which was increased in size with the view to meet changed conditions of traffic demands.

The Erie Canal.—Of these early canals the outstanding exam-

ple was the Erie, in the State of New York between Buffalo and Albany This canal was originally projected by the Western Inland Lock Navigation company in 1792, to accommodate boats 40 ft. long, 20 ft beam and 2 ft. draft The State took over the work in 1817 and constructed a canal between the above named points whose bottom width was 28 ft, surface 40 ft. and depth 4 ft. The locks were 90 ft long by 12 ft wide An enlargement, begun in 1835 and completed in 1862 increased the surface width to 70 ft, the depth to 7 ft and the locks to 110 ft by 18 ft.

In 1895 a further enlargement was authorized, though the work was not begun until 1905 As finished in 1916, the present canal has a bottom width of 75 ft in earth and 90 ft in rock, a depth of 12 ft and locks 300 ft. long in the clear and 45 ft wide with a depth of 12 ft. on the sills The original canal as opened in 1825 was 363 m long, while the existing canal system of New York, including branches to Lakes Champlain, Ontario, Seneca and Cayuga, comprises 525 m of canal, river and lake navigation.

Erie Barge Canal.—The cost of the recent enlargement to make what is known as the Barge canal, including terminal facilities in New York and Buffalo, amounted (June 30, 1926) to $174,-859,957 22 This sum, however, does not include any allowance for the cost of the original canal, nor of the enlargement in 1835–1862, nor for interest during construction and subsequent thereto. As there are no tolls other than for the use of the terminal facilities, there can be no credit given in the interest account, and as the net cost of operation is always a liability the State's investment is steadily increasing The net annual cost of operation is nearly $3,000,000 exclusive of interest, depreciation or allowance for taxes.

On the Barge canal the towing path has been entirely suppressed so that all boats must proceed under their own power or be drawn by tugs This requirement has developed new and interesting types of vessels The navigation regulations of the canal require that boats shall not exceed 300 ft. in length. that their speed shall not exceed 6 m per hour in the canal and 10 m in lakes and canalized rivers, and that no greater number of barges shall be taken in one tow than can be passed in two lockings.

In spite of all the money spent in providing increased facilities, the tonnage using the canal has been very disappointing The average number of net tons per annum has been as follows.

For the decade ending	*Tons*	*For the decade ending*	*Tons*
1850	1,889,561	1900	3,868,504
1860	3,943,965	1910	3,286,670
1870	5,518,533	1920	1,898,601
1880	5,629,293	1927 (7 yrs)	2,068,245
1890	5,243,925		

Though tonnage has increased each year since 1921, the maximum annual tonnage during that part of the decade ending with 1927 was less than that during any year from 1846 to 1913 both inclusive. In spite of a free canal, modern improvements in vessels and mechanical propulsion and towage, the canal has been unable to compete with railway transportation and the tonnage is still, though somewhat improved, considerably below what was carried in the days of animal towing Were a toll charged sufficient to cover interest on construction and operating expense, the canal would carry no traffic at all The open season for navigation usually begins about May 8 and ends about December 1, though both limits are subject in any one year to considerable departure from the average dates, on account of seasonal variations. A boat makes about 33 m a day owing to locking delays while 517 tons constitute the average load per loaded boat Two-thirds of the traffic consists of building materials and products of agriculture

Other Interior Waterways.—Jurisdiction over interior navigable waterways is vested in the Federal Government Navigable waterways are defined as those that can be operated either in their natural state or after improvement. The control of such improvements is placed by law under the War Department and executed by the corps of engineers of the army Omitting the harbours on the coast and on the Great Lakes, which are not within the purview of this article, the federal government has expended on the interior waterways nearly $550,000,000 in improvements and spends annually in maintenance and operation over $6,000,000 including the Mississippi River, exclusive of any allowance for interest on the capital invested. The inland waterways thus developed or improved for navigation are approximately 25,000 m in length, and therefore greatly exceed any other system of inland navigation. The work has consisted in deepening by dredging, by controlling the current by jetties or revetments or by canalizing by means of dams and locks As it is impossible to discuss all the component parts of this vast undertaking it will suffice to refer to the most important elements, the Ohio and the Mississippi rivers and the Sault Ste Marie canal.

The Ohio River is navigable from Pittsburgh to its mouth, 968·5 m., and presents the longest piece of river canalization in the world. The river borne commerce is steadily increasing and amounted in 1926 to nearly 20,000,000 tons, of which, 18,500,000 consisted of non-metallic minerals with coal and coke, and sand and gravel in almost equal proportions. Practically all this material is carried in barges in tow

The Mississippi river, whose total length is almost 2,477 m. is navigable from Minneapolis to its mouth in the Gulf of Mexico, 1,950 m, in which distance there is a fall at low water stage of 685 ft.

In general terms, the river consists of a series of reverse bends in which deep water always prevails, connected by wide reaches called "crossings" in some of which obstacles to navigation occur in the form of sand reefs Below the mouth of the Ohio, improvement for navigation consists in the removal of such obstructions by dredging, and in the revetment of banks to discourage their formation Above the mouth of the Ohio these activities are supplemented by contraction works of permeable or impermeable construction, designed to promote greater uniformity of width and of depth (*See* MISSISSIPPI RIVER *Engineering*)

From the Passes to Baton Rouge the river is open for navigation throughout the year, between Baton Rouge and the mouth of the Ohio about eleven months, while above that point about eight months, depending on the seasonal variations

The first Mississippi river steamboat arrived at New Orleans in December, 1811 The steamboats carried packet freight, passengers and mail Coal, hay, etc, were still floated down by barge and railroad competition gradually enforced the more expeditious handling of bulk commodities in fleets of barges pushed by tow boats, and brought back upstream, loaded when possible The railroad definitely supplanted the packet boat, and by the beginning of the World War had so seriously encroached upon the business of the barge lines that river commerce had been reduced to a rather desultory traffic in a few classes of bulk commodities Commercial statistics for the year 1913, show for the reach Vicksburg to New Orleans, through which traffic was heaviest, a total tonnage of 2,417,859, of which 1,128,677 tons was petroleum.

During the World War the Government established a barge line as an emergency measure to relieve railroad congestion It proved a success and has been followed by the establishment of other lines as private and common carriers, and by steady increase in volume of traffic, upon the lower river. Comparative statistics covering a five year period are given in the following table.

Commercial Statistics—Mississippi River—1922–26

Stretch	Miles	Annual tonnage		
		1922	1924	1926
Minneapolis to mouth Missouri river	675	818,059	769,139	691,637
Mouth Missouri river to Cairo (mouth Ohio river)	209	548,114	738,728	1,005,979
Cairo to Memphis	227	923,386	1,153,021	1,660,188
Memphis to Vicksburg	375	1,441,048	1,666,440	4,792,780
Vicksburg to New Orleans	367	5,544,506	7,633,277	11,074,488

Since each of the above named reaches is treated as a separate stream, traffic passing through a portion of two reaches is reported by both. The figures in the table are therefore not additive.

As stated above the greatest part of the freight is in bulky commodities and is carried in barges in tow. The standard barge of the Inland Waterways Corp, owned and operated by the U.S.

Government, is of steel, 200 ft. long and 40 ft. wide, drawing 8 ft when fully loaded with 1,500 tons. The usual tow consists of 6 barges lashed three abreast with a stern wheel steamboat in the middle, *see* fig. 2. The standard coal barge is one 176 ft. by 26 ft., 28 of which make a tow carrying 16,800 tons, though there is a record of 63 barges in a single tow from Pittsburgh to New Orleans.

Connecting Lake Superior and Lake Huron is the St. Mary's river, 63 m. long with a fall of 21 ft The greater part of this fall occurs at one point and is known as the Sault Ste. Marie, or commonly as the "Soo" rapids. To provide passage over these rapids locks have been constructed by both the American and Canadian Governments, as the St Mary's river is a boundary stream. The American locks, four in number, are the more important in size.

The channel width is 300 ft. for one way and 600 ft. for two way traffic with a minimum depth of 21 ft This depth is in accordance with a depth of 22 ft in the Detroit river and the limiting depth in the lake harbours which in 65 cases varies from 19 to 21 ft. though about the same number of less important harbours have been dredged to accommodate vessels drawing 14 ft. The "Soo" canal is a very busy waterway The number of vessels passing exceeds 20,000 annually with a net registered tonnage upwards of 72,000,000 carrying nearly 90 000,000 cargo tons. The bulk of this cargo consists of three items. of iron ore, about 58,000,000 tons, of coal, 14,000,000 tons and of farm products, 10,000,000 tons.

Waterways and canals in Canada consist in improvements rendering feasible navigation through the Great Lakes to the St Lawrence river and thence to the sea. The first link in this important chain is the single Canadian lock in the St Mary's river With that lock and the proper channel regulation in the Detroit river, which is merely a strait connecting lakes Huron and Erie, it is possible for a vessel to pass from any Canadian port on Lake Superior to any port on Lake Erie through Canadian or international waterways To permit passage from Lake Erie to Lake Ontario around Niagara Falls the Canadian Government has constructed the Welland canal wholly in Canadian territory The available depth of water in the locks in this canal is but one illustration of successive progressive steps in American waterways. In 1824 it was 8 ft, increased to 9 ft in 1842, to 10 ft in 1853, to 12 ft. in 1872, to 14 ft in 1887, and will become 30 ft. by the project inaugurated in 1913 to be completed soon after 1930 The new project will provide a canal 25 m long and distribute the fall of 326 5 ft in four single locks and one flight of three double locks, each with usable lengths and widths of 820 and 80 ft Between Lake Ontario and tide water at Montreal, vessels use the St Lawrence river and canals at the rapids There is a fall of 207 5 ft. overcome at present by 26 locks with minimum dimensions of 245 ft, 45 ft and 14 ft The improvement of the St Lawrence to make it available for ocean going vessels drawing nearly 30 ft. and so have it conform with the Welland canal is now under consideration by the American and Canadian Governments, the chief deterrent consideration being the great cost of the undertaking.

The only important canal remaining in the United States constructed by private capital and operated on a commercial basis, is the Cape Cod canal, acquired by the Federal Government in the spring of 1928. This canal projected in the 18th century to connect Buzzards and Massachusetts bays and avoid the dangerous navigation on Nantucket Shoals on the outside of Cape Cod was completed in 1914. As built it had a length between shore lines of 8 m with a dredged approach channel in Buzzards bay, 5 m. long. The bottom width was 100 ft and depth at low water 25 ft. There is a considerable tidal range at both ends setting up alternating currents and giving a depth at high water of about 30 ft. There were no locks and the canal was crossed by one railroad and two highway bridges The original conception was to make a canal with a bottom width of 200 ft. and the government has in hand extensive plans for enlargement. The water distance between Boston and New York is shortened by about 80 m. (W B. Pa.)

VIII. DEFENCE

ARMY

History.—When Washington took command, on July 3, 1775, of the lines of colonial militia besieging Boston the United States army was born Although it was still a year and a day before the Declaration of Independence, the event marked the union of the forces of the 13 separate Colonies under one head. These men were largely militia and minute-men of local communities, given to going home whenever a particular danger was past, and loath to cross boundaries for service in other states. In January, 1776, the Continental Congress wisely decided that the troops it had directly raised and equipped should be separate in organization from those of local communities These "Continentals" were enlisted for longer terms, were trained more thoroughly, and thereafter provided Washington with a small, but comparatively more stable, nucleus, to work with, and they proved his chief reliance in the dark hours of the war They were the beginning of a Regular army. Washington's force varied from 8,000 troops in the operations around New York to as low as 4,000 after the winter at Valley Forge and as high as 26,000 in November, 1779 Other generals seldom had more than 6,000 men at their command, while some of the most important work of the war was done by bands of a few hundred under Sumter on the Catawba, Marion in the Peedee Swamps and Clark in the North-west.

When peace was declared Congress ordered the disbandment of the entire army except "twenty-five privates to guard the stores at Ft Pitt and fifty-five to guard the stores at West Point" Indian disturbances on the frontier soon caused an increase, and, when Washington was inaugurated President, the number of men in service was 595 Until 1812 the army passed through swift periods of rise and fall, an index of national fear From a bare single regiment when the Constitution went into force, it changed to two in 1779, three in 1791, six in 1796, nine in 1798, six in 1800, three in 1802, eleven in 1808, though the number authorized was always much higher than the number actually in service Under stress of the War of 1812 the army increased from 21 regiments in January, 1812, to a paper strength of 51 regiments a year later, though it is doubtful it a sixth of the authorized 58,000 men were ever recruited Counting militia and local combatants possibly 60,000 men at the most served during the war. The Regular army was reduced to 6,600 by 1820, the artillery stationed largely in the coast fortifications, and the infantry in the northern, western and southern frontier posts Just before the Mexican War the army had shrunk to an actual strength of 5,300 men, occupying more than 100 posts When war was declared the Regular army was recruited to war strength, and about 20,000 volunteers responded to the call, many of whom had to be sent home again because they could not be outfitted About 20,000 troops took part in the war altogether, Scott having about 10,500 with him in the Valley of Mexico In 1848 the troops were reduced to 8,000 scattered over the immense area to which the country had grown The task of dealing with the Indians in the Far West increased the army to a strength of 12,698 men by 1855, which it retained up to the Civil War

Enlistments in the Federal army during the Civil War numbered 2,898,304, including re-enlistments The number in service at one time was probably but little over 1,500,000. Estimates of the men in Confederate service vary from 700,000 to 885,000. Reduction on the usual scale in the Regular army was impossible after the Civil War because of the large number of troops (about 19,000) stationed in the South to support the military governments of the Reconstruction period, because of the threat of Maximillian in Mexico which sent Sheridan to the border with a large command, and because of increased Indian outbreaks in the West during the Civil War and immediately afterward. The Act of 1866 provided for a Regular army of 54,000 men paper strength. The actual strength was 38,540 men which decreased until in 1878 the effective strength was less than 20,000 men The force was well trained, however, because it saw almost constant service against the Indians in the West. At the beginning of 1896 the army numbered slightly less than 25,000 men, the smallest force in proportion to

population since the Revolutionary War. Calls for volunteers in the Spanish-American War increased the army to 216,029 men on Aug 31, 1898, its highest total. An Act in 1899 authorized the President to keep the strength of the Regular army at a maximum of 65,000, and in 1901 the maximum was raised by law to 100,000. The problem of administering the newly acquired overseas possessions called for this increase, the demand being so acute in 1901 that there was not a Regular infantry regiment within the borders of the United States. By 1904, however, the Regular army had dwindled to 59,000 men, and in 1907 it numbered 62,398, of whom 34,262 were stationed in the United States. (X)

History Since 1910.—On Feb. 27, 1911, Congress, besides making certain adjustments and staff increases, added 200 line officers to the regular army in order to meet the demands of the National Guard for instructors On Aug. 24, 1912, it passed an act commonly known as the "Manchu law" which required line officers to serve two years out of every six with troops. On April 27, 1914, it voted $250,000 for aircraft and on July 18, 1914, authorized an aviation section of the Signal Corps which was to have a maximum strength of 60 officers and 260 enlisted men

From the aspect of the World War while it was confined to the Eastern hemisphere and under the pressure of disturbances arising from Mexico, on whose border the entire stock of military aeroplanes of the United States proper was speedily consumed, the Government gradually realized the necessity of military upbuilding On June 3, 1916 it passed a National Defence act which provided an increase of the regular army from a war maximum of 128,653 to one of 287,846, organized the army of the United States into the regular army, volunteer army, officers' reserve corps, enlisted reserve corps and the National Guard while in the service of the United States; limited the number of enlisted men of the line to 175,000; proportioned the regular army into 65 regiments of infantry, 25 of cavalry, 21 of field artillery, seven of engineers, a coast artillery corps, two battalions of mounted engineers and other corps and bureaux of the War Department; defined the organization of a division to be three brigades of three regiments each, with auxiliary troops; made the term of enlistment seven years, three with the colours and four with the reserve, raised the aviation section of the Signal Corps to 148 officers, inaugurated vocational training; and federalized the National Guard by causing each member to take a new oath, which bound him to the will of the President as well as to State authority. The increased strength thus provided was, however, restricted in point of time by its division into five annual increments. Aug 29, 1916, another act created a Council of National Defence, composed of the secretaries of war, navy, interior, agriculture, commerce and labour, for the "co-ordination of resources for the national security"

Mexico.—When on March 9, 1916, the Mexican bandit, Pancho Villa, with about 1,500 men, killed 18 Americans and wounded many others in an attack on Columbus, N.M, units of the regular army and National Guard were concentrated along the border and Brig-gen J. J Pershing was sent into Mexico proper at the head of a punitive expedition of two brigades of cavalry and one of infantry After 12 minor engagements, Pershing's provisional division was brought north of the Rio Grande and later the National Guard organizations were ordered to their respective States (Feb 1917). These activities revealed concretely an inability to mobilize readily, an utter lack of aeroplanes and many deficiencies in staff-work, transportation and supplies. The concentration, extending approximately a year, afforded providential means of field training for the National Guard and machine-gun practice and manoeuvres for the regular army. Altogether the blow aimed by Villa against the United States proved to be an impetus toward preparation for the part America was soon to play.

The World War.—When the United States came into the World War on April 6, 1917, the regular army had received only its first increment from the act of 1916, and the National Guard was undergoing combined demobilization and reorganization. The strength of the available forces at that time was 199,705 officers and enlisted men, of whom 127,588 were regular army, 5,523 Philippine Scouts and 66,594 National Guard in the Federal service In addition, there were some 4,000 enlisted reservists, 2,192 in the Officers' Reserve Corps and some 117,500 national guards men not in the Federal service. The regular army was distributed as follows: United States, 94,076 (largely in the vicinity of Mexico); Philippines, 12,428; China, 1,383; Hawaii, 9,900; Panama Canal Department, 7,552; Porto Rico, 1,482; Alaska, 767. Of these 5,791 were officers. In addition there were, with various degrees of training, 3,199 National Guard officers in the Federal service, 6,926 not in the Federal service, 169 Philippine Scout officers and the 2,192 reservists mentioned—a total of 18,277.

Mobilization.—The three main and immediate problems for the general staff in supplementing the force on hand were. first, the acquisition of a legalized system of raising the required number of enlisted men in an equitable and efficient way; second, a quick method of improvising additional officers for training and leadership; and third, a sound and steady production of shelter and supplies for the large numbers to be summoned to the colours

The first problem was met by the Selective Service Act, May 18, 1917, which among other items allowed the regular army at once the full war strength of the 1916 Defence Act, provided for drafting into Federal service all members of the National Guard and its reserves, limited voluntary enlistment to four infantry divisions and authorized the conscription of a force of 1,000,000 men June 5, 1917, there were registered for the draft 9,925,751. July 3, 1917, the President called into service the entire National Guard which totalled 379,323 in the Federal service by Aug 5, 1917 The summoning of the first draft was delayed by lack of shelter and supplies, especially woollen clothing, until Sept 5, 1917, between which time and the spring of 1918 some 687,000 reported Dec. 15, 1917, all registrants were placed in five classes, according to personal qualifications and national needs Out of some 3,700,000 men in the army at the end of the war, about 2,800,000 had come from the draft, which had furnished a practical, uniform and just supply of recruits.

The second problem was met principally by three sets of reserve officers' training camps. The first series of 16, which began May 15, 1917, at 13 army posts in the United States, enrolled some 38,000 qualified applicants Aug 11, 1917, at the conclusion of the course, commissions in various grades up to colonel were awarded 27,341 graduates The second series of eight camps, beginning Aug. 27, 1917, enrolled over 20,000 candidates Nov 27, 1917, commissions as in the first series were awarded to 17,237 graduates These two series were composed largely of college men A special school for coloured candidates at Ft Des Moines, Ia, between June 18, 1917, and Oct. 18, 1917, graduated 630 captains and lieutenants

The third series of 27 camps, which began Jan. 5, 1918, partook more of the nature of schools, since 90% of the applicants were former enlisted men From this series there were graduated April 19, 1918, 11,659 men, who were pronounced eligible for appointments as second lieutenants The total output of all the series up to this time was over 57,000 graduates. After May 15, 1918 officers' training schools in the United States and its possessions replaced the camps until the end of the war

The Supply Question.—The third problem was not so speedily solved, principally because of the lack of preparation for undertakings of such demands and magnitude It was found necessary at once to construct camps and cantonments for the immediate occupation of troops, to organize adequate transportation, to obtain storage for current supplies and reserves, to prepare for their orderly distribution, to gain port facilities at home and abroad and to divert and almost revolutionize resources and industry on the basis of mobilization and operation of a large American army. The Council of National Defence, a functioning but restricted agency when war was declared, by means of its sub-committees and dollar-a-year men (prominent by reason of their previous efficiency, who offered their services to the country for a nominal remuneration), gained immediate contact with the commercial world and fathered the powerful War Industries Board, primarily existing on July 28, 1917, under the council with Frank A. Scott as chairman, but reorganized on March 4, 1918, as a separate administrative agency directly under the President, with Bernard M. Baruch as chairman. The new board, plenipotentiary

in character, co-ordinated and controlled resources, industry and transportation so as to produce an adequate flow of supply to the army and navy without impeding unnecessarily commercial activity in the United States. In its deliberations there took part representatives from the army, who controlled for the service through the operations and the purchase, storage and traffic divisions of the general staff

By an interlocking organization of these and other co-ordinate and subordinate agencies, tedious, duplicating and extravagant systems of supply were gradually eliminated Partly by appeals, partly by autocratic means the country, as it approached the end of the war, was made into a smoothly working plant with an output directed to meet the situation in Europe. The flow of materials to the Western front is pictured in the 9,000,000 tons of cargo that had been sent by the embarkation service at the time of the Armistice over a 3,500 m line of communications Shortly after the inauguration of the system of control made by the inland traffic service, the freight congestion in the United States was removed Between May 1917 and the Armistice the railways transported 8,714,582 men In addition to providing for 16 officers' training camps and 16 National Guard cantonments, the construction division was called upon to build 16 national army cantonments with an aggregate capacity of 640,000 men By Nov 1, 1918, it had 130,000 employes engaged upon 448 projects involving $756,000,000.

American Expeditionary Forces.—May 26, 1917, the secretary of war, in a letter to Maj -gen J. J Pershing, directed him to command the land forces of the United States operating in Continental Europe, to proceed there with his staff and to establish, after consultation with the French War Office, bases, lines of communication and depots, for active participation at the front; to co-operate with the troops of the other countries employed against the enemy and in so doing to preserve the identity of the forces of the United States (*See* under UNITED STATES section on *History, The War and Peace*) By the date of the Armistice, 29 American divisions had been engaged in active fighting, and American forces were holding 134 km or 22% of the entire Western front, having captured some 63,000 prisoners, 1,378 cannon and 9,650 machine guns The casualties for the entire American effort for the war were. Battle deaths, 50,510; wounded without mortality, 193,663, deaths other than battle deaths, 69,446, deaths from all causes, 119,956, prisoners of war, 4,423, total, 318,042.

Germany.—In accordance with the terms of the Armistice, American forces were selected to establish one of the three bridge-heads in the territory of the former German empire. The III. Army, with Maj -gen J T. Dickman commanding, and designated as the army of occupation, began its advance on Nov. 17, toward Coblenz, occupied by United States forces until 1923.

Other Fronts.—On Sept 1918 an expeditionary force of some 10,000 men was sent to Siberia About 5,000 American troops saw hard fighting in north Russia, and one regiment served in Italy.

Demobilization.—The Armistice necessitated the demobilization of some 3,700,000 in service overseas and in the United States, the termination of contracts with due regard to the interests of industry and the Government, the co-ordination with labour over the employment situation, and the prevention of congestion of ex-soldiers in the larger cities.

On the morning of Nov. 11, 1918, Gen. March issued orders for the immediate discontinuance of all mobilization; on Nov. 16 he gave specific instructions for the discharge of certain temporary forces in the United States, on Nov. 22 he issued instructions to Pershing covering procedure which would facilitate discharge in the United States of the oversea forces, but left to the commander-in-chief of the American Expeditionary Forces the order of return of units. The demobilization of personnel involved intricate problems of the care and rehabilitation of sick and wounded, the location of demobilization camps, the discharge of special classes for relief of distress and the needs of industry, the avoidance of congestion of labour, the economy to be exercised in transporting discharged soldiers, and the procedure at demobilization camps involving physical examinations and disinfection of discharged soldiers. It was necessary to retain in the service, in addition to the regular army, a large number who were indispensable to the care of billions of dollars' worth of property, and to the work connected with disembarkation, demobilization and convalescent centres, hospitals, domestic guard duty, fire protection and border police. By Jan. 4, 1919, there were discharged 732,766 men, by Feb. 1 the number had increased to 1,026,664, by May 1, to 1,936,011; and by July 1 to 2,736,654. By April 1, 1920, demobilization of enlisted men was practically completed In addition to the demobilization of personnel, the army was called upon to cause industry to return speedily to its peace time course, after labour, capital and manufacture had been occupied for a year and a half in preparing materials for war The problems confronting the War Department during the transition included the disposal of war supplies, the appropriate rate of curtailment of war production so as not to create widespread unemployment and economic disturbance, the settlement of claims and contracts, the adjustment of real estate connected with war activities, the liquidation of international obligations and of sale abroad

On Nov. 11, 1918, the equipment branch of the operations division, general staff, made a study of existing supplies, which resulted in the classification of materials and the retention of a war reserve During Jan 1919 there was established a claims board, which by the middle of the year had adjusted 25,196 contracts, besides those allowed to run By Sept 1, 1919, property in the United States costing about $700,000,000 had been sold for about $530,000,000 or 77% of its cost. Surplus property in France estimated to have cost $1,250,000,000 was sold for $500,000,000 Out of an estimated value of $3,276,349,533 worth of surplus property on hand at the Armistice, there remained in Jan 1926 only $9,278,269 worth, the materials represented by the difference having been sold at an average of 36% of their cost

Phases Since the War.—In order to overcome the waste and confusion incident to unpreparedness, Congress passed on June 4, 1920, the National Defence Act, which established the army of the United States in the approximate proportions of one-half organized reserves, one-third National Guard when called into service, and one-sixth regular army, the last factor being limited to 280,000 officers and men. For training and tactical control, the country and its possessions were divided into corps areas, all three components of the army within each area being potentially organized for prompt mobilization The regular army, the component engaged primarily in military training, was to be responsible for the instruction and proficiency of the other two components The President could change the strength of the different arms to suit varying demands of national defence and the developments of the new services, such as air, chemical warfare and tank corps. Within the regular army a single promotion list for officers throughout all branches, except the Medical Corps, equalized advancement by seniority. Provision was made for reserve officers' training corps in colleges and for training camps during summer months. Altogether the legislation was viewed generally as the first sound military policy of the United States Accordingly, in 1921, the army spent its efforts upon training and recruiting qualified personnel On June 30, 1922, Congress reduced the regular army to a maximum of 175,000 officers and men, and later in the year made the maximum for officers 12,000, so that it was necessary to separate from the service over 100,000 officers and men, many of whom had recently enlisted or been commissioned But 1925 the regular army found itself unable through lack of funds and numbers to carry on for itself and the other components of the Army of the United States the entire training contemplated by the latest Defence Act. Though $334,533,786 was voted in the Army Appropriation bill, less than half of that amount went to purely military upbuilding of the regular establishment That body, aside from its work with the reservists and National Guardsmen, lent aid to industry, commerce and public welfare The Corps of Engineers put many millions into mapping, waterways and harbours; the bureau of insular affairs increased revenues from island possessions; the medical department made signal contributions in the treatment of empyema, pulmonary tuberculosis and orthopaedic ailments for mankind and rinderpest for animals,

the judge-advocate-general's department in one particular of settling national claims before U S courts handled suits involving $55,000,000; the adjutant-general's office administered the Adjutant Compensation Act covering the cases of 5,250,000 men; the Quartermaster Corps was the only available agency for the immediate and material relief of the Miami and Mississippi flood sufferers, and rushed to Miami alone an initial lot of supplies valued at $106,000; the chemical warfare service produced means of eradicating vermin, rodents, moths, bats and flour weevils from vessels, bakeries, depots and warehouses, saving a Western plant in one instance over $75,000; the Air Corps, in its perfection of the parachute, its photography, its patrolling of forest fires, its delivery of serum and its bombing of ice jams not only proved helpful to aviation but to general comfort as well, and the Signal Corps in operating the 37 radio, cable and telegraph stations between Seattle and Alaska, in serving other departments of the Government with the largest radio net in the world and in laying 4,588m. of cable, assisted the public materially in efficiency and economy. In its educational system the army operated 43 separate schools by the end of 1927. The regular force in 1928 came to the understanding more than ever that national security and preparation to maintain peace remained its paramount duty Signal influences which have retarded progress toward that end in recent years are found in squalid housing conditions, stagnation in promotion, the country's fast diminishing reservoir of war veterans and the waning strength of a permanent establishment. Temporary war structures are the present supply of shelter for a large part of the officer and enlisted personnel Increase in junior grades since the war with subsequent curtailment has retarded promotion to such an extent that many officers could ordinarily never become colonels The asset of trained war veterans has through disability, age, death and domestic obligations materially been decreased in the decade since the war Moreover the regular army is numerically less than on April 6, 1917, notwithstanding the population has increased some 20 millions The following table, while partially disclosing the truth of the statement that national defence costs the average American citizen less than a penny a day, also reveals the trend in recent years toward a positive decline in strength

Year	Estimated population of U S	Strength of regular army (officers and men)
1917 (Apr 6)	113,854,000	127,588
1918 (June 30)	115,461,000	725,065
1919 ,,	117,064,000	836,845
1920 ,,	118,683,000	200,299
1921 ,,	120,902,000	219,527
1922 ,,	122,545,000	138,424
1923 ,,	124,539,000	113,646
1924 ,,	126,771,000	132,665
1925 ,,	128,617,000	127,523
1926 ,,	130,570,000	124,928
1927 ,,	132,256,000	125,027
1928 ,,	133,836,000	125,000 (est)

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NAVY

The present United States navy was preceded by several provincial navies and a Continental navy which had their origin in the Revolutionary War. When the colonists besieged Boston the British Government sent supplies to convert the garrison into a field army. This mobilization brought many transports from England to the American coast without adequate naval protection, and in September, 1775, Washington commissioned seven ships of war and filled his own needs with stores captured from the British The most important prize was an ammunition ship which enabled him to compel the evacuation of Boston. The following summer, General Arnold retreating from his repulse at Quebec built a flotilla on Lake Champlain with which he delayed the advance of the British army into New York until workmen could be summoned from Canada to outbuild his navy This was then destroyed, but the delay thus incurred caused the British invasion to be postponed till the following year, 1777, and by that time the conditions in New York had so changed that the British force from Canada surrendered at Saratoga. This campaign on the lake was in effect the most important American naval incident of the war.

As for the State navies most of the individual States availed themselves of their sovereign power to establish local navies to defend their own commerce and seize British shipping along their respective shores The States also issued letters of marque to privateers and dealt with prizes in their admiralty courts The State navies were local in their activities, but they and the State privateers took many prizes which were counterbalanced by American losses to the British fleet and privateers.

The true forerunner of the United States navy was the Continental navy, authorized by the Continental Congress and operated by a Committee of the Congress and then by a Board of Admiralty including members of Congress. These executive organizations, holding only delegated authority, were frequently unwarrantably overridden by Congress. Congress adopted a disciplinary law, the articles of war, abridged and adapted from the British law, and as many of the principal officers and men of the new navy had served in the British fleet, the entire ship's organization and administration followed those of the British. The Committee of Congress carried on its executive work through two local supervisory boards which ordered courts-martial and procured and bought ships Under these at different ports were Continental agents to man ships and purchase supplies, shipbuilding agents for construction and prize agents to handle prize cases. The administrative system was very loose and unsatisfactory.

The total naval force was at no time over 3,000 men and 20 ships with 550 guns. The British force on the American coasts was nearly four times as large The general policy of the committee was to strike at British commerce, and many prizes were made Such operations kept open communications with France and helped to bring about the French alliance. Discipline was not well established, esprit-de-corps was lacking and the ships were short-handed, for the most efficient men preferred privateering On the other hand, the British navy was also short-handed, for the colonials, who had furnished 18,000 men to the navy, in the Seven Years' War, were now hostile

The principal accomplishment of the navy was the victory of John Paul Jones in the sinking Bon Homme Richard over H M S "Serapis." Although a minor incident of war in itself, it showed the late colonials that they were not inferior in stamina to the men of the mother country, and was the foundation of American naval tradition and esprit-de-corps By no formal Act of Congress, but by cessation of appropriations, the Continental navy went out of existence after the peace of 1783, leaving the victory of Jones as a priceless heritage to the future United States navy.

Upon the establishment of the Federal Constitution, no need was at first felt for a navy; but the depredations of the Barbary Powers upon United States shipping caused Congress to authorize a fleet under the War Department for the protection of commerce. The support of commerce is still the governing policy of the Navy Department, as the attack on hostile commerce was the objective of 1776. The six ships of 248 guns laid down under the Act of 1794 were designed and equipped by the best talent in the country and were unequalled in their class. A force of nearly 2,000 officers and men (including marines) was authorized for them.

As these ships approached completion in 1798, Congress created a Navy Department under a Secretary of the Navy as a cabinet officer, exercising delegated authority from the President as constitutional Commander-in-Chief. The disciplinary law of the navy was modelled after that of the Continental navy. With the appointment of several senior officers from the old Continental service, the new one, as was natural, again assumed for American ships the customs and organization of the British fleet. As for

the department itself, the organization and control were very rudimentary, and ships and naval stations did much as their respective commanders pleased During the administration of Jefferson, the organization, however slight, which had been wisely laid down under President Washington fell to pieces

The successes in the quasi-war with France in 1798 and the squadron operations against Tripoli in 1803–5 completed the formation of the navy. Thereafter the United States service had standards of its own of squadron administration, of heroic service, and of tradition and esprit-de-corps to live up to Just previous to the War of 1812 the navy increased its tonnage to 14,260 and its officers and men to 5,500, besides 1,300 marines, the usual complement of marines on board ship being about one for each gun (although not serving the guns).

Upon the declaration of war against Great Britain in 1812, on account of war measures affecting trade and shipping, the squadron at New York put to sea without waiting for orders from Washington and covered the return of American shipping, besides operating successfully against hostile commerce It was well done. though the administration could claim no credit. There were several frigate actions which brought much prestige to the navy, but soon the overwhelming might of the British navy drove American commerce from the seas, blockaded American ports, destroyed American towns and paralyzed American industries. The important victories of the navy were on lakes Erie and Champlain The first cut the lines of communication of the British army in Michigan and obliged it to flee to Canada, thus giving America permanent possession of the Ohio Valley, and the second turned back the British army advancing into New York The country was mortified and depressed by the failure of the army to occupy Canada and by the coastal raids, but the naval victories together with Jackson's defeat at New Orleans of the veterans of Wellington's Peninsular army gave full compensation in the exaltation of the national spirit As the campaigns in the Mediterranean in 1803–5 had knit the navy, so the naval victories of 1812–14 established the self-confidence of the people Thenceforward, the nation was independent, not only politically, but in spirit

The lack of departmental organization made itself evident during the war and the Secretary of the Navy resigned under pressure The new secretary, William Jones, proposed a complete organization based on that of the British Admiralty, yet avoiding its defects on the civil side. Congress amended his proposal, and in 1815 provided for a board of three naval commissioners The terms of the act gave the board control of the civil and military branches of the navy under the secretary. But President Monroe decided that the material side should have technical supervision by the board and the military side, the "employment" of the navy, was something to be cared for by the civil secretary and his clerk without naval advice Thus Jones' effort to provide a "General Staff" to direct strategic operations and training was postponed for a century The Board of Navy commissioners set to work to centralize naval administration, to draw up regulations and to limit the vagaries of captains by requiring them to answer to the department But the board did not give entire satisfaction and in 1842 Congress substituted for it a group of civil bureaus for the supply and maintenance of the navy.

As in 1815, so in 1842 the original bill provided for an office of operations, but Congress saw only the need of creating an organization to spend the money it appropriated. It did not see that it was equally needful to organize for the purely executive work of managing the fleet. Between the close of the war in 1815 and the Civil War in 1861 the navy was chiefly occupied in assisting commerce. Exploring and surveying expeditions went out over the world. A commercial treaty with Turkey was initiated and Japan was brought into the circle of western nations. A squadron was maintained on the coast of Africa for the suppression of the slave trade. After 1815 the navy shrunk to under 4,000 men and then increased to over 12,000 (with marines), at the time of the Mexican War in 1846–7. This war made no great demands on the navy although it took possession of California, administered the government, and escorted and landed the army at Vera Cruz for the march to Mexico City.

When the Civil War came in 1861 the navy took a great part It expanded from about 10,000 men to 60,000 and from 133,000 tons of shipping to over 500,000 at the close in 1865 Its principal task was to cut off the Confederacy and its field armies from sources of supply across the ocean. This it did by a very effective blockade of the coasts and by seizing the control of the Mississippi river in conjunction with Grant's army so that little from the south-western area got to the field armies The work was comparable to that f the British navy in isolating Germany in the World War. For this administrative task the Navy Department added new bureaus, but the principal change in organization was the appointment of an assistant secretary to direct operations and practically to assume the duties of a chief-of-staff When the war was finished the office of assistant secretary was abolished and the duties of operation of the navy were taken as a side-line of work by one of the maintenance bureaus.

For nearly 20 years after the war public interest lay in the political reconstruction of the South and the economic development of the West The navy was neglected and it grew rather stale Numbers fell to 10,000 and efficiency was not high But in the early eighties, public interest revived and by the time of the Spanish-American War in 1898, the navy had some fine ships and was gaining efficiency. The two battles of Manila and Santiago, in which two hostile squadrons were destroyed with only one American killed, made it impossible for Spain to continue the war The policy of the United States and the development of the navy were greatly modified by the war, for the country now began to realize that it was a world power with trade interests extending everywhere But for the moment sea-power was not imperative and the navy turned to contemplate the possibility of a war with Germany and to prepare itself if called upon The navy now grew rapidly and the fleet developed its organization and administration for handling large bodies of combatant ships.

In 1909 Secretary Meyer attempted to perfect the departmental organization by his executive authority without appeal to Congress He grouped the material and personnel bureaus under two aides in his office. established an inspection system under another, and most important, he established an Office of Operations under a fourth aide to manage the training and employment of the fleet The last aide headed a general staff in effect although not in name The change was a distinct betterment.

As it became apparent to the Administration after the opening of the World War in 1914 that it was necessary at least to be able to make a show of force, Congress in 1915 completed the organization of the department by establishing an office of naval operations for the direction of the fleet after the bureaus of maintenance had supplied the raw materials in ships and men The following year, 1916, at the request of the President, Congress authorized 16 capital ships of the largest size, and for the former method of promoting officers by seniority, it substituted a system of selection by merit, a measure of far-reaching efficiency After the United States entered the war in 1917, the navy personnel was increased from some 75,000 (including marines) to eight times as many, including reserves in service No major naval action occurred after American entry to the war, but the American navy added a squadron to the British Grand Fleet, laid a huge system of mines in the North Sea, and swept them up after the war, escorted convoys off Ireland and in the Mediterranean, and transported army stores and about 1,000,000 soldiers to France After the armistice, the navy was rapidly reduced to its present (1929) figure of 112,000 officers, men and marines.

Soon after the entrance of America into the World War, the shipbuilding programme of 1916 was at the request of Great Britain temporarily laid aside to build torpedo boat destroyers, merchant ships and other types of craft which the allies lacked The building programme of 1916 was resumed after the armistice When the new Administration took office in 1921 it invited Great Britain, France, Italy and Japan to a conference on the reduction of naval armaments to meet at Washington in November 1921. At the assembly the American delegation proposed to sacrifice the greater part of the 1916 programme and reduce the battleship tonnage of this country immediately and Great Britain later

to 525,000 tons and that of Japan to 315,000 tons with corresponding limitations in all other classes of combatant ships. This was promptly accepted by Great Britain as to battle-ships, but she refused to cut her cruisers. France refused to abolish submarines and Japan limited fortifications in the western Pacific outside of Japan proper, thus altering the value of the 5-5-3 ratio proposed by the United States. No new ships were authorized for several years. By 1926 many of the U.S. cruisers were old and obsolete and several cruisers of the largest size permitted by treaty (10,000 tons and 8-inch guns) were authorized. There was discussion on armaments at Geneva in 1926. Conversations then followed between representatives of America and Great Britain and, as an agreement seemed possible to the President, he called a conference at Geneva in 1927 between the five powers, but only Great Britain and Japan accepted. Contrary to the American expectation the British delegates proposed changes in the Washington Treaty which were refused, and no agreement could be reached as to cruisers, as the British desired a large total number and the United States large individual ships, each country's demands being based on her geographical needs. The following are the ships and tonnage of the American Navy (1929)

Table of Combatant Ships of the United States Navy

(1) Classes limited by treaty	No.	Tonnage
Battle-ships built, ready for service	18	525,850
Aircraft-carriers, built, ready for service	3	78,700
Aircraft-carriers, appropriated for	1	13,800
All the above ships are under 20 years of age since date of completion		
(2) Classes unlimited by treaty		
Cruisers, building, appropriated for or authorised	23	230,000
Cruisers, completed, ready for service	32	254,425
Of the above finished cruisers, 22 of 179,425 tons are over 20 years of age, and ineffective owing to deterioration of material and obsolescence of design The 23 cruisers building are largely to replace these old ships		
Destroyers, under 16 years of age since completion	260	310,429
over effective age of 16 years	10	7,986
Submarines, under 13 years of age since completion	108	81,807
over effective age of 13 years	14	5,652
building	2*	5,520*
Light mine-layers, under 16 years of age since completion	14	16,674
Mine-layers, under 20 years old since completion	2	7,600

There are many other auxiliary ships belonging to the navy as tenders, hospital ships, fuel ships and supply ships of various kinds which are not usually considered as combatant ships although most have a slight armament

*Exclusive of 3 whose design is not yet approved

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AVIATION ORGANIZATION IN THE UNITED STATES

The three services in the United States, the army, navy and Marine Corps, have their own aviation forces which work with the service to which they are assigned and upon the specific problem for which they are trained.

The bureau of aeronautics of the navy department, as its designation implies, is one of the major departments under the secretary of the navy and the chief of naval operations The Bureau of Aeronautics is charged with the procurement of aircraft and all accessories necessary to operate them, and naval aviation operates as a part of the fleet at the direction of the secretary of the navy, the assistant secretary of the navy for aeronautics and the chief of naval operations. The chief of the Bureau of Aeronautics, in conjunction with the heads of his various sections, submits recommendations as to the type and number of aeroplanes required, the use to which they will be put and the extent to which they will be utilized to assist in successfully carrying out all naval missions. Aviation in the navy is generally considered to be a necessary part of the navy rather than a separate organization working in conjunction with it An air force, with naval aviators and suitable aircraft, accompanies the fleet at all times and instead of performing missions of its own, simply supplements every phase of naval operation

The aviation organization of the army is almost identical with that of the navy and is termed the Army Air Corps. It is charged, as is the bureau of aeronautics, with procurement; and questions of operations, etc., are handled through the chief of staff of the United States army Practically the only difference between the organizations of the two services is that all army personnel on aviation duty are attached to the Air Corps, while the navy has no similar organization within the naval service in general to which personnel is attached

The United States Marine Corps has an aviation branch whose duties are similar to both those of the army and navy and which is conducted in almost exactly the same way as naval aviation

The mission of aviation in the three services differs widely as the army aircraft operate primarily over land and have in a majority of cases only land problems to consider Naval aviation operates almost altogether with the fleet and along the coasts, and although practically all of their missions are carried on at sea, naval aviators are trained in land plane flying in preparation for duty on carriers. Aviators in the Marine Corps are trained primarily for expeditionary duty, which consists of a combination of both land and sea flying During the World War this aviation branch under the command of the United States navy, operated land planes against inland objectives in conjunction with the British navy. In the future it must be prepared to carry out similar missions, and also to operate from the decks of carriers or the surface of the sea in connection with the landing of forces on hostile territory, where it may be called upon to use either land or seaplanes.

The services have been criticized on numerous occasions for duplication of effort in the procurement of material and consequent useless expenditure of large sums. This statement is without foundation, as excellent co-operation is maintained Each service is kept informed of the activities of the others by means of an exchange system and any special information required is furnished upon request. Any duplication which exists takes place in connection with projects which are of such wide scope that the results cannot prove to be other than beneficial. In the opinion of the majority the aviation forces of the United States are allocated in a manner that will best increase the efficiency of the armed forces as a whole and strengthen the defence of the nation See also Air Forces (H. C. M.)

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IX. CONSTITUTION AND GOVERNMENT

An account of the governmental system of the United States must be largely descriptive of the organization of National and

State Governments. But it must also analyze certain of the fundamental characteristics that distinguish the United States Government from other Governments Bearing this two-fold object in mind, it will be convenient to discuss the general characteristics first, and to follow with a description of governmental organization. Under this plan, the discussion of the Constitution and Government of the United States is organized as follows:

1. The Federal system
2. Written Constitutions
3. Judicial construction of written Constitutions
4. Separation of powers
5. Presidential system of Executive organization
6. The National Government
7. The State Governments
8. Local Government in the States
9. The Party system

1. THE FEDERAL SYSTEM

By the Declaration of Independence in 1776, the thirteen American colonies of Great Britain expressed their action as that of "these united colonies," but the terms of the declaration implied that each became an independent State The thirteen united in declaring independence and in the conduct of war, though their co-operation was ineffective The Articles of Confederation, adopted in 1781, constituted a legal symbol of union, but the Central Government under these articles had no coercive power over the States, and no power whatever capable of exercise directly upon the citizens of the States The national Constitution framed in 1787 and put into effect in 1789, was intended to remedy this situation by creating a Central Government with large powers and with authority to exercise these powers, not merely upon the States, but directly upon all citizens of the country When the first Congress of the United States under the Constitution of 1787 assembled in New York in April, 1789, the Union had a membership of eleven States North Carolina and Rhode Island soon joined their sisters of the original thirteen States. The thirteen have now grown to forty-eight

Share of States in the Government of the Nation.—Under the Federal principle in the United States, the States, as such, are constitutionally guaranteed their territorial integrity, and are expressly recognized as units in the organization of National Government They have equal representation in the United States Senate They are treated as units in the election of president and vice-president, and of members of the Federal House of Representatives They have a decisive share in the amendment of the Constitution of the United States

When the National Government was being formed, a sharp conflict of interests arose between the small States and the large States The smaller States contended for complete equality among the States in the organization of the National Government, and the larger States contended for influence in proportion to population A compromise was reached by which the States are equally represented in the United States Senate irrespective of population, and in proportion to their population in the House of Representatives. By the terms of the Constitution no State may without its consent be deprived of its "equal suffrage in the Senate"

Representation in the National House of Representatives is based upon population. Under the Constitution, each ten years, after the decennial Federal census, the Congress of the United States determines how many members will constitute the House of Representatives, though there has now been no re-apportionment since 1911. This number is then divided into the total population of the forty-eight States. In this manner a ratio of representation is obtained. Each state is entitled to as many representatives as this ratio is contained in its population, although each State, no matter how small its population, is entitled to at least one representative. After the division of the representative ratio into the population of each of the States, large fractions of population may remain; and the states having the largest remainders have in the past received additional representatives, as long as the number agreed upon was not exceeded

In the election of the president and vice-president of the United States, the framers of the national Constitution provided for so-called electoral colleges. Each State chooses a number of presidential electors equal to the number of its members in the National House of Representatives, plus its two senators. The plan of the Constitution was that these electors should actually exercise a choice as to who should be president However, almost since the beginning of the Government, candidates for the presidency and vice-presidency have been nominated by the great political parties of the country in advance of the choice of electors. These political parties also nominate within each State their candidates for presidential electors. The candidates of any party for electors are definitely pledged in advance to vote for the candidates nominated by that party for president and vice-president For this reason, everybody knows who will be president immediately after the November election at which the electors themselves are chosen In this respect, unwritten law, developed by usage, has altered the operation of the written text of the Constitution In recognition of the fact that presidential electors are merely a device for casting a certain number of votes allotted to the State, Iowa, Nebraska, Wisconsin and Illinois provide for a direct vote for candidates for president and vice-president, and omit from their ballots the names of candidates for presidential electors

The great political parties nominate candidates in national nominating conventions, which usually meet in June or July preceding the November election for the choice of presidential electors These conventions are composed of delegates chosen either by primary elections or by party conventions in the States In the Democratic convention each State is represented by a number of delegates equal to twice the number of the State's combined representation in the Senate and House of Representatives of the United States. In the national Republican convention the representation of the States in the two houses of Congress is taken as a basis, but reductions are made in the number of delegates from States having small Republican votes The States may, however, properly be regarded as units in the machinery for nominating party candidates. And in the nomination of presidential candidates, a populous state wields a large influence—an influence greatly magnified if the State is both populous and politically doubtful.

Two methods are provided for amending the Constitution of the United States An amendment may be proposed by two-thirds of the members of both houses of Congress, and goes into effect when ratified by the legislatures of three-fourths of the States, or by conventions in three-fourths of the States, as Congress shall determine. Congress is required by the Constitution to call a convention for proposing amendments, on the application of the legislatures of two-thirds of the several States No convention has ever been called, and Congress has always provided for the ratification of Federal amendments by State legislatures rather than by conventions called for this purpose The machinery employed in the adoption of all the nineteen amendments to the Constitution of the United States has been (1) proposal by two-thirds of both houses of Congress and (2) ratification by the legislatures of three-fourths of the States

The States as governmental units still have a decisive influence with respect to any change in the National Constitution In other respects, so far as they influence the organization and Government of the nation, they have tended to become merely units for national election purposes. The State has to a large extent lost its political individuality as a unit in the Government of the nation. The decreased political importance of the State as a unit in national affairs is due mainly to the development of rapid means of travel and of communication The constant shifting of population from one State to another has prevented the newer States from developing the solidarity possessed by the original thirteen. The very increase in the number of States has reduced the importance of each as a unit in the National Government

Not only this, but, since the establishment of the Federal system, national politics has dominated The ambitious political

leader looks to advancement from State to national office. Nominations for the presidency are the most conspicuous prizes in the political organization. The popular election of United States senators by each State under the Seventeenth Amendment has itself tended to reduce emphasis upon the state as a political unit, and to treat it as merely an electoral area in the organization of the National Government. While the States still determine affirmatively who shall vote in State and national elections, the Fifteenth and Nineteenth Amendments forbid discrimination on account of race, color, previous condition of servitude or sex, and the United States Supreme Court has recently held that the Fourteenth Amendment forbids State legislation with respect to like discriminations in party primaries Of all the States, Maine alone still adheres to a date for State elections different from that for national elections. As soon as national and State elections came generally to be held upon the same day, we had a full establishment of the dominance of national politics.

Powers of the States and Nation.—In powers within their own borders and in senatorial representation the States are equal.

The States under the Federal system are units in the formation of a nation, not Governments independent of a nation. Before the Civil War a number of conflicts arose between National and State power, in which first one group of States and then another asserted its authority to proceed independently of the nation Pennsylvania, Massachusetts, Virginia and other states in turn opposed the supremacy of National power under the Constitution The Civil War settled finally and conclusively that the States are merely units, although indispensable units, in the formation of a single national organization

The limitations imposed upon the States by the Constitution of the United States clearly indicate the purpose to establish a single national organization, with the States as units in that organization States are forbidden, without the consent of Congress, "to keep troops or ships of war in time of peace, enter into any agreement or compact with another State or with a foreign power, or engage in war, unless actually invaded, or in such imminent danger as will not admit of delay." They are forbidden to enter into treaties, alliances, or confederations. These types of limitations upon the States indicate a definite purpose to deprive the States of any independent existence as organizations in themselves, and this purpose is supported by the language making the "Constitution, and the laws of the United States which shall be made in pursuance thereof, and all treaties made or which shall be made under the authority of the United States," the supreme law of the land

The powers of the National Government are such as are granted to it by the Constitution of the United States They must be found within the terms of that document It has no others This basic principle was implied but not expressed in the Constitution as first adopted. So important was its expression in the Constitutional text regarded that the Tenth Amendment, adopted in 1791, provides that "powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people" The States gave up certain powers in establishing the National Government They set out these powers in a written document, and expressly reserved all other powers to themselves or to the people. The powers of the nation, found within the terms of this written document are superior to the powers of the States.

Who is to determine, in case of doubt or conflict, whether such a superior power, asserted by the Government of the United States, is within the terms of the Constitution? Before the Civil War, States often asserted the authority to determine for themselves what powers belonged to the National Government, but such assertions were unsuccessful Since 1816 the legal principle has been established that the line between National and State powers is to be drawn by the United States Supreme Court, an organ of the National Government.

What are the powers granted to the nation? Express powers, couched in most cases in broad language, are conferred on Congress, by a series of seventeen paragraphs in Article I, section 8, of the Constitution. In even more general terms powers are conferred on the Executive and Judicial Departments of the United States In only one case is the power granted to the National Government expressed as an exclusive power. Certain powers are of such a character that they must be exercised exclusively by the National Government, as for example, the levying of Federal taxes, borrowing money on the credit of the United States, constituting Federal tribunals inferior to the Supreme Court, and the establishment of a uniform rule of naturalization. Others are made exclusively National by Constitutional prohibitions upon the States The Federal power to coin money is supplemented by forbidding States to coin money. The Federal war powers are made exclusive by prohibitions upon the States The Federal treaty-making power is supplemented by forbidding State treaties and by inhibiting State compacts without the consent of Congress Other powers are of such a character that they may be exercised by either of two Governments, but not by both The grant of such a power to the National Government makes it exclusive

Of necessity, many of the powers granted to Congress are not exclusive In such matters, States may exercise power also, provided State action does not conflict with the superior powers of the National Government in the same field Congress has complete power to regulate bankruptcies, but during a good part of the time since 1789 there has not been a Federal bankruptcy law, and the matter has been left to the States Congress has only in small part exercised its power to fix the standard of weights and measures, and there is valid State legislation upon this subject in all the States. The Constitution itself expressly provides for concurrent authority over the militia, and the Eighteenth Amendment expressly confers the concurrent power of enforcement upon "the Congress and the several States" Under a general grant of power to regulate interstate commerce, Congress has full power, but the states may legislate in regard to local needs and circumstances, unless Congress otherwise directs

Although all powers of the National Government must be found within the terms of a written document, this by no means implies that all powers must be expressly granted by that document The Constitution of the United States grants a number of important powers in broad terms to Congress and to the other departments of the National Government It further empowers Congress "to make all laws which shall be necessary and proper for carrying into execution the foregoing powers, and all other powers vested by this Constitution in the Government of the United States, or in any department or officer thereof"

Throughout the earlier decades of Government under this Constitution, political and legal contests centred about the meaning of the words "necessary and proper," one party emphasizing the word "necessary" as narrowing the powers conferred and the other the word "proper" as broadening them. The rule of broad and liberal construction announced by Chief Justice Marshall in 1819 has prevailed·

"Let the end be legitimate, let it be within the scope of the Constitution, and all means which are appropriate, which are plainly adapted to that end, and which are not prohibited, but consistent with the letter and spirit of the Constitution, are constitutional."

Substantially all powers not National belong to the States, and such powers must be determined in large part by a process of subtraction. Naturally no precise result can be obtained when the powers to be subtracted are based on broad implications and are not definitely determined The important national powers with respect to interstate commerce, taxation, treaties, post offices and post roads, and maritime jurisdiction, have been construed broadly, almost without exception

For more than a century the United States Supreme Court has been engaged in determining the line between National and State power This is a continuing duty. It is impossible to draw any definite or permanent line between National and State functions The steamboat and the railroad, the telephone and the telegraph, the aeroplane and the radio have been the potent factors in the development of National power. Railroad regulation began with the States, but has tended to come almost completely under National control. Rapid progress in this direction has been made

since the creation of the Interstate Commerce Commission in 1887. The so-called anti-trust movement began with the States, but restrictive commercial practices have largely come under National supervision with the Sherman Anti-Trust Act of 1890 and the creation of the Federal Trade Commission in 1914 Where a problem is national in character its solution will by some means fall to the National Government The broad and flexible powers of that government are capable of further expansion as new needs develop with economic, social and engineering changes

Along with the increase in National powers and in the activities of the National Government has come also a similar increase in the functions performed by the State Government With the increased complexity of modern life, the functions taken over by the nation are small as compared with the new activities of State Government. State Governments today do more than ever before and cost more in proportion

Powers of State Governments are broad and comprehensive Subject only to the condition that the Government shall be Republican in form, the States organize their own Central and Local Governments and provide revenues for the support of these Governments The State Courts administer the great body of law affecting the rights of individuals, and for the suppression of crime Education, though aided by the National Government, is under the control of the States and of the Local Governments created by them The same statement applies to the construction and maintenance of highways, and to the great mass of governmental details with which the citizen comes in daily contact. Indeed, the American of to-day is still in much the position described by James Bryce forty years ago.

"The State, or local authority constituted by State statutes, registers his birth, appoints his guardian, pays for his schooling, gives him a share in the estate of his father deceased, licenses him when he enters a trade (if it be one needing a license), marries him, divorces him, entertains civil actions against him, declares him a bankrupt, hangs him for murder The police that guard his house, the local boards which look after the poor, control highways, impose water rates, manage schools—all these derive their legal powers from his State alone."

Separate Administrative and Judicial Systems of Nation and States.—Throughout the territory of each State two governments operate—the Nation with its administrative and judicial organizations for the enforcement of National law, and the State with its administrative and judicial organizations for the enforcement of State law. Federal revenues are collected through officers controlled from Washington, State revenues are collected by independent State and local officers Taxes levied by the two are in some cases similar in character The Nation and a number of States impose income taxes, but their administration is independent Violations of State law are tried and punished in State Courts, violations of National law in separate Federal Courts In some cases the laws of the two are directed to the same purpose, and are substantially identical The Constitutions of both forbid that a person be twice put in jeopardy for the same offence, but in legal theory the two Governments are so distinct that one act, forbidden by substantially identical laws of each, may be punished by each as a separate offence

The reasons for this sharp distinction between the two Governments are historical The Articles of Confederation (1781–1789) sought to act through the Governments of the several States, and not directly upon the citizens of the States Government under these Articles failed, because each State finally determined for itself whether it would enforce the policies of the Congress The National Government, organized under the Constitution of 1787, had it thought proper, might have sought to use the States as agencies for the enforcement of National law, as is largely done under the Federal systems of Germany and Switzerland But under the circumstances it was natural to build up an independent administrative and judicial system This system has steadily grown with the expansion of National activities.

2. WRITTEN CONSTITUTIONS

Under the Federal system it is substantially necessary to have a written document defining the organization of the Central Government, and determining the respective powers of the States and the Central Government It was natural, therefore, that Articles of Confederation should be framed for the creation of the first Union of the American States, and that, when improvement was needed, these Articles should be replaced by the National Constitution of 1787

There was no similar legal necessity that written constitutions be framed for the Government of the American States. Yet the colonies were accustomed to written instruments of Government Certain of them operated under Royal Charters Massachusetts largely remained under its Charter Government until 1780, Connecticut until 1818, and Rhode Island until 1842 In other colonies the royal commissions to governors gave some written basis for government Moreover, the leaders in the colonies were familiar with and largely adherents of the theory that government is a result of social compact, and theories of natural rights were strong

It was therefore natural that, upon separation from England, the several colonies should embody in written form a declaration of their rights and the general organization of their governments Before the framing of the National Constitution in 1787, constitutions had been framed and adopted by all the original thirteen States except Connecticut and Rhode Island The framers of the National Constitution therefore had before them the texts of State constitutions and were familiar with the experience under these constitutions Each State is now governed by a written Constitution

3. JUDICIAL CONSTRUCTION OF WRITTEN CONSTITUTIONS

The Constitution was regarded from an early date as law of a superior order and of a more permanent character than legislative acts Under the first State Constitutions legislatures were the dominant organs of Government They abused their wide powers, and helped develop a feeling that legislative authority should in some measure be curbed In New Jersey in 1780 a statute was declared invalid as violative of the State Constitution Other decisions of this character gradually accumulated Apparently the framers of the Federal Constitution were in 1787 of the opinion that it would be the function of the Federal Courts to preserve the powers of State and Nation under the Federal Constitution Such a power in the Federal Courts carries with it authority, in a case involving the issue, to declare either a Federal or a State law invalid as violative of the Constitution of the United States Since Chief Justice Marshall's opinion in 1803, in *Marbury* v *Madison,* the principle of judicial power to declare laws unconstitutional has been established in the Federal system The authority of State Courts to declare State laws invalid as violative of State Constitutions is equally well established Except for a few provisions which are regarded as committed to the political organs of Government, it may therefore be said that placing language in a written Constitution makes such language judicially enforceable as against the legislative bodies Whereas Parliament is the supreme lawmaker under the English system of government, in the United States the written Constitution as finally construed by the courts is supreme Where constitutional provisions are clear and precise this supremacy of the Constitution as judicially construed makes little difficulty But where language is used that is not capable of precise definition, as that of the Fourteenth Amendment that no State shall "deprive any person of life, liberty or property without due process of law," the court in fact determines not only the constitutionality but also the wisdom of legislative action.

4. SEPARATION OF POWERS

National and State Governments in the United States are each organized into three departments The theory of separation of powers is formally announced in forty State constitutions In the remaining eight State Constitutions and in the Constitution of the United States the same constitutional result arises from the fact that these nine documents create three departments of government, and vest the legislative power in one, the executive power in another, and the judicial power in a third

There are no clear lines separating one governmental function from another, and the courts have therefore been unable to develop any logical lines of division. Legislative power having been delegated to Congress and the State legislatures, the courts frequently say that legislative power may not be delegated, but the very necessities of modern life have forced in the United States, as in England and on the Continent, the vesting of a large amount of subordinate legislative authority in permanent administrative bodies within the executive department. In order to avoid terming this a delegation, the courts have come to designate such powers as "*quasi*-legislative," rather than "legislative." In the same manner, administrative bodies within the executive department have come to exercise powers that are sustained on the ground that they are "*quasi*-judicial" rather than "judicial" The result is therefore not dissimilar from that in countries that have not attempted to set up three separate departments through judicially enforceable constitutions. But such flexibility as develops under the American plan comes more slowly, and can be achieved only with judicial approval. A study of American political institutions must, therefore, always take into account the greater rigidity in governmental structure resulting from the constitutional principle of separation of powers.

5. PRESIDENTIAL SYSTEM OF EXECUTIVE ORGANIZATION

The Federal Government and the States of the United States have adopted the presidential system of executive organization, as distinguished from the cabinet or ministerial system found in England and most other countries. Under the presidential system there is an independent executive (president or governor) elected for a fixed term, and holding office during that term irrespective of whether he is or is not in political harmony with both legislative bodies or either of them The members of the legislative bodies are elected at fixed times and for fixed terms, and no power is vested in the executive to dissolve them or to force elections at any other times than those fixed. The principle of separation of powers as applied in the United States precludes any member of the executive department from having a seat in a legislative body. Under this system the president or governor has real executive authority, and in all States but North Carolina has and exercises large power to control legislation by an executive veto. The presidential system pre-supposes that the executive and the legislature may at times not be in political harmony And in fact this is the case in many of the states and in the National system In the States of New York and New Jersey in recent years the governors have often been members of the Democratic party, while both houses of the state legislature have been controlled by the Republican party. The power ordinarily vested in the legislative bodies to impeach and remove the executive is judicial in character, and efforts have only occasionally been made to employ the power of impeachment to remove an executive politically hostile to the two houses of the legislature. Such an effort was made, unsuccessfully, to remove Andrew Johnson from the presidency of the United States.

The presidential system is more rigid than the ministerial plan of government, but it accords with the American doctrine of separation of powers. When the country faces a crisis, as during the Civil War and the World War, popular sentiment maintains political harmony between the President and Congress; and the executive tends to become the dominant factor in government. The presidential system of the United States in fact met the serious problems of the World War with less difficulty than did the ministerial systems of England and France.

6. THE NATIONAL GOVERNMENT

The National Constitution.—The Constitution of the United States, framed in 1787 and adopted in 1789, is a brief and well-drafted document. Its influence has been felt not only in the United States, but in the Federal systems of Switzerland, Argentina, Brazil, Canada and Australia. The Constitution outlines the organization of the three departments of the National Government, defines the powers of that Government, and the relationship between the Nation and the States. It provides a method of amendment, and has been nineteen times amended since its adoption. The first ten amendments, adopted in 1791, were the direct results of criticisms of the Constitution at the time of its adoption, and may almost be regarded as parts of the original document. Of the other amendments, the Eleventh, adopted in 1798, overcame a decision of the United States Supreme Court to the effect that a State might be sued by a citizen of another State. The Twelfth Amendment, adopted in 1804, corrected a defect in the original Constitution as to the method of choosing the president and vice-president. The Thirteenth, Fourteenth and Fifteenth Amendments were the immediate outcome of the Civil War. The Thirteenth abolished slavery, the Fifteenth forbade denial of the right to vote "on account of race, color or previous condition of servitude." The Fourteenth Amendment, regarded for a while by the courts as limiting itself to the protection of the freed slaves, has become, by expansion of the terms "due process of law" and "equal protection of the laws," the means through which the United States Supreme Court determines the policy of state enactments in the field of social legislation. The Sixteenth Amendment in 1913 gave Congress an effective power to levy a Federal income tax Popular election of United States senators under the Seventeenth Amendment, adopted in 1913, has somewhat reduced the importance of the State, as has the Eighteenth (1919) transferring the liquor problem to the National Government The Nineteenth Amendment (1920) nationalized women's suffrage On the whole the process of amendment, while to some extent enlarging Federal powers, has been less influential in this direction than the decisions of the United States Supreme Court.

Congress.—Legislative power in the National system is exercised by a Congress composed of two houses The two houses have grown—the Senate from 26 to 96 members, and the House of Representatives from 65 to 435 members

United States senators are elected for six year terms, and terms are so arranged that one-third of its members retire each two years Since 1913 the elections in each state are by popular vote of the whole State, except that temporary appointments to fill vacancies are permitted. Members of the House of Representatives are elected for two years, and the whole membership changes each two years. Each State is required to be divided into districts equal to the number of members it has in the House of Representatives, though where additional members are assigned to a State and it makes no reapportionment, the additional members are elected from the State as a whole Each member of the House of Representatives is required to be a resident of the State from which he is chosen; political and sectional interests make it practically impossible for a person to be elected for a district within the State in which he does not reside The result is that an able and experienced person ceases to be a member of Congress if he fails of re-election by his district. In addition to the elected members, territorial delegates sit without vote in the House of Representatives—two from the Philippines, and one each from Alaska, Hawaii and Porto Rico.

During the two year term of members of the House of Representatives, two sessions of Congress ordinarily occur—the so-called long session, beginning in December of the odd-numbered years and adjourning usually in early summer of the succeeding year; and the short session beginning in December of even-numbered years and closing on the succeeding March 4, when the terms of members of the House expire Congressional elections take place in November of even-numbered years; the terms of members then elected begin after the succeeding March 4, but the newly elected members do not come into regular session until the succeeding December, more than a year after their election. The short session is always composed in part of members who have already failed of re-election, and who may therefore be said not to represent their constituents. It is of course possible for the president to call the newly elected Congress in special session at any time after March 4, and this is occasionally done.

The organization and procedure of the two houses of Congress are to a limited extent determined by Congress, and to a larger extent by the size and traditions of the two houses. The rules of

the Senate permit great freedom of debate, those of the House of Representatives restrict debate and expedite business. Under the Senate rules obstructive tactics may be and are often resorted to, though such tactics relate in fact to relatively few measures. The House of Representatives, with its larger membership, would be helpless with complete freedom of debate, yet both houses accomplish a large amount of legislative business, as is indicated by the passage of nearly one thousand measures at the first session of the seventieth Congress which convened December 5, 1927, and adjourned May 29, 1928

The House of Representatives elects from its own members a speaker as presiding officer The vice-president of the United States is the presiding officer of the Senate The work of both houses is largely done in committee The committee systems of both houses developed largely by accident, and many committees in each house, once created for important tasks, remained long after their usefulness had ceased. The Senate in 1921 and the House of Representatives in 1927, reorganized their committees and materially reduced their number. There are now thirty-four standing committees in the Senate, and forty-seven in the House of Representatives. Although they may in some cases have different names, the committee organizations of the two houses closely parallel each other There is an appropriations committee in each house; committees on commerce and interstate commerce in the Senate, and a single committee on interstate and foreign commerce in the House, a committee on ways and means in the House, and a finance committee with similar functions in the Senate Each house has a judiciary committee The committees referred to are regarded as of distinct importance; though other committees are at times equally powerful The Senate committee on foreign relations is peculiarly important, because treaties may not be entered into without the concurrence of two-thirds of the senators

Committees in each house are controlled by the political party having a majority of the members of that house Appointment to important committees goes largely to seniority in term of service, and a member serving continuously over a long period is likely to become chairman of an important committee, if his political party is in control Seniority as such naturally plays a larger part in the House of Representatives than in the Senate with its smaller number of members, though the business of the Senate is in good part controlled by a small group of experienced members. Leadership in the two houses is always exercised by a few members of the politically dominant party In the House of Representatives for many years before 1911, the real leadership was largely vested in the speaker, who made up the appointments to standing committees Since 1911 the speaker has been relegated more distinctly to the position of presiding officer, committees have been elected by the House itself on the basis of selections first made by the party organizations The majority and minority floor leaders have large influence In the Senate there is less of individual leadership than in the House of Representatives

The Federal Executive.—In discussing the presidential system, the relation between the president and Congress has been generally described. There are no constitutional limitations upon a president's succeeding himself, but a tradition exists that a president should not serve for more than two terms, a tradition based on the example set by Washington and other early presidents.

The Constitution expressly authorizes the president to make certain appointments to office and the expansion of the National Administration has greatly increased the number of officers owing their appointment to him. The more important appointments are subject to confirmation by the Senate. The United States Supreme Court has determined that where power to appoint to office is vested in the president this carries with it a complete power to remove from office. Efforts upon the part of Congress to impose restrictions upon the president's power to remove even his more direct advisors led to the effort to impeach President Andrew Johnson in 1868, which failed.

The president's control over the National Executive Administration is primarily exercised through the heads of ten executive departments, appointed by the president. These departments are: Department of State, Department of the Treasury; Department of War; Department of Justice; Post Office Department, Department of the Navy; Department of the Interior; Department of Agriculture; Department of Commerce; Department of Labor The heads of these departments are popularly termed a cabinet. They are responsible to the president, and the extent to which he meets with them and seeks their advice rests entirely in his discretion In addition to these ten departments there are numerous boards and offices The Federal executive organization under the president is not systematically organized, and plans for its reorganization have been under consideration for about twenty years The need for such reorganization has become increasingly apparent with the expansion of activities of the National Government The great mass of the lesser employees are selected under a merit system, for whose conduct a Civil Service Commission was first created in 1883 (*See* CIVIL SERVICE, *United States*) The finances of the national government have been to a large extent systematized through the creation of a bureau of the budget in 1921, and through an improved committee organization effected in the House of Representatives in 1927 for the consideration of national appropriations and expenditures.

The president's influence in the national government rests upon (1) powers granted him by the Constitution and by Federal statute, (2) political factors not found in constitutions or statutes, (3) the personality of the president.

The president's position as head of a large executive organization, with wide powers of appointment and removal, in itself makes the position important The authority to veto legislation, subject to being overridden by two-thirds of the two houses, gives him a power that may be employed with effect The authority to recommend measures to Congress is only of such value as may be given to it by the position and influence of the president making the recommendation He is charged with the conduct of foreign relations, though here his authority is materially crippled by the requirement that two-thirds of the senators concur in treaties.

But the president's political position is equally as important as his constitutional power He is in effect the chieftain of his party. He is also the one outstanding figure in American politics His utterances are news, and appear conspicuously in every newspaper in the country. These factors supplement his constitutional power, and make it possible for him to occupy a dominant position in the Federal system

The possibilities of exercising power are great. The extent to which power is actually exercised depends upon the personality of the president and his capacity for political leadership The influence of the presidency varies with the man who occupies the office and with the circumstances that surround him In time of war, as under Lincoln and Wilson, the presidency dominates. Andrew Jackson dominated in a time of peace. James Bryce in 1886 said that leaders are not chosen for the presidency, but real and dominant leadership has in recent times been exercised by Cleveland, Roosevelt and Wilson The possibilities of the presidency were well expressed by Woodrow Wilson before he came to that office "The President is at liberty, both in law and conscience, to be as big a man as he can. His capacity will set the limit; and if Congress be overborne by him, it will be no fault of the makers of the Constitution,—it will be from no lack of constitutional powers on its part, but only because the President has the nation behind him, and Congress has not He has no means of compelling Congress except through public opinion "

Little need be said about the vice-president His chief official duty is to preside over the Senate, though he has substantially no influence in the deliberations of that body. The machinery for nominating party candidates ordinarily chooses a vice-presidential candidate almost purely on the basis of political expediency, and with little consideration of the fact that the vice-president may succeed to the presidency. Yet within the past thirty years two vice-presidents—Roosevelt and Coolidge—succeeded to the presidency as a result of death, and then were elected to the office

The Federal Judiciary.—The Constitution of the United States provides for a Supreme Court "and such inferior courts as the Congress may from time to time ordain and establish " For

the enforcement of Federal law, Congress has provided a complete judicial system paralleling that of the states The judges of these courts are appointed by the president of the United States, and hold their offices during good behaviour They are removable only by the cumbersome machinery of impeachment

At the head of the judicial system is the Supreme Court of nine judges, which sits at Washington There are nine Circuit Courts of Appeal, each with at least three circuit judges, and to each circuit is assigned a Justice of the United States Supreme Court, though pressure of business has now made it impossible for judges of the Supreme Court to go on circuit The District Court is the court of original jurisdiction In erecting districts for the organization of this court, state lines are regarded The smaller States constitute single districts, the larger are divided For the districts in which Federal judicial business is especially heavy, more than one district judge is provided For example, four districts with fifteen judges exist in New York. There are more than eighty districts, with 129 judges, and the number of judges constantly increases The enforcement of the Federal Prohibition Act has enormously increased the business of the Federal Courts, and has forced an increase in the number of judges In addition to the general system of courts here outlined, there are a Court of Claims, Court of Customs Appeals, and Federal Courts for the District of Columbia and the territories

With the two systems of courts—Federal and State—exercising jurisdiction over the same territory, it is necessary that there be certain principles as to their relationship. Such principles may be briefly summarized as follows.

(1) Upon questions of Federal constitutional law, the United States Supreme Court is the final court of review If the highest court of a State holds a Federal statute or treaty to be invalid, or a State statute valid that is alleged to violate the Federal Constitution or Federal statutes, the losing party has a right to a final decision by the highest Federal court Where Federal constitutional issues are otherwise involved in State courts, the United States Supreme Court, may, in its discretion, review the state decision

(2) All cases involving the enforcement of the criminal law of the Federal government are tried in the Federal Courts

(3) Cases of admiralty and maritime jurisdiction and bankruptcy proceedings are tried in the Federal Courts

(4) Under Federal statutes, the Federal Courts alone have jurisdiction of suits against the United States, and of suits for the enforcement of Federal revenue, immigration, and other similar laws directly affecting the administration of the Federal Government.

(5) In civil cases involving as much as $3,000, and (a) arising between citizens of different States or (b) arising under the constitution, laws or treaties of the United States, the parties have the choice of suing either in State or Federal Courts, but if the plaintiff sues in the State Court, the defendant may transfer the case to the Federal Court

Through legislation of 1925 an effort has been made to reduce the number of cases that must be decided by the United States Supreme Court That court has a limited original jurisdiction, the most important cases of such jurisdiction being cases to which a state is a party Cases not infrequently arise in which one State sues another State. Aside from its original jurisdiction, cases come to the United States Supreme Court either from the highest State Courts or from the lower Federal Courts. The decisions of the United States Supreme Court are of primary importance in the fields of constitutional and public law

7. THE STATE GOVERNMENT

The forty-eight State Governments of the United States have certain common characteristics Each State is legally the equal of every other State in the Federal system Each controls the organization of its own State and Local Governments. Each has a written Constitution providing for three departments of Government, with a legislature of two houses elected by popular vote, and a popularly elected governor as head of its executive department. Each State has a judicial system not essentially dissimilar in external organization from that of the other States. Each State has created local governing areas for the performance of certain functions. The Government of each State and of its important local areas is controlled through political parties organized on a National basis

Superficially, all the forty-eight State Governments appear to be more or less alike, and appear to be doing the same things. The constant shifting of population has prevented the development of sharp differences in governmental organization Not only this, but from one state to another there has been a great deal of copying of political and legal institutions. However, each State is distinguished from its fellow States, not only in size and population, but also in location, climatic conditions and resources and these differences reflect themselves in the political and governmental organization of the States

The State Constitution.—The Constitutions now in force in the forty-eight States vary a great deal in length and in content Some were adopted in an earlier period, and some bear recent dates. The Constitution of Connecticut, adopted in 1818, together with subsequent Amendments, requires only about sixteen printed pages, the Louisiana Constitution of 1921 requires ninety pages The present Constitutions of Oklahoma, California and a number of other States are highly detailed Massachusetts still boasts that it is governed by the Constitution of 1780, but this Constitution has been altered in form by so many Amendments that it would hardly be recognized by its original framers By Amendment or by the adoption of new Constitutions, the States have steadily readjusted their institutions to meet changing needs The National Constitution has proved a model for much of the development in the field of State constitutional history, particularly with reference to the establishment of three co-ordinate departments of Government

In most of the States the State Constitutions organize three departments of government in some detail They contain elaborate declarations or bills of rights, and most of them contain provisions regarding the organization of local government Limitations upon the power of State legislatures have multiplied Moreover, the framers of Constitutions are inclined to include in these documents regulations of any matters of great public interest at the time The State Constitution has in this way come to contain many matters of temporary detail, and such detail requires frequent amendment

The State Constitutions provide for methods of change The methods employed are three. (1) constitutional conventions, (2) legislative proposal of amendments, (3) proposal by popular initiative petition All but twelve of the State Constitutions expressly provide for constitutional conventions. in all of these twelve except Rhode Island it is recognized as proper to employ conventions for constitutional change Ordinarily conventions assemble as a result of popular vote, and submit their recommendations for popular approval

Proposals of constitutional amendment may be made by the legislatures in forty-seven States In New Hampshire changes may be made only by constitutional convention Methods of amendment through legislative proposal vary in the forty-seven States, but in all except Delaware, a legislative proposal of amendment must be submitted to and approved by popular vote before it becomes effective Details of the amending process vary In some States, as California, Louisiana, New York, the adoption of amendments through legislative proposal is easy; in others, as Illinois, Indiana and Minnesota, the constitution is substantially impossible to amend.

The proposal of constitutional amendments through popular initiative petition, followed by popular vote, is a fairly recent development, but this plan has now been adopted by thirteen States. In these States also, there is a varying ease or difficulty in employing the plan of amendment In Oregon and four other States it is as easy to amend the Constitution through initiative petition and popular vote as it is to enact a statute through the same devices In each State that has adopted the plan of popular initiative, this plan has merely been added to the two already existing devices of constitutional conventions and proposal by

legislative action. By the three methods of change more than 1,500 amendments were proposed in the forty-eight States between 1900–20, of which about three out of five were adopted

The State Legislature.—In all of the American States, legislative power is exercised by a body composed of two chambers Constitutional amendments for the organization of a legislative body composed of but one house were proposed in Oregon in 1912 and 1914, in Oklahoma in 1914, and in Arizona in 1916 All of these proposed amendments failed.

The smaller house of the legislature is in all of the States called the Senate All but eight of the States call their larger house a House of Representatives; but the eight have such varying titles as Assembly, General Assembly, and House of Delegates. Nearly half of the States use the term Legislature to designate the two houses together, but twenty use the term General Assembly, and three use the term Legislative Assembly Massachusetts still uses the term General Court, which was first employed in the Colonial Charter, and New Hampshire uses the same term In view of the fact that the legislative bodies have somewhat varying names in the several States, it has been customary to refer to the larger of the two houses as the lower house, and to the smaller as the upper house

To a large extent the exact number of members of the two houses, or of one of the two houses, is left to legislative determination, subject to constitutional restrictions The size of the two houses varies a good deal from one State to another The Minnesota senate is the largest, with sixty-seven members, and that of Delaware the smallest, with seventeen The size of the lower house ranges from thirty-five in Delaware to four hundred and fourteen in New Hampshire The membership of the lower houses is especially large in several of the New England States because of the system of town representation, but in these States the Senate is relatively small

In a majority of States, senators are elected for four years and representatives for two years In some States, one-half of the members of the Senate are elected every two years, so that the Senate has continuous membership, as contrasted with the House, whose membership is chosen as a whole at each election In Alabama, Louisiana, Maryland, South Carolina, and Mississippi, however, four-year terms have been provided for members of both houses, and a number of States have a two-year term for members of both houses

In some States financial measures must originate in the lower house, and in most of the States the Senate has certain powers with respect to confirmation of executive appointments The provisions for impeachment of public officers also ordinarily prescribe that charges shall be brought by the lower house and tried by the Senate But on the whole it may be said that, from the standpoint of legislation, the two houses of the American State Legislature have equal powers and do not represent different points of view in the community Distinct differences that existed in many States in earlier times have substantially ceased to exist, although in a number of States differences in territorial representation have grown up.

In the earlier State Governments the substantially equal representation of local areas was not grossly unfair, because of the absence of great inequalities in their population. To a large extent, the idea of geographical representation survives in a number of States. The lower houses of Connecticut, New Hampshire, and Vermont, and both houses of Rhode Island, are based upon town representation; and with the growth of large urban communities this basis has become highly unequal In 1920, New Haven with 162,000 inhabitants, had two representatives in the lower house of the Connecticut legislature, but so also did the town of Union with 257 inhabitants. Such inequality is not confined to New England.

The present representative system is the result of two conflicting forces. In most of the States some attention is paid to local governmental areas It is common for constitutional provisions to forbid the crossing of county boundaries in the establishment of representative areas On the other hand, the principle of equal representation upon the basis of population has steadily developed. The more common plan today is to provide for the periodical reapportionment of membership in the two houses, upon the basis of population Delaware, however, permits a reapportionment only by constitutional change; and other States, while providing for periodical reapportionment, limit the basis of representation in such a manner as to preserve an inequality

Members of the State legislature are chosen from local districts by popular vote Proportional representation has been proposed, but has not been adopted by any State All States adopt the plan under which a candidate is elected who receives a plurality of the votes in his district, though Illinois since 1870 has provided for three members of the lower house in each electoral district, and that each voter may vote for three or cumulate his votes for one or two candidates

Under the first State Constitutions provision was generally made for the annual election of members of legislative bodies and for annual legislative sessions Frequent and regular sessions of the legislature were deemed essential safeguards of popular rights, and were at this time thought sufficient safeguards Most State legislative bodies now meet in January of odd years, and Constitutions ordinarily prescribe the number of days for which the session may continue In Alabama the State legislature meets in regular session only once each four years

As is the case with Congress, the work of state legislatures is largely done through committees There is little of an effective legislative program or of organized leadership in the two houses An efficient and influential governor occasionally exercises a distinct leadership in important matters of constructive legislation, but over legislative enactments in general his influence is negative rather than affirmative

He now has a veto power over legislation in all of the States except North Carolina, and the veto can, in most of the States, be overcome only by a two-thirds vote, although only a three-fifths vote is required in some States, and a bare majority in others There has also been a definite increase of the governor's control over appropriations, through the vesting in him of a power to veto items in appropriation bills Such a power now exists in all but ten of the States There has been a tendency in some States to extend the governor's veto power still farther The Washington and South Carolina constitutions confer upon the governor the power to veto any item or section of a bill presented to him In addition, several States have recently given the governor wide powers with respect to the State budget

The veto power is not an idle weapon in the governor's hands Its use and effectiveness depend upon several factors—the extent of the governor's constitutional power, the personality of the governor, and the political agreement or disagreement at the time between the governor and the two houses Of some 16,500 measures passed in 1923 by the legislatures of forty-four States, more than eleven hundred were disapproved in their entirety, and more than one thousand parts of bills were disapproved Of the bills disapproved, 104 were re-passed by legislatures, and of the parts vetoed only 40 were re-passed

The State Executive.—In the first State Constitutions the executive department was subordinate to the legislature In most States, the governor and certain other state officers were chosen by the legislature, and an executive council, also chosen by the legislature, was substantially placed on guard to prevent executive usurpation. Such an attitude toward the governor was natural in 1776; but the governor's power almost immediately began to grow. New York in 1777 made its governor popularly elective, though it at the same time created two councils—the Council of Revision and the Council of Appointments—to share with the governor the powers of veto and of appointment to office Massachusetts (1780) and New Hampshire (1784) soon followed with the plan of popular election Executive councils now remain only in Massachusetts, Maine and New Hampshire

In all States the governor became a popularly elected officer, and hence independent of legislative dominance Other State officers became popularly elective, though some such officers are still chosen by State legislatures Until about fifty years ago, the functions of State Government were few, and were chiefly con-

ducted by a small group of popularly elected officers. As new needs have developed, the Constitution itself has provided for new offices, which have usually been filled by popular election Illinois has six such officers in addition to the governor; Idaho and Nebraska, seven each Chief among the state executive offices, independent of the governor in most states are. lieutenant governor; secretary of state; superintendent of public instruction; attorney general; treasurer; and auditor or comptroller

By creating a group of State officers, all popularly elected in the same manner, State Constitutions in fact create a plural executive, although the theory of American State Government presupposes a single head of the executive department But only to a slight extent are constitutional powers directly conferred upon the lieutenant governor, secretary of State, and other popularly elected State officers The governor has thus had the opportunity to become the chief State executive in fact as well as in constitutional theory. The increase in the governor's executive power has come about primarily through the creation of new offices by statute, and the vesting in the governor of power to appoint to such offices In this manner, as new state functions were assumed, numerous offices were created, without reference to any efficient supervision by the governor Some States had as many as two hundred independent officers, most if not all of whom were appointed by the governor, but over whom it was physically impossible for the governor to exercise an effective supervision A recent movement in the States has sought to organize executive functions into a small group of departments, each under a director appointed by and responsible to the governor. One of the chief difficulties in building up an effective State executive system is that the governors of half the States are elected for terms of only two years. In the other States the term is four years, except in New Jersey where it is three

The State Judiciary.—Generally the states have courts of three types:

(1) Justices of the peace, having a limited and inferior jurisdiction in both civil and criminal cases Justices of the peace are ordinarily elected from towns or townships or from districts created for the purpose within the county The jurisdiction of justices of the peace is strictly limited by statute, and their courts are not courts of record. Appeals are allowed from their action to a court of general trial jurisdiction; and ordinarily the trial in the higher court is a trial *de novo*

(2) In all States there are courts of general trial jurisdiction, known as Superior Courts, District Courts, Circuit Courts, and in some States by still a different name The court of general trial jurisdiction has ordinarily a general authority to try all cases in law and equity. Six States still retain the old English plan of separate courts for the trial of cases at law and in equity, but most of the States have abolished the distinction between law and equity. In some States, as in Arizona, California, and Ohio, the court of general trial jurisdiction is organized upon a county basis, and there is a separate court for each county The more common plan, however, is to have the court of general trial jurisdiction go on circuit from one county to another, at least in the smaller counties of the State

(3) Each State has a court of review whose function is chiefly that of hearing appeals from the courts of general trial jurisdiction. This court is ordinarily termed the supreme court But in Kentucky, Maryland, and New York it is called the Court of Appeals, and slightly different names are used in several other states. The highest court is usually given some original jurisdiction, but ordinarily this original jurisdiction is small, and its use is strictly limited by the court itself, in order that time may be available to hear appeals from other courts

Once these three features are outlined, State judicial organization becomes to a large extent a mass of diversities. In many larger communities a municipal court has been organized, which not only replaces justices of the peace, but is granted a much more extended jurisdiction than has ever been conferred upon justices of the peace. In a number of the States there is also a so-called County Court, with some jurisdiction, both civil and criminal, and also usually a fairly large authority with respect to rather distinctly administrative matters, such as those relating to county affairs, elections, and charities. Where county courts exist independently of the court of general trial jurisdiction, they are often vested with authority in probate matters as well.

There are also other types of trial courts with special jurisdiction. Every large community now has a juvenile court. Other specialized courts, such as domestic relations courts, morals courts, boys' courts, speeders' courts, and small claims courts have been established in many larger communities, often as branches of a municipal court In some cases there are separately organized criminal courts, although ordinarily criminal jurisdiction is exercised by the courts of general trial jurisdiction

The State judicial organization has placed great emphasis upon appeals from lower to higher courts No case of any importance is regarded as settled until it has been taken to the highest court Increased complexity of appellate court organization has been forced by the growing number of appeals to be heard The increased mass of appellate work has been handled in three ways (a) by increasing the number of judges of State supreme courts, (b) by authorizing such courts to sit in sections; and (c) by creating intermediate appellate courts, standing midway between the trial courts of general jurisdiction and the highest court.

There are now three methods of selecting judges in the United States· (1) In thirty-eight States, judges of the highest court are elected by the people In all of these States except one the trial judges are chosen in the same manner (2) In four States the judges are elected by the legislature, and in one they are appointed by the legislature upon the nomination of the governor (3) In five States the highest judges are appointed by the governor, subject to confirmation by the governor's council in Maine, Massachusetts, and New Hampshire, and to confirmation by the Senate in Delaware and New Jersey Certain inferior judges in other states are also appointed by the governor

8. LOCAL GOVERNMENT IN THE STATES

What is ordinarily referred to as the "State Government" is the central organization located at the State capital But this central organization does much the smaller part of the work of the State Unlike the National Government, which establishes its central organization for substantially all national activities, the State conducts a large part of its governmental business through locally elected officers There is no one system of local Government for the forty-eight States or for any of these States The geography of local Government in each state is a patchwork, with the same territory often occupied by from ten to a dozen separate governing bodies, each with slightly varying boundaries, and with independent powers.

Certain types of organization may be termed the usual forms of local government These are (a) the county, which is found in all of the States, though the name "parish" is employed for a similar unit of local Government in Louisiana, (b) towns or townships, which in most of the States where they are found are merely subdivisions or units of the county, although the New England town was the original area for local Government and is more important than the county; (c) the city In addition to the city, which is theoretically the chief unit of local Government for urban areas, most state laws provide for the incorporation of small communities as villages, with a simpler form of Government than that provided or permitted for cities

In addition to these usual types of local Government, other forms will be found in each of the States Park and sanitary districts in more settled areas, drainage and irrigation districts in rural communities, road districts, school districts, and numerous others will be found oftentimes occupying the whole or a part of the same territory as that covered by the usual types. Aside from several New England States in which the county is merely a convenient area for direct state administration, county Government has certain common characteristics. There is a locally elected county board, of varying size and composition, and there are a number of locally elected county officers who perform their duties largely without subordination to the county board, except as they may oftentimes depend upon the county

board for appropriations. County boards are usually grouped into two classes: (1) small boards of commissioners elected at large by the county; (2) large boards elected by townships and cities within the counties. But in a number of States, counties are divided into districts for the election of a small county board. In each county will be found a clerk (or clerks) of court and a sheriff. Each county provides a court house and a jail Locally elected county judges and county treasurers will ordinarily be found, and a prosecuting officer elected by the voters of the county. In many States the county is a unit of school administration, and there is a county superintendent of schools, usually elected by the voters of the county A movement is now actively under way toward a more centralized executive organization in the county

The terms "town" and "township" are usually employed to designate areas of local Government into which the county is divided, though in New England the town is the most important unit of local Government. New England towns have areas of from twenty to thirty sq m , and usually include both rural territory and more compact village settlements About three-fourths of them have less than 2,500 inhabitants each, and hence may properly be classed as rural communities The large communities usually become incorporated as cities, and generally the creation of city Government terminates the existence of town Government within the city's limits The town meeting is the chief organ of government in the New England towns

So-called town or township systems of Government are found in the great central group of States extending from New York to Nebraska. The forms of township Government in these States may be classified as follows: (1) Those which, as in New York, have the town meeting and township representation on the county board; (2) those, as in Minnesota, which have the town meeting but no township representation on the county board, and (3) those, as in Pennsylvania, which have merely a local township organization, but no representation on the county board and no town meeting.

Efforts have been made to introduce the township system in the States of the South and of the West, but in these States the counties are ordinarily divided into subordinate districts, largely for administrative purposes; and such districts, though sometimes called townships, usually have little, if anything, of independent authority in the field of local Government

The growth of urban population has naturally led to the development of cities as the chief agencies to meet local needs occasioned by more compact population. The chief forms of city Government in the United States are primarily three: (a) the mayor-council, or Federal, plan; (b) the commission plan; and (c) the manager plan

The mayor-council or Federal plan is still the most general. It is to a large extent organized upon the analogy of the National Government There is a popularly elected mayor with large powers, which have tended steadily to develop The mayor normally has a veto power and a fairly large power of appointment; although several of the more important officers, such as clerk and treasurer, are usually elected by the voters of the city, just as is the mayor. There are ordinarily under the mayor a group of departments whose heads are appointed either by the mayor alone or by the mayor with the approval of the council. Usually there is a council composed of a single house, whose members are elected from wards into which the city is divided, although occasionally some or all of the members are elected from the city at large.

The fundamental characteristic of the commission plan of city Government is an elective commission, usually of three or five members, having large municipal powers, both legislative and executive. Each of the commissioners is the head of a department, and there are as many main city departments as there are commissioners. Along with this system has come ordinarily the initiative and the referendum on municipal ordinances, and a power to recall the members of the commission by petition and popular vote.

The so-called manager type of city Government had its origin about 1908, though it first received serious consideration upon its adoption by the City of Dayton, Ohio, in 1913. More than three hundred cities in the U S are now governed under the manager plan. Under this plan there is a small commission or council, whose members are usually elected from the city at large This body determines the policy of city Government, and selects a manager to administer the affairs of the city

Through the commission plan, which originated in 1901 and which for perhaps fifteen years had great sway in American city development, and through the manager plan, which originated in 1912 and has in recent years tended to replace the commission plan, much has been done since 1901 toward the reconstruction of city Government in the United States

9. ELECTIONS AND POLITICAL PARTIES

The State Government has the primary responsibility for the conduct of elections, National, State and local State Constitutions and State laws set up machinery for the conduct of elections, and determine the qualifications for voting, subject to the federal restrictions against discriminations on account of race, colour, previous condition of servitude, or sex.

Through a succession of changes, the States have now come to have substantially universal suffrage for males and females above the age of twenty-one years Suffrage for women became national in 1920, through the adoption of the Nineteenth Amendment to the Constitution of the United States Educational qualifications for voting have been imposed in some States, as in New York; and qualifications as to education or tax-paying have been imposed in a number of Southern States, which discourage voting by negroes State laws require registration of voters in the larger communities, to identify those qualified to vote

Few officers are chosen by popular vote in the Federal system—the president, vice-president, members of the two houses of Congress, and presidential electors are so chosen A much larger group of State officers are chosen by popular vote; and an even larger number of county, city and other local officers When all of these types of offices are united on one ballot or in one election, the voter is oftentimes faced with the problem of choosing one hundred or more officials from among several times that number of candidates Moreover the so-called initiative and referendum have been adopted in 18 States; constitutional amendments are proposed for popular approval by State legislatures, and under many State laws, proposals of municipal bond issues and other local questions must be submitted for popular approval The voter is somewhat at a loss when forced to express himself upon perhaps 30 technical proposals, and upon several hundred candidates for public office. His choice upon the measures submitted to him is largely hap-hazard, except upon the occasional measure of real importance His choice among candidates for National, State and local officers is primarily guided by political parties.

Practically throughout its history, the United States has been a country of two parties. A third party has occasionally been important, as was the case with the Progressive party under the leadership of Theodore Roosevelt in 1912. In the early years of the nation, the Federalist party represented the interests of a stronger nationalism; the Republican party under Jefferson, the interests of the States. In the period of Andrew Jackson, the name of the then dominant party changed from Republican to Democratic, and, the Federalists having disappeared, the Whigs became the other great party The Whigs were replaced by the Republicans, who elected Abraham Lincoln to the presidency in 1860. During all of this period lesser parties have existed, and have occasionally cast a vote sufficient to determine which of the two major parties should control

Political parties originated as voluntary organizations But they soon came to control the election to local, State and National offices; for in the election no one except a candidate of one of the two leading parties had or has the possibility of being elected The methods of the political party thus became of importance to the Government itself Today political parties are in reality no longer voluntary organizations, but are rather organs of the Gov-

ernment itself, controlled in great detail by State legislation One of the first respects in which political parties came under official control was the printing of the ballot Before 1888 parties printed their own ballots, and naturally determined also the conditions under which the names of their party candidates should appear upon such ballots Serious abuses arose under this arrangement, particularly with respect to the secrecy of the ballot Beginning in 1888, the States adopted the official or so-called Australian ballot Under the official ballot plan, ballots are printed at governmental expense This expense is usually borne not directly by State government but by the local bodies charged by the State with the conduct of elections. In providing for the printing of ballots, State laws at the same time necessarily determine the conditions under which party organizations shall be entitled to have the names of their candidates appear upon such ballots.

But with the adoption of the so-called Australian ballot political parties still had, and have, sufficient power to determine the form of that ballot. Massachusetts and a few other States have adopted a plan under which the names of the candidates are grouped under the titles of the offices, though under the Massachusetts plan the party to which each candidate belongs follows the name of the candidate This arrangement of the ballot makes it necessary for the voter to mark separately on his ballot the name of each candidate for whom he desires to vote Most of the States, however, have adopted the so-called "party-column" ballot. The party-column ballot varies in different States, but its fundamental idea is that all of the candidates for one party shall appear in a single column, so that a voter may vote for all of them by placing one mark upon the ballot If the voter does not wish to vote the party ticket, he is put to the burden of marking each of the candidates for whom he wishes to vote, or at least each candidate not belonging to his own party

The methods of party nomination next came under State control Serious abuses in the party convention system for the nomination of candidates and the framing of party platforms led to legislation regulating the convention, but such regulation did not appear sufficient The primary election system (*see* PRIMARIES) has now been established in some form in all but three of the States, although recently there has been a strong political movement against primary elections and some gain for the older convention system Where the primary system has been adopted, conventions normally remain, with more limited functions

Control by law over the official ballot and over the methods of party nomination has naturally been followed by a detailed regulation of the machinery of party organization Through primary elections, the party voters in most of the States choose their party committeemen. State laws determine the power of such party committeemen, and also determine the manner in which they shall form the various party governing bodies State laws also determine how party organizations shall frame platforms Governmental regulation of political parties has largely been occasioned by a feeling that party organizations themselves control the government, and that they should, rather, be controlled by the Government. But governmental regulation has not weakened political parties.

When it is first created, a party usually stands for some political principle as opposed to other parties. Ordinarily, however, parties are merely convenient devices for the operation of Government, and for presenting political issues to the voters when such issues arise Political issues are not created merely by the existence of two opposing parties, and during much of the time no real issues exist upon the basis of which parties may oppose each other. At such times parties proclaim principles, but have no sharp differences When issues are altogether absent, parties still perform the functions of narrowing the choice of the voter, and of uniting candidates into groups for final elections.

The political expert (who is termed "boss" if sufficiently successful) has the tasks of keeping the party organization together; getting party members to the polls; and rewarding political service He can perhaps be more successful if he holds no office, because by holding office he divides his energies and subjects himself to personal criticism for possible errors of political conduct. Each political group has its precinct and ward committeemen, who are normally on the public payroll (local, State or National), if their group is in power, and whose continuance on that payroll depends upon their efficiency, not as public employees, but in controlling the vote of the precinct or ward. The spoils of office and the grosser forms of political corruption are the lesser coin of political organizations Gross corruption reacts upon those who practice it But there are contracts to be let, without too great an insistence on standards, and other similar opportunities for continuous profit Furthermore, important business and professional interests in a community usually cooperate with the organization in return for special favours.

With party organization a vast and complex mechanism, nomination and election to office almost of necessity come, in most cases, as a reward for service in the party organization No man or woman who lacks the support of a party organization has much opportunity either to be nominated or elected, though an independent candidate may occasionally win, in case of great popular upheaval Even under such conditions, the independent candidate who wins must almost necessarily have financial resources sufficient to set up a rival organization of his own Many States have enacted statutes limiting expenditures of candidates in party primaries and in elections, but such laws have not been effectively enforced When enforced they operate in favour of the candidate sponsored by the political organization. Those who come to office usually do so only after a long apprenticeship in party service, which has worn off the fine edge of youthful idealism

The recognition that national parties should not control in the election of local and judicial officers has led to a movement for non-partisan elections In a number of States judicial officers are nominated and elected through ballots required to contain no party designations But a candidate must actually be sponsored by a political organization if he is to fare well in any election The non-partisan election has accomplished more in municipal than in State elections

Parties are organized on the basis of national issues Few such issues are important in State Government, and fewer still in local Government But the party organization, though national in scope, supports itself largely through the offices and other profits derivable from State and local Government In spite of the movement for non-partisan elections, it is still possible to apply to the American party system the statement made by James Bryce in the eleventh edition of the ***Encyclopædia Britannica:***

"The national parties have been so pervasive in their influence and the working of their machinery has formed so important a part of the political history of the United States, that it is necessary here to call attention to the high significance of this element in the system of the Republic The party system has made nearly all elections, including those for state offices and city offices, the functions of which have, as a rule, nothing whatever to do with national party issues, matters of party strife fought upon party lines It has disposed voters in state and city elections to support party candidates, of whom they might otherwise have disapproved, for the sake of maintaining in full strength for national purposes the local party organization, and it has thereby become a fruitful source of municipal misgovernment It has thrown great power into the hands of party managers, because where the strife between the two great parties is keen and the result of a contest doubtful, discipline and obedience are deemed needful for success It has tended to efface state lines, and to diminish the interest in state issues, and has thus helped to make the nation overshadow the states"

The democratic movement in the United States places upon the voter the duty of electing numerous officers of whose qualifications he cannot have knowledge, and of expressing an opinion upon numerous measures of whose merit he cannot be informed The most intelligent citizen, devoting all of his time to public affairs, would in a large number of cases, of necessity, cast an unintelligent ballot. But the functions so imposed upon the voter must be exercised, and the political party has been devised for their exercise. So long as the voter is asked to vote too much party organization rather than political principles will dominate American policies except in the occasional case where the issue as to a candidate or a principle becomes sufficiently important to force the party organization into the background.

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X. HISTORY

BEGINNINGS OF SELF-GOVERNMENT, 1578–1783

The American nation owes its origin to colonizing activities in which the British, Dutch, Swedes, French and Spaniards bore a share, and which were continued during a period of more than two centuries at the beginning of the modern era The settlements of the Dutch and Swedes (New Netherland and New Sweden) were soon merged in those of the British, and of the territory colonized by Frenchmen and Spaniards the United States, as it was in 1783, included only certain outlying regions All the European nations which were interested in colonization shared in the enterprise, and the population of the region was therefore cosmopolitan from the outset; but the British, especially after 1660, secured a controlling influence

Permanent settlements on the Atlantic seaboard were first made in the early years of the 17th century, and they continued steadily to increase until after 1680 Relatively speaking, that was the period of settlement, but population continued slowly to advance westward. In the 18th century occurred a large immigration of Germans and Scottish-Irish, who settled in Pennsylvania and New York and thence overflowed into the western parts of Virginia and the Carolinas The only Colony founded in the 18th century was Georgia (1732), by means of which British outposts on the Florida frontier were strengthened

General Aspects of Colonization.—British colonization originated chiefly in private initiative, though it acted in half-conscious obedience to certain general principles To this fact is due the trend toward self-government, which was fundamental and controlling in the history of the British on the American continent. But to an extent the tendencies which favoured self-government were counteracted by the influence of the British Crown and parliament The influence of the Crown was continuous, except during the period of the Civil War and Commonwealth (1642–60), while that of parliament was not felt until the middle of the 17th century, and its colonial legislation subsequent to that time was chiefly confined to matters of trade The activities of Crown and parliament were directed toward the securing of imperial interests and of that degree of subordination and conformity which, in States that have developed from Roman and feudal origins, attaches to the condition of colonies or dependencies. The term "imperial control" therefore suggests the second tendency in colonial affairs, to the discussion of which the historian must address himself.

Among the colonists the trend toward local independence and self-government was in harmony with the spirit of the English. Neither was it lacking among the other nationalities represented in the Colonies But in the case of the British it was greatly strengthened by the fact that the Colonies were founded by private initiative, the government legalizing the efforts of the "adventurers" and planters, but leaving them in many cases almost wholly to themselves Hence many small Colonies and settlements were founded A variety of motives—economic, religious and political—contributed to the founding of these Colonies, and naturally people correspondingly different in type came to inhabit them The remoteness of the Colonies from Europe and the difficulties under which communication with them was maintained confirmed and perpetuated the tendency toward independence Somewhat similar conditions controlled intercolonial relations, kept the colonists apart from one another and checked co-operation Thus it was that the causes which confirmed the colonists in the spirit of independence toward the mother country also made them jealous of external authority.

Chartered Colonies.—The term "chartered Colonies" is the one which best describes the forms under which the British-American settlements were founded and under which they all continued for varying periods They were the direct and characteristic results of private initiative The discoverers and would-be colonizers, acting individually or in groups, collected the ships, men and resources necessary for their enterprises, and procured from the Crown a charter By this document the King conveyed to them a claim to the soil which would be valid in English law, gave them the right to transfer Englishmen thither, to trade with them and with the natives, and to govern the Colony, subject to the conditions of allegiance and of British sovereignty in general The rights and liberties of the colonists as British subjects, without attempt to define what they were, were guaranteed by the charters, and the grantee was prohibited from passing laws or issuing orders which were repugnant to those of England In only a part of the charters—those chiefly which were issued subsequent to 1660—was express reference made to the calling of assemblies So general were the provisions of the charters that they only remotely determined the forms which government should assume and what the rights of the colonists should be A considerable variety of institutions and social types existed under them But their very indefiniteness made them valuable as objects of appeal to those who in time of controversy were upholding local rights and liberties

London and Plymouth Colonies.—Of the chartered Colonies there were two varieties—proprietary provinces and corporate Colonies Though alike in the fact that the patentees who founded them were mesne tenants of the Crown, they were quite unlike in their internal organization and to a considerable extent also in the character of the people who inhabited them The proprietary province was a development from the principle of the fief, though with many variations The early charters of discovery, those for example which were granted to John and Sebastian Cabot and to Sir Humphrey Gilbert, contemplated the founding of feudal principalities in the New World The grant to Sir Walter Raleigh, which resulted in the abortive colonial experiment at Roanoke, was of the same character At the period of transition from the rule of the Tudors to that of the Stuarts, trading companies and companies for colonization were increasing in number and importance. The joint companies which were chartered by James I. in 1606, one to have its residence at London and the other at Plymouth, were of this character. They were granted the right to colonize, the one in northern and the other in southern "Virginia"; the intervening territory, three degrees in breadth, being left common to the two The rights of the companies were confined to settlement and trade. The Plymouth patentees achieved no permanent result; but those of London founded Jamestown (1607) and other settlements along the James river, which later became the province of Virginia

But before this result had been reached the London patentees had secured in succession two new charters, one in 1609 and another in 1612. By means of these grants they had practically separated from the Plymouth company, had secured a concession of territory 400m. broad and extending through the con-

tinent, and had been able to perfect the organization of their company. By the grant of 1606 the right to govern the Colonies had been reserved to councils of royal appointees, but by their later charters the London patentees were fully incorporated, and in connection therewith received not only the power to grant land but rights of government as well This made the Virginia Company of London the proprietor of the province which it was founding It now appointed resident governors, councillors and other officials and instructed and controlled them in all ways, subject of course to the general supervision of the King in council Under the charter of 1606, in order to facilitate colonization on a strange continent, joint management of land and trade was temporarily instituted But under the fully organized company this system was abandoned, and private property in land and the control of trade through private "magazines" were established A number of distinct plantations and settlements were founded. From these localities, in 1619, under authority from the company, representatives were elected who met with the governor and council at Jamestown and formed the first colonial assembly held on American soil. Its acts were duly submitted to the company in London for its approval or disapproval. Other assemblies were called, the tobacco industry was established and the principles upon which traffic in that staple was to be conducted with Europe were announced. Thus Virginia assumed the form of a proprietary province, with an English trading company as its proprietor

New England Council.—Meantime west of England men had been making fishing voyages and voyages of discovery to northern "Virginia," which now was coming to be known as New England In 1620 a new charter was procured, the reorganized company being known, in brief, as the New England Council Like the London patentees, this body was now fully incorporated and received a grant of the vast territory between 40° and 48° N lat. and extending through to the South Sea (Pacific). Full rights of government, as well as of trade and settlement, were also bestowed The moving spirit in this revived enterprise was Sir Ferdinando Gorges (*q v*), an Anglican and royalist from the west of England For a time John Mason (*q v.*) was his most active coadjutor. Such backing as the company received came from nobles and courtiers, and it had the sympathy of the court. But lack of resources and of active interest on the part of most of the patentees, together with the development of a Puritan interest in New England, led to the failure of this enterprise No Colony was established directly by the council itself, but that part of its vast territory which lay adjacent to the coast was parcelled out among the patentees and by them a few weak and struggling settlements were founded They were all proprietary in character But, as events proved, Plymouth Colony (founded in 1620), which was Puritan and Separatist to the core, became a patentee of the New England council; and the Colony of Massachusetts Bay (founded 1628–30), which was to become the citadel of Puritanism in America, procured the original title to its soil from the same source At the outset both Massachusetts and Plymouth must be classed as proprietary settlements, though far different from such in spirit and destiny. Massachusetts soon (in 1629) secured a royal charter for its territory between the Merrimac and Charles rivers, and thus took a long step towards independence of the council. At the same time the Plymouth settlers were throwing aside the system of joint management of land which, as in the case of Virginia, had been imposed upon them by adventurers who had lent money for the enterprise; were paying their debts to these same adventurers, and were establishing a system of self-government similar to that of Massachusetts Thus a strong Puritan interest grew up in the midst of the domain granted to the New England council, and in connection therewith the type of colony to which we have given the name corporate came into existence.

Corporate Colonies.—In order to understand the nature of the corporate colony, it is necessary to explain the internal organization of that type of company which, like the Virginia Company of London, was founded for purposes of trade and colonization It was composed of stockholders, who became members as the result of the purchase of shares or of migration to the Colony as planters, or of both acts combined. In the Virginia company they were known as the "generality," in the Massachusetts and other companies as the "freemen." In them, when met as a democratically organized body under the name of "quarter court" or "general court," was vested the governing power of the company. It elected the officers, chief among whom were a treasurer or governor, and a council or board of assistants These, as well as the subordinate officers, held annual terms only Membership in such companies might be indefinitely increased through the issue and sale of shares They were, in other words, open companies, whereas the New England council was a closed body, its membership being limited to 40.

Massachusetts.—In 1629 the prospects of Protestantism at large, and of Puritanism in England, were so dark that the founders of the Massachusetts company, who were decidedly Puritan in spirit and inclined to nonconformity in practice, resolved to remove with their charter and the governing body of their company into New England Preparatory to this, John Winthrop was elected governor and a settlement was made of their business relations in England After the removal had been made, the assistants and general court met in New England and business was carried on there exclusively by planters An order was soon passed that none should vote or hold office who were not members of some one of the churches within the Colony As all these churches were Independent or Congregationalist in form and doctrine, this order gave a wholly new definition to the term "freemen " It made of this colony something approximating to a biblical commonwealth, and subordinated trade, landholding and settlement to the interests of the Puritan faith. As local settlements about Massachusetts Bay were founded, the general court, which before had been a primary assembly—simply the freemen of the company—came to consist partly of representatives elected by the freemen of the towns In this way a second chamber—that of the deputies—was added to the assistants to form the general court of the Colony Taxes were levied by this body, and laws and orders proceeded from it which related to all functions of government It elected or appointed the governor and other chief officials

Of primary importance in the affairs of the Colony was everything which concerned religious belief and church government The churches and their relation to the civil power presented the great questions upon which hinged its policy. This was true not only in its internal affairs, but in its relations with other Colonies and with the mother country. An ecclesiastical system was developed in which Independent and Presbyterian elements were combined By a rigid system of tests this was upheld against Antinomians, Baptists, Quakers and dissenters of all sorts.

Connecticut and Rhode Island.—As a consequence of the Puritan migration from England and of the expulsion of dissenters from Massachusetts, Plymouth and Connecticut, the New Haven Colony, and the towns about Narragansett Bay which became the Colony of Rhode Island were settled. These all were corporate Colonies, organized upon fundamentally the same plan as Massachusetts Their settlers at the outset had no charters, but by means of plantation or town covenants assumed powers of government, which ultimately were vested in general courts similar to that of Massachusetts Rhode Island was formed by a union of towns, but elsewhere the Colony was coeval with or antedated the town Connecticut and Rhode Island, in 1662 and in 1663 respectively, secured royal charters by which they were incorporated within New England itself and the governments which they had established there were legalized. New Haven was absorbed by Connecticut in 1664 under the charter of 1662 and Plymouth remained without a charter from the King until, toward the close of the 17th century, it became a part of the enlarged province of Massachusetts.

The most prominent feature of the New England land system was the "town grant," which in every case became the territorial basis of a group settlement. Throughout New England, and in the outlying districts which were colonized by New Englanders, settlement was effected by groups. The process began in Ply-

mouth and was extended through the entire section. The Puritan migration from Europe was of the same general character. Groups of people, animated by a common religious or political ideal, broke away from their original or temporary abiding-places and pushed farther into the wilderness, where tracts of land were granted to them by the general court.

Over the founding of towns the general courts, as a rule, exercised a watchful supervision. Not only did the courts fix and maintain their bounds, but they issued regulations for the granting of lands, for common fields, fences, herds, the punishment of trespass, the admission of inhabitants and freeholders, and the like But subject to these general regulations, the allotment and management of its land was left to each town The Colonies had no land system apart from the town It was partly in order to manage their lands that the towns were made centres of local government and town meetings or boards of town proprietors were established. By means of town action, taken in town meetings and by local officials, the land of each settlement was laid off as house lots, common and common fields, meadow and pasture. Detailed regulations were made for the management of common fields and for their ultimate division and allotment among their proprietors The same was true of fences and herds The result was an organization similar to the English manor, but with the lord of the manor left out To this peculiarity in the form of New England settlement is due the prominence of the town, as compared with the county The town was the unit for purposes of taxation and militia service as well as of elections It was also an important ecclesiastical centre

As a result of the process thus sketched, southern New England was settled by a population of English origin, with similar instincts and a form of political organization which was common to them all Gorges, meantime, had secured (1639) a royal charter for his province of Maine, but Mason had died before he obtained such a guaranty for his settlements on the Piscataqua river. The small communities along that entire coast remained weak and divided In 1635 the New England council surrendered its charter The helplessness of the Gorges family was insured by its adherence to the royalist cause in the English Civil War Massachusetts availed itself of a forced interpretation of the language of its charter respecting its northern boundary to extend its control over all the settlements as far N E as the Kennebec river. This was accomplished soon after 1650, and for the time Anglican and royalist interests throughout New England seemed hopelessly wrecked New England had thus developed into a clearly defined section under Puritan domination. This fact was also clearly indicated by the organization, in 1643, of the New England Confederacy, or the United Colonies of New England (*see* NEW ENGLAND)

Middle and Southern Colonies.—The Colonies of the middle and southern sections of the territory which later became the United States were wholly proprietary in form This was true of New Netherland (founded by the Dutch West India Company in 1621) and of New Sweden (settled under the authority of the Swedish Royal Company in 1638), as well as of the English Colonies In the case of Virginia and of the Dutch and Swedish settlements, trading companies were the proprietors But the later English Colonies, beginning with Maryland in 1632, and continuing with the Carolinas (1663), New York (1664), New Jersey (1665), Pennsylvania and the Lower Counties, afterwards Delaware (1681), were founded by individual proprietors or proprietary boards. Georgia (1732), the only English Colony settled after 1681 on the continent, existed for 20 years under a proprietary board of trustees By the efforts of adventurers of this class, put forth chiefly during the period of the Restoration, the entire coast-line from Florida to Acadia was permanently occupied by the English. But, unlike New England, the population was of a mixed character, as were the economic and religious systems, and to an extent also the political institutions.

As has already been stated, in their internal structure and in the course of their history the proprietary provinces differed very materially from the corporate Colonies. Those of later English origin also differed in some important respects from Virginia under the company and from New Netherland and New Sweden. The system of joint management of land and trade, which was so characteristic of early Virginia, was outgrown before the other proprietary provinces were founded. Neither did it prevail in the Dutch and Swedish provinces.

In the proprietary province the proprietor, or board of proprietors, was the grantee of powers, while in the corporate Colony it was the body of the freemen organized as an assembly or general court. He might exercise his powers in person, or, as was usually the case, delegate them to one or more appointees In any case, the form of government of the proprietary province was essentially monarchical in character The powers that were bestowed were fundamentally the same as those which were enjoyed during the middle ages by the counts palatine of Chester and Durham The normally developed provinces which resulted were miniature kingdoms, and their proprietors petty kings This character arose from the fact that the grantee of power was the executive of the province This branch of government was thereby brought into the forefront At the beginning and for a long time thereafter it continued to bear the leading part in affairs. It was not so in the corporate Colony, for there the freemen and the general court stood at the centre of the system In most of the corporate Colonies the executive was strong, but that was due to the political and social influence which its officials had gained, and not to their tenure of office

Proprietary Colonies.—In every case, apart from the ordinary rights of trade and the guarantees of the liberties of the colonists, the powers which were bestowed on the proprietors were territorial and governmental The territory of the provinces was granted under the conditions which by English law controlled private estates of land An entire province, or any part of it, could be leased, sold or otherwise disposed of like a private estate It was an estate of inheritance, descending to heirs The attitude of proprietors toward it was that of landlords, investors or speculators in land. They advertised for settlers, and, in doing so, an ever present motive with them was the desire to secure more private income from land In 1664 the duke of York sold New Jersey to Berkeley and Carteret, and the sale was effected by deeds of lease and release In 1708 William Penn mortgaged Pennsylvania, and under his will devising the province legal complications arose which necessitated a suit in chancery

In all the later proprietary charters, except that of New York, the operation of the statute *Quia emptores* was suspended, so far as relations between the proprietor and his immediate grantees were concerned By virtue of this provision each proprietor, or board, became the centre from which originated an indefinite number of grants These were held directly of the proprietor and through him of the Crown In practice the same was true also of New York The proprietors were thus left free to make grants on such conditions as they chose. Preparatory to the exercise of this power, the proprietors issued so-called "concessions" or "conditions of plantation," stating the terms on which they would grant lands to colonists Under a system of head rights, analogous to that which existed in Virginia, land was thus bestowed on settlers upon easy terms. Proportional amounts of land were granted upon the importation of servants, and in this way a traffic in servants and their head rights to land was encouraged among planters and masters of merchant vessels In all the provinces, except New Netherland, a quit-rent was imposed on all grants. In the Dutch province rents were sometimes imposed, but they varied in character and differed from the English quit-rent. In Maryland fines were levied on alienations. In Maryland and Pennsylvania the demand for land became so great that it was sold

In all the provinces territorial affairs were administered directly by the provincial authorities, and not by towns as in New England In Maryland a land office was fully organized, towns developed only to a very limited extent, and when they did originate they were in no sense village communities Lots in them were granted by provincial authorities and they were subject to a quit-rent They were simply more densely populated parts of the counties, and, unless incorporated as boroughs, had no distinct

institutional life. In almost all cases land, in the provinces, was granted to individuals, and individual ownership, with direct relations between the owners or tenants and the proprietary authorities, was the rule

Had governmental powers not accompanied the territorial grants, these grants would have been estates of land, unusually large, no doubt, but nothing more In cases where the governmental rights of proprietors were suspended or resigned into the hands of the Crown, they remained thereafter only private landlords But the rights of government bestowed with the land made the territory a province and the proprietor its political head.

The provincial charters made the proprietors of the proprietary provinces the executives of their provinces and for the most part left it to them to determine how and under what forms the governmental powers which they had received should be exercised The powers which were definitely bestowed were executive and judicial in character, giving to the proprietor an importance, especially at the outset, which was comparable with that enjoyed by the general courts in the corporate Colonies It made him in a derived and inferior sense the source of office and honour, the fountain of justice, the commander of the militia, the recipient of the provincial revenue, the constituent part of the legislature But in most cases the proprietors did not attempt to exercise these powers in person By means of commissioners they appointed a group of leading officials for their provinces, as a governor, councillors, a secretary, surveyor general, receiver general or treasurer, and somewhat later an attorney general These all held office at the pleasure of the proprietor.

The Governor.—The governor was *par excellence* the agent for the proprietor for all purposes of administration In making appointments the proprietor was usually guided by the governor's recommendations In some cases he was a relative of the proprietor, family influence in Maryland after the Restoration came to dominate the government of the province In all his important acts the governor was required to take the advice of his council, and that body was expected to co-operate closely with him, but the governor was not bound to follow their advice The relations between the two were the same as that between the King and his privy council in England As settlements multiplied and counties and other local subdivisions were formed, other and inferior offices were created, the right of appointment to which rested with the governor By means of an executive, thus organized, land was granted and the revenue from it collected, counties and other local divisions were established, early preparations were made for defence, courts were opened and the administration of justice begun

In the later proprietary charters generally, with the exception of that issued to the duke of York, provision was made for assemblies It was made, however, in very general terms, and it was left to the option of the proprietors to determine when, where and how they would call them These legislatures did not originate in the natural or pre-existent rights of Englishmen, nor did the existence of a parliament in England make them necessary, though it greatly increased the difficulties of governing the Colonies without them These legislatures were immediately proven to be indispensable and their activity in the provinces gradually opened the way for the growth of modern democratic institutions

The Legislature.—When met in regular form, the provincial legislature consisted of the governor, the council or upper house, and the assembly or deputies These deputies, who were elected by the localities, constituted the only representative part of the legislature. In tenure and functions the governor and council were largely independent both of the deputies and of the electors They were a part of the executive and were naturally swayed by a regard for the interests of the proprietor and by administrative traditions In many cases the importance of the councils was increased by the fact that, with the governor, in early times they formed the highest judicial tribunal in the province. As the governor had the sole power of calling, proroguing and dissolving the general assembly, the council might advise him in such a way as to destroy the body itself or thwart its plans The joint work of the council and assembly was subject to the veto of the proprietor, or of both the proprietor and his governor. The legislature of the province, therefore, differed materially from the general court, though in practice this was somewhat offset by the fact that in the New England Colonies the magistrates were usually re-elected for a long series of terms.

In the province, as in the kingdom, the legislature was in a sense an expansion of the executive, developed out of it, and was to an extent controlled by it Out of this relation arose the possibility of conflict between the two parts of the legislature—that which represented the people and that which represented the proprietor. In the history of the provinces this formed the central line of cleavage From the first the assemblies largely controlled taxation Using this as a lever, they endeavoured to limit and define the powers of the executive and to extend the sphere of legislation more widely Fees, from which officials derived most of their support, were a favourite object of their regulation Occasionally offices which had originally been appointive were made elective Protests of various kinds were made against official cliques Now and again the lower house came to a deadlock with council or governor. Threatened or actual revolt was sometimes necessary to bring the executive to terms. By such tactics as these the popular elements in the constitutions of the provinces asserted themselves The sphere of ordinance was gradually limited and that of statute extended

Constitutions.—In a number of provinces—the Carolinas, New Jersey and Pennsylvania—the proprietors at various times initiated elaborate constitutions, in which not only a land system, but forms and functions of government were prescribed on a large scale These were variously known as fundamental constitutions, concessions and agreements, and frames of government, and in every case were submitted to the general assembly for its acceptance or rejection. Long struggles often ensued over the question of acceptance, which usually ended in the modification or rejection of the schemes

Course of Development.—The history of these provinces was not uniform In New Netherland and New York occurred a struggle for the establishment of a legislature, which continued at intervals for 40 years and was not permanently successful until after New York had become a royal province The proprietors of New Jersey never secured a royal charter, and therefore were not able to establish satisfactorily their claim to rights of government Within the vast reaches of the Carolina grant developed two provinces One of these—North Carolina—was almost entirely neglected by the proprietors, and the weakened executive repeatedly succumbed to popular violence In South Carolina many violent controversies occurred, especially over the efforts of the proprietors to compel the acceptance of the Fundamental Constitutions, which originated with Locke and Shaftesbury. But in the end this failed, and a simple form of government, such as was adapted to the needs of the province, was developed In Pennsylvania the liberal policy of the proprietor led at the beginning to unusual concessions in favour of the colonists, one of the most characteristic of these being the grant of an elective council The total neglect of provision for defence by the Quaker province led to the suspension of Penn's powers of government for about two years after the English Revolution and the outbreak of the war with France. This did away with the elective council for the time, and an appointive council was soon substituted. Finally, in 1701, the council was deprived of its powers of legislation and thereafter the legislature of Pennsylvania consisted of only one house—the assembly.

Imperial Control, 1606–1760.—Imperial control over the Colonies, it is to be noted, proceeded chiefly from the English Crown It was exercised through the secretary of State, the privy council and a succession of boards subordinate to it which were known as commissioners of plantations or the board of trade; by the Treasury and Admiralty boards and their subordinate bureaux; by the attorney general and the solicitor general and by the bishop of London The more continuous and intimate supervision proceeded from the privy council and the commissioners subordinate to it, and from the Treasury board,

which caused the auditing of such revenue as came from the Colonies, supervised expenditures for them and had an oversight over appointments in the colonial service The privy council received letters and petitions on almost every kind of colonial business, caused hearings and inquiries to be held, and issued letters, instructions and orders in council on an equally great variety of matters It also acted as the regular court of appeal for the plantations As time advanced, more of the administrative business passed directly into the office of one of the secretaries of State and the privy council became less active The Admiralty was concerned with the equipment of the navy for service in the Colonies, and the high court of admiralty with the trial of prize cases and of cases arising from violations of the acts of trade. The bishop of London had supervision over the appointment and conduct of clergymen of the English Church in the colonies and over parish schools there

Parliamentary Control.—The parliament by mentioning the dominions in its statutes could extend their provisions to the colonies The early acts of supremacy and uniformity contained such reference, but it was dropped after the Restoration and no serious attempt was ever made to enforce uniformity in the Colonies Parliament did not begin to legislate seriously for the colonies until after the Restoration Then the acts of trade and navigation were passed, to which additions were made in the reign of William III and from time to time during the 18th century This body of legislation comprised the most important acts relating to the Colonies which were passed by Parliament A few statutes relating to military affairs were passed about the middle of the 18th century About 100 statutes in all were passed prior to 1760 The colonists themselves imitated in a general way the organization and procedure of the English courts The main features of the common law came spontaneously into force in the Colonies The legislatures of several of the Colonies adopted large parts of the statute law of England The colonists were always accustomed to avail themselves, as far as possible, of the great English statutes which guaranteed liberty After about 1690 the obligation was very generally enforced upon the Colonies of sending the acts of their assemblies to England for acceptance or rejection by the King in council

But this, though far-reaching, was only one of the objects which were sought through the exercise of imperial control Its chief object was to maintain the rights of Great Britain over the Colonies and her interests in them in all respects The diplomacy of Great Britain concerned itself to an increasing extent, as the 18th century advanced, with the acquisition or losses of colonial territory, with the fixing of boundaries and with the securing of commercial interests The interests of trade more than any other subject, determined the colonial policy of England The church and her interests also demanded attention In all these matters the English executive—the Crown—continuously, and for the most part exclusively, managed colonial affairs During the Commonwealth in the 17th century, parliament was the source of all activity, whether legislative or executive, but at other times its legislation was confined chiefly to the subject of trade

Isolation of the Colonies.—A natural condition which affected colonial administration as a whole and to a large extent determined its limits and character was the remoteness of the Colonies from England At best three months were required for sending a dispatch from London to America and procuring a return This explains the large degree of self-government which the Colonies possessed and the indifference with which their affairs were usually viewed, even by British officials Only a relatively small part of colonial business came before English officials or received their serious attention Only at long intervals and in summary fashion was it brought to the attention of Parliament It is believed that the affairs of the continental Colonies were never seriously debated in Parliament until after the beginning of the controversy which led to the American War of Independence Social and political intercourse with the colonists and governmental control over them were therefore very imperfectly developed In fact, the control over them was almost wholly executive, and during most of the period it was to a degree unintelligent and weak; in fact it was something more resembling a federation

Chartered Colonies.—The central fact in colonial history during the 17th century was the development of the chartered Colonies. At their founding, as we have seen, the Crown delegated rights of settlement and subordinate rights of government to proprietors, who used them in a variety of ways The effect of this was to introduce a number of mesne lords between the king and his colonial subjects, a phenomenon which centuries before had vanished from England itself The patentees governed the colonists, and the Crown interfered only at intervals to adjust matters Under the first two Stuarts some rather desultory efforts were made to check the development of such a system in the early stages After a controversy over a contract for the sole importation of tobacco, which became involved with the political struggles of the time in England the charter of the Virginia Company of London was revoked (1624) A royal commission was appointed to readjust the affairs of Virginia and to inaugurate its government as a royal province In 1634 a board of commissioners of plantations was created and it received very large powers over the Colonies The year following the New England council resigned its charter, a writ of *quo warranto* was issued against the Massachusetts charter, and a plan was nearly perfected for sending out Sir Ferdinando Gorges as royal governor, or rather governor general, to New England But means were lacking, the suit against the Massachusetts patent failed to accomplish its purpose, and troubles at home soon absorbed the attention of the Government

During the Great Rebellion in England New England was left practically to itself Strife broke out in Maryland, over which the home Government was scarcely able to exercise even a moderating influence The Dutch from New Netherland and Europe were able to monopolize a large part of the carrying trade in tobacco and European goods Virginia assumed an attitude of distrust or hostility toward the new Government in England In 1651 and 1652 Parliament sent out a commission, with an armed force, which adjusted affairs in Virginia by suspending Government under Sir William Berkeley, the royalist governor, and leaving control in the hands of the assembly By a stretch of power the commissioners also took control of affairs in Maryland, but there they intensified rather than allayed the strife Baltimore, however, managed to save his interests from total wreck, and at the Restoration was able to re-establish his authority

Navigation Acts.—During this time of unstable government in England the seeds were planted of a colonial policy which was henceforth to dominate imperial relations It was then that England entered upon the period of commercial rivalries and wars The Cromwellian Government determined to wrest the control of the carrying trade from the Dutch, and the Navigation Act of 1651 and the first Dutch War were the result Gen Robert Sedgwick was sent against New Netherland, but ended in attacking Acadia At this time also the national hatred of Spain, which had so characterized the age of Elizabeth, reasserted itself and the Spanish seas were invaded In connection with these events plans were formed for a more systematic colonial administration which Cromwell did not live to execute, but which were taken up by Clarendon, the duke of York, the earl of Shaftesbury and a large group of officials, lawyers and merchants who surrounded them They took definite shape after the Restoration in the creation of a council for trade and a council for foreign plantations, in the passage of the acts of trade, in the conquest of New Netherland, in the settlement of the Carolinas, and in a resolute attempt to adjust disputes in New England These events and their consequences give greater importance to the next three or four decades than to any later period until the colonial revolt

The council for foreign plantations was continued, sometimes under a patent and sometimes as a committee of the privy council, until in 1696 it was commissioned as the board of trade As a board of inquiry and report, subordinate to the privy council, the most important business relating to the Colonies was transacted before it The acts of trade, in which the principles of the system were laid down, were passed in 1660, 1663, 1673 and 1696 They expanded and systematized the principles of mercantilism as they had long been accepted The import and export trade of the

Colonies was required to be carried on in English and colonial built ships, manned and commanded by Englishmen. The policy of the staple was applied to the trade of the Colonies by the enumeration of their chief products which could not be raised in England and the requirement that such of these as were exported should be brought to England and pay duties there, and that the supplies not needed for the English market should be sent thence to foreign countries. The same policy was applied to all colonial imports by the requirement that they should pass through English ports In order to prevent intercolonial traffic in enumerated commodities, which might lead to smuggling, the act of 1673 provided for the levy of an export duty on them in the Colonies in cases where a bond was not given to land them in the realm

In the 18th century severe restrictive measures were passed to prevent the growth of manufactures in the Colonies; but these acts proved mostly a dead letter, because the Colonies had not reached the stage where such industries could be developed on any scale. Certain compensations favourable to the Colonies also appear in the system, *e g*, the measures to suppress the raising of tobacco in England and Ireland, in order that the colonists might have the monopoly; the payment of bounties on the importation of naval stores and on the production of indigo by the colonists; the allowance, on the re-exportation of colonial products, of drawbacks of part or all of the duties paid on importation; the admission of colonial imports at lower rates of duty than were charged on the same products from foreign countries In order to ensure the enforcement of these acts elaborate provisions became necessary for the issue of bonds, and this, with the collection of a duty in the Colonies, led to the appointment of colonial customs officers who were immediately responsible to the commissioners of the customs and the Treasury Board in England. With them the governors were ordered to co-operate. Courts of vice admiralty, with authority to try cases without a jury, were established in the Colonies; and just before the close of the 17th century they were given jurisdiction over violations of the acts of trade, a power which they did not have in England It thus appears that the resolve to enforce the policy set forth in the acts of trade resulted in a noteworthy extension of imperial control How far it was successful in the immediate objects sought it is impossible to say. In some of the Colonies and at some times the acts were practically nullified Illegal trading was always carried on, especially in time of war. But in the large it is probable that the acts were effective, and their existence always furnished a standard to which officials were required to conform.

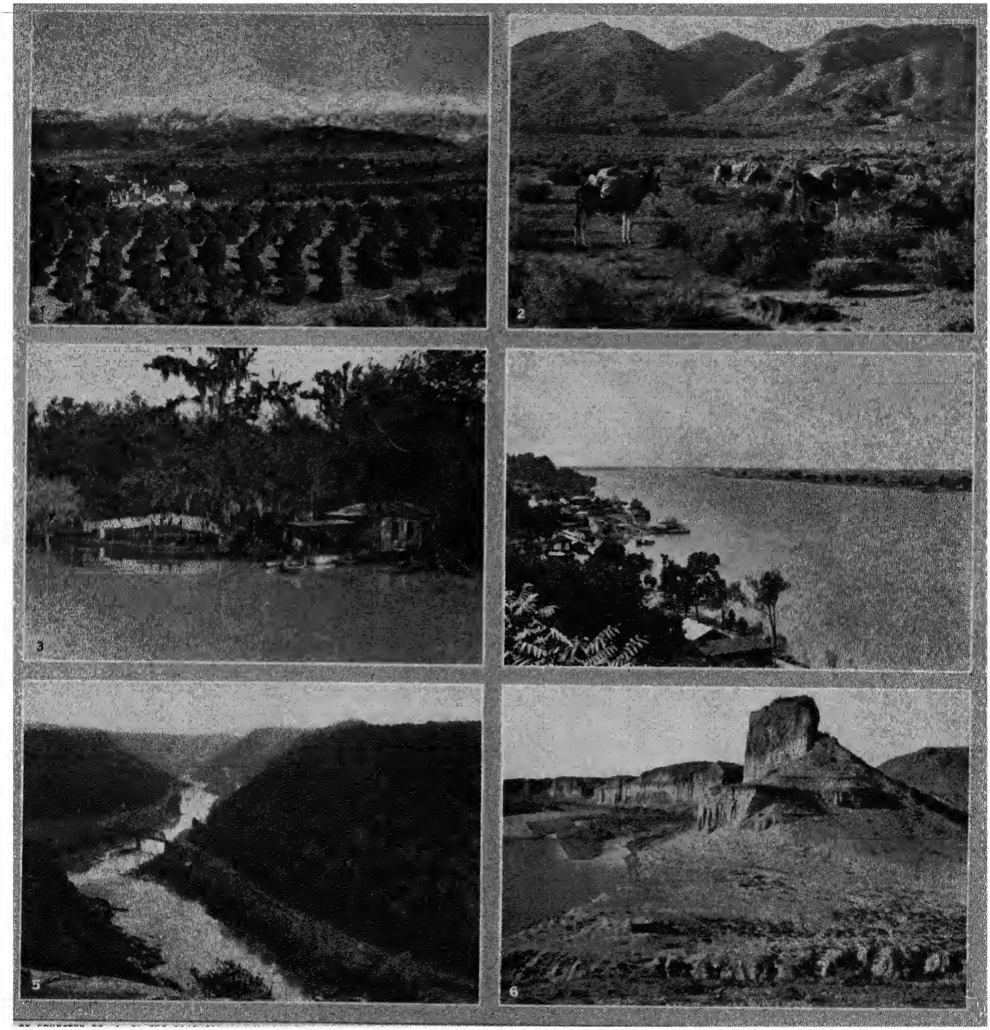
By the Act of Union of 1707 Scotland was admitted to the advantages of the English trade system. In 1733, in order to check the development of the French colonies and prevent the importation of their products into English possessions, the Molasses Act was passed. This provided for high specific duties on rum, molasses and sugar, when imported from foreign colonies into those of Great Britain. So high were these rates that they could not be collected, and little attempt was made to enforce the act.

Returning to the 17th century, the conquest of New Netherland by the British in 1664 was an event of great importance. Taken in connection with the settlement of the Carolinas, it completed the hold which the English had upon the North American coast and gave them for the first time an extent of territory which could be profitably developed The occupation of New Netherland was effected by a royal commission, which was also empowered to hear complaints and report a plan for the settlement of disputes in New England. A little more than ten years later a similar body, accompanied by a military force, was sent to Virginia to adjust matters at the close of Bacon's rebellion. But the commission of 1664 was the most noteworthy example of its kind. Yet, though it succeeded at New Amsterdam and in the southern Colonies of New England, it failed at Boston. Massachusetts would not admit its right to hear appeals. It did not succeed in wresting from Massachusetts the territory of New Hampshire and Maine, which the heirs of Gorges and Mason claimed.

Dominion of New England.—In 1676 Edward Randolph was sent as a special agent to Massachusetts, to require it to send agents to England. He returned to England the sworn enemy of that Colony and continued to be its tireless prosecutor. A series of negotiations ensued which lasted for almost a decade, and ended in the revocation of the Massachusetts charter by a decree in chancery, 1684. New Hampshire had already been organized as a royal province. Government under the charters of Rhode Island and Connecticut was soon after suspended. All New England was then organized as a dominion or viceroyalty under Sir Edmund Andros Assemblies were everywhere abolished and government was left wholly in the hands of the executive. New York—also without an assembly—and New Jersey were soon after incorporated with the Dominion of New England, its boundary being extended to the Delaware river After Bacon's rebellion in 1676 the lines of executive control were strengthened in Virginia, but the assembly continued active. These rapid changes involved the downfall of the former system of chartered colonies and the substitution of royal provinces in their place. The effect of this was to introduce into the Colonies a large number of officials of royal appointment. The entire executive and judiciary in a royal province was appointed directly or indirectly by the king. Its members held under commissions subject to the king's pleasure and were controlled by his instructions

Colonial Reorganization.—By the abolition of assemblies and the union of Colonies on a large scale James II. did violence to the strongest feelings and traditions of the colonists The New Englanders not only viewed the levy of taxes by prerogative with the utmost aversion, but they feared a general unsettlement of land titles, the destruction of much that was valuable in their system of town government, and the introduction of Anglican worship They shared also in the fear, which was widespread among the colonists, that the Crown intended by an alliance with the French and Indians to force Roman Catholicism upon them. Therefore the fall of the Stuart Government in England was the signal for an uprising at Boston (April 1689) followed by a less successful one at New York. The Dominion of New England at once collapsed and the old Colony Governments were generally restored A revolt against the Catholic proprietor in Maryland resulted in the suspension of his powers of government and the organization of Maryland as a royal province. William III. granted a new charter to Massachusetts (1691) in which full provision was made for an assembly, but also for a governor and secretary of royal appointment. Rhode Island and Connecticut were allowed to remain under their corporate charters New York and New Hampshire were organized as royal provinces with assemblies. Proprietary government struggled back into existence in New Jersey In Pennsylvania the governmental powers of the proprietor were suspended from 1692–94, because of his neglect of provision for defence; then they were restored and Pennsylvania continued under proprietary government until the War of Independence

The transition from the system of chartered colonies to that of royal provinces was thus well advanced towards completion. But it was a gradual process, and the later stages of it were not reached until the second decade of the 18th century South Carolina became provisionally a royal province in 1719, and a parallel change was completed in North Carolina a decade later. Georgia received a royal government in 1752. But in 1715 Maryland was permitted to resume its proprietary form After the Revolution of 1689 the change to royal governments did not involve in any case the abolition of colonial assemblies. Henceforward the Crown had a fully equipped executive in every royal province. The governors exercised the royal rights of calling, proroguing and dissolving the assemblies; they assisted in initiating legislation and exercised the right of veto. All bills passed by the assemblies were required to be submitted to the King in council for acceptance or disallowance. The upper houses of the legislature were the councils of the provinces. These were small bodies and consisted, in every case except Massachusetts, of royal appointees. Their support was in most cases given to the governors, and by that means they were greatly assisted in resisting the encroachments of the lower houses of assembly which were elected by the freeholders. But, as a rule, the Crown made no provision for the salaries of its governors and other officials, and left them largely dependent for support on appropriations by the assem-



BY COURTESY OF (1, 2) THE SOUTHERN PACIFIC LINES; PHOTOGRAPHS (3, 4, 5, 6) EWING GALLOWAY

VIEWS IN DIFFERENT SECTIONS OF THE UNITED STATES

1. View from Smiley Heights near Redlands, Calif.; immense orange groves in the foreground, snow capped mountain peaks in the background
2. A burro pack train in Death Valley, Mojave desert, California
3. Picturesque lumberjack houseboat at the edge of a Louisiana swamp. When work in that immediate section is finished, the lumberjack puts out in his houseboat and drifts down the swamp to the next job
4. The broad Mississippi river near Natchez, Mississippi. A ferryboat and two old style river steamers of the stern wheel type are tied alongside the bank
5. Kanawha river winding its way through a valley in the Appalachian plateau of West Virginia
6. Buttes of the Green River in Wyoming. Mountain sides have been cut away by centuries of erosion

blies. Under this system of balanced forces, analogous in general to that which was reached after the Revolution in England, the Colonies entered upon the long period of the French wars.

Struggle with the French, 1690–1760.—Early French discoveries and colonization in North America were confined chiefly to the valley and gulf of the St. Lawrence. These led in the early seventeenth century to the establishment of the province of Canada. By 1610 the French had possessed themselves of the valley of the lower St. Lawrence, and the relations with the Indian tribes were being determined During the next 50 years Canada grew slowly into an autocratically governed province, in which the Roman Catholic church was so strong as to contest supremacy at times with the civil power. The fur trade became from the first a most important industry. The Jesuits and other priestly orders undertook missionary work on a large scale among the natives. The fur trader and the missionary soon extended French influence through the region of the Great Lakes. Between the Iroquois and the French, wars were almost continuous, but with the other Indian tribes the French were in general on friendly terms. The Iroquois maintained friendly relations with the Dutch and afterwards with the English. This deeply affected relations between the English and the French, as well as the entire development of the province of New York.

French Expansion.—Exploration was a most important incident of both the fur trade and the missionary enterprises of the French. Between 1670 and 1690 their work culminated in the great exploring activity of Marquette, Joliet and La Salle The Ohio and Mississippi rivers were discovered and their courses were mainly or wholly traced Explorers also penetrated far into the regions beyond the Mississippi Posts were established at various points along the Great Lakes During the first two decades of the 18th century the French also established themselves on the Gulf of Mexico, Mobile being founded in 1702 and New Orleans in 1718. Quebec and the Gulf ports were then connected by a series of forts which, though few and weak, sufficed for communication and for the establishment of a claim to the Mississippi valley. They were Niagara and Detroit, commanding the approaches to lakes Erie and Huron; Fort Miami, on the Maumee river, Fort St. Joseph, at the southern end of Lake Michigan; Vincennes and French Fort, on the Wabash; Fort Chartres, on the Mississippi opposite St Louis; Michilimackinac and Ste Marie, which guarded the upper lakes French zeal and enterprise had thus seized upon the heart of the continent It seemed possible that English settlements might be confined to the coast, for they expanded slowly and no genius for exploration or sympathy with Indian life was shown The tendency of British commercial policy was likewise to confine them there The Indian alliances of the English were also far less extensive than those of the French The provinces of South Carolina and Georgia had conflicts with the Spanish on the Florida frontier, and in these the Indian tribes of the south were also involved. But these rivalries were slight and local in character when compared with the struggle for supremacy which was preparing between the French and English

The conflict with the French was precipitated by events in Europe. It was the English Revolution of 1689 that opened the great conflict between France and England. The question of Protestantism versus Catholicism was involved, but at bottom the struggle was one for the balance of power among European States. Rival claims, too, existed between the two powers in America, Africa and Asia. Questions of commercial and naval supremacy world-wide in extent were involved, and the colonial possessions of the two States were necessarily drawn into the struggle. In America it involved four intercolonial wars (Dutch War with France, War of Queen Anne or Spanish Succession, War of Austrian Succession and Seven Years War), which were closed respectively by the treaties of Ryswick (1697), Utrecht (1713), Aix-la-Chapelle (1748), and Paris (1763). On the American continent during the first two wars the struggle was confined to the northern frontier, and consisted of devastating raids by the French and Indians, which in turn provoked retaliatory efforts on the part of the English. These took the form in part of attacks on Acadia and of unsuccessful efforts to conquer Canada by means of joint expeditions by sea and land. The favourite land route was that from New York by way of Lake Champlain to Montreal, while the expeditions by sea were forced to make the long and perilous voyage round Nova Scotia and through the Gulf and River St. Lawrence to Quebec. In 1690 and again in 1711 an enterprise of this kind was actually undertaken Acadia, "with its ancient limits," and the claim of France to Newfoundland and the Hudson Bay territory were, however, ceded to England by the Treaty of Utrecht.

Wars Between French and British in America.—As the great world conflict progressed the relative importance of the colonial and maritime issues which were involved increased The first two wars had their origin primarily in European questions. The third war had its beginning in the Spanish West Indies, and clearly revealed the existence of the Bourbon Family Compact, which bound France and Spain together On the American continent its most striking event was the capture, in 1745, of Louisburg, a stronghold which the French had recently fortified on Cape Breton. This victory was secured largely by the efforts of the New England colonists In the following year another plan for the conquest of Canada was thwarted by the necessities of war in Europe. At the close of the war Louisburg, too, was restored to the French After this fashion did the world struggle react upon the special interests of the English in North America, and perplex and irritate the colonists.

In the fourth intercolonial war (1754–63) the struggle between the two nationalities in North America was decided Events which immediately preceded this war—the occupation of the Ohio valley and the building of Fort Duquesne—clearly revealed an intention on the part of the French to exclude the English from the Mississippi valley. A persistent effort was also made to recover Acadia. The western, as well as the northern, frontier was now threatened, and the war which followed affected all the Colonies. Great Britain sent over a succession of commanders-in-chief. Great improvement was made upon the crude efforts at joint colonial action which had characterized the earlier wars. the Albany congress of 1754 greatly surpassed in importance the meetings of governors and military officers which had occasionally been held in previous times, though its plan of colonial union failed. The campaigns of this war were all upon a comparatively large scale. Campaigns were carried on not merely along the line of Lake Champlain and in Acadia, but against Fort Duquesne, Oswego and Fort Frontenac, Louisburg and Quebec itself. The weak Spanish power was overthrown in Florida and expeditions were sent against the southern Indians In all quarters, and especially after Pitt became secretary of State, the British assumed the offensive The Navy of Great Britain, as well as its Army, was called into action on a much larger scale in America than ever before The result was the conquest by the British of Canada, and all North America east of the Mississippi river; the French claim to territory west of this river was ceded to Spain in 1762.

The wars with the French brought the problem of colonial defence among the English into greater prominence than ever and added it to the other questions at issue Against the Indians the colonists in the 17th century had provided for their own defence. Chiefly with this object in view, each Colony had developed a militia system But such a force was not fitted for long campaigns or large operations: it was comparatively undisciplined; the commissariat was poor or totally lacking, and the men were able to remain away from their homes for only brief periods. The colonists possessed no navy So poor were means of communication and so isolated were the Colonies from one another, that co-operation was very difficult. Equally difficult was it to secure proportional contributions of money from the Colonies Early in the French wars the British Government prescribed quotas both of men and money to be raised by the Colonies, but little attention was paid to these except by the Colonies in immediate peril Because of the limited amount of available money and the modest resources of the colonists heavy taxation was impossible. The assemblies resorted to the issue of bills of credit, to which they gave legal tender quality, and for the redemption of which in nearly all cases they made inadequate provision. The

paper depreciated and in some Colonies became worthless. Great confusion resulted, involving loss to all, and among the sufferers were British merchants Strained relations were produced between the assemblies and the colonial executive, who, acting under royal instructions, persisted in vetoing bills for additional issues of currency. For this reason, in addition to others, the assemblies withheld the salaries of governors and other officials, and in this way sought to coerce the executives In some Colonies the assembly secured the right of electing the treasurer, and in most of them appropriations were made specific Thus by skilfully utilizing their control over the purse, and that during a long period of war, the colonial assemblies were able materially to limit the authority of the executives It was in such ways as these that the Constitutions of the provinces became developed and liberalized during the French wars

The Canadian Government.—The quality of the rank and file of the Canadian militia was not essentially different from that of the British Colonies But the Canadian Government was autocratic The power of the French was also concentrated in a single large province These conditions greatly promoted military efficiency. When taken in connection with their Indian alliances, they enabled the French to take the offensive in the earlier wars much oftener than did the English, and with much greater effect The English frontier was more accessible and more exposed than was the lower part of the valley of the St. Lawrence. Quebec was in every sense a citadel to which additional security was given during a large part of every year by the intense cold of the Canadian winter But so superior were the training and enterprise of the French *coureur de bois* that, with his Indian allies, he was far better able than the English farmer or artisan to penetrate the wilderness, whether in winter or in summer, and massacre the exposed dwellers on the frontier It was this class which gave the French the superiority in the long succession of raids by which the English frontier was laid waste

Though the French by their skill and boldness achieved a remarkable success, their defects and weaknesses were equally evident. The flow of population from France to America was never great, and was diminished by the exclusion of Huguenots The natural growth of population within New France was not rapid and the French colonists did not become sufficiently numerous to maintain the interests to which their vast claims and possessions gave rise At the opening of the last intercolonial war the proportion of English to French colonists was approximately 15 to one. The resources of the British exceeded those of the French colonists to a corresponding degree Had the decision of the questions at issue depended upon population and wealth alone, the issue could not long have remained doubtful But they were so offset by other circumstances, already alluded to, that the result of the struggle was for a long time uncertain The motherlands were to be the decisive factors in the problem, which thus depended to an extent on complications which existed in Europe or even on remoter seas and continents When the climax of the struggle was reached the result might have been different if France at the time had not been so deeply involved in the politics of central Europe

Of the first importance in reaching a decision were the fleets and armies of Great Britain and France, or those parts of them which were available for use on the continent of North America During the larger part of the period under review the French neglected their fleet, while the English steadily advanced toward naval and commercial supremacy But the first conspicuous service on the northern coasts was that which was rendered by Commodore Peter Warren and his squadron at the capture of Louisburg in 1745. In the next year a large French fleet was despatched to North America, but it accomplished nothing. In the last intercolonial war the operations before Louisburg in 1758 and at Quebec in 1759 decisively proved the superiority of the British Navy. The Colonies also, in the later stages of the struggle, contributed loyally toward the result. France failed to make her natural military superiority effective in North America, and her power on that continent had to yield before the combined attacks of Great Britain and her Colonies by land and sea.

Colonial Revolt, 1763–76.—The Treaty of Paris (1763), by which the period of colonial wars was concluded, added vast stretches of territory to the dominions of Great Britain in North America The Floridas, Canada and Louisiana as far west as the Mississippi river now came into the possession of the English. Of the islands which were occupied, the two most important—Guadaloupe and Martinique—were restored to the French The retention of Canada in preference to these involved an important change in the nature and objects of British colonization Hitherto tropical colonies had been preferred to those in northern climes. But it was now bent upon continental expansion. Canada and the West were retained and the most important French islands were given back The development of modern industry—the so-called industrial revolution had already begun in Great Britain Its effect was vastly to increase the population of the British Isles and to necessitate an overflow into the unoccupied regions of the globe Henceforth, as time progressed, colonies were to be valued as homes for a surplus population quite as much as sources of raw materials and food supplies The retention of Canada and the West also coincided exactly with the desires of the continental Colonies The chief gains of the war went therefore to them and not to the island colonies They now possessed a continental domain which was adequate to their need for expansion, and their long-cherished desire to be rid of the French was gratified The conquest of the French removed the sense of dependence on Great Britain for military aid previously felt by the northern Colonies in particular

Increase of Imperial Control.—In consequence of the policy thus adopted, largely increased burdens were devolved on the Imperial Government, while the conquest and the events which led to it strengthened imperialist sentiment. The course of action which was at first favoured by leading officials, both in England and the Colonies, was a more systematic administration of Indian affairs, the employment of sufficient regular troops under the commander-in-chief to defend the newly acquired territory, the maintenance of posts with English settlers in the interior on a scale sufficient to prevent the French or Spanish from securing the trade of the region Improved methods of administration were urged, French methods were praised and the shortcomings of the surviving chartered Colonies were again emphasized This all required additional revenue, as well as administrative vigour, and that at a time when Great Britain was especially burdened with debt and when several of the Colonies had recently incurred heavy expenditures The large acquisitions of territory also necessitated some changes in the acts of trade The necessity for their more vigorous enforcement was revealed by the existence of a large contraband trade between the colonists and the enemy during the later years of the war and also of a considerable illegal trade with Europe These conditions, together with the conviction that, as the continental Colonies had reaped the chief advantages of the war, some favour should be extended to the islands, led to the passage of the Sugar Act by the Grenville ministry in 1764 It also caused a resort to writs of assistance in two of the Colonies, and finally the legalization of them in all the Colonies by Act of Parliament (1767) The aid of the Navy was directly invoked in the enforcement of the trade laws, and the activity of the customs officials and of the admiralty courts in the Colonies was increased Garrisons of regular troops—numbering several thousand —with a commander-in-chief were now present in the Colonies in time of peace, and their aid might possibly be invoked by the civil power to suppress disorder The Sugar Act itself was a trade and revenue act combined, and the fact was expressed in the preamble of the measure It was intended directly to affect the traffic between the northern Colonies and the foreign West Indies in lumber and food-stuffs, molasses and rum The duty on foreign molasses, for which provision had been made in the Molasses Act of 1733, was halved; but now it was proposed really to collect this duty. A cry was immediately raised in New England that, if the duty was collected, the manufacture of rum—of which molasses was the staple material—would be lessened or wholly prevented and a most important industry sacrificed The fisheries would incidentally suffer. In spite, however, of the opposition which it provoked in the northern Colonies, it is probable that the Sugar Act could have

been permanently enforced. The Act of Trade of 1673 and the Molasses Act—though it was not fully executed—were two early instances of the exercise by Parliament of the right to tax the colonies. Had the Sugar Act been enforced, a clear and decisive precedent in favour of this right would have been established In view of the general situation, that was probably as far as the British Government should have gone at that time But it immediately committed itself to another and still more significant measure, and the two acts combined caused an outburst of protest and resistance from the colonists

The Stamp Act.—Repeatedly in earlier years the imposition of a stamp duty upon the Colonies had been suggested The cost of the regular troops which must be stationed in America was estimated at about £300,000 annually The Sugar Act was expected to yield about £45,000 a year It was thought that the colonies should raise about £100,000 more as their reasonable share of the cost. George Grenville resolved to secure this by means of a stamp duty. This would fall upon the island colonies equally with those of the continent, though it would be expended chiefly for the enlarged military force on the mainland Though its simplicity and ease of collection recommended it, the Stamp Act was a purely fiscal measure, and its character was not concealed by any features which allied it to the earlier acts for the regulation of trade It was passed by Parliament in 1765, almost without debate and with scarcely a thought that it would be resisted It provided for the appointment of officials to distribute the stamped papers in the colonies and further extended the power of the admiralty courts by giving them jurisdiction over violations of this act The legal theory upon which the act was based was that of the unqualified sovereignty of Parliament as the representative body for the whole empire, and that its authority, if it chose to use it, was as effective for purposes of taxation as for the regulation of trade or other objects of legislation But never before, during the century and a half of colonial history, had the taxing power been so unqualifiedly exercised It followed close on the heels of the Sugar Act, which itself had aroused much hostile criticism The two measures also came at a time when the consciousness of strength among the Colonists had been increased by the defeat and expulsion of the French Moreover, at the time when the policy was initiated, George III had undertaken to crush the Whig party and to revive the latent prerogatives of his office This resulted in the formation of a series of coalition ministries Vacillation and uncertainty were thus introduced into the colonial policy of the Government The royal policy also brought into the public service in England and kept there an unusually large group of inferior men who persistently blundered in the treatment of colonial questions It was only with the accession of the North ministry, in 1770, that permanence and a certain consistency were secured But, in the view of the colonists, the prestige of the Government had by that time been seriously lowered

Resistance to the Stamp Act.—Determined opposition to the Stamp Act was shown in all the Colonies, by or before the time (Nov 1) when it was to go into effect. The forms assumed by this opposition were such as characterized the entire controversy with Great Britain until the opening of hostilities in 1775 It consisted in the passage of resolutions of protest by the lower houses of some of the colonial legislatures; in the calling of a congress at New York which was attended by delegates from nine of the Colonies, in the activity of mobs organized under the name of the "Sons of Liberty"; and, finally, in a somewhat widely extended movement against the importation of British, or even foreign, goods and in favour of frugality and the encouragement of home manufactures The newspaper press also sprang into much greater activity than ever before, and many notable pamphlets were published The most important resolutions at the outset were those adopted by the Virginia House of Burgesses and by the House of Representatives of Massachusetts. Through the first-named body the dramatic eloquence of Patrick Henry forced five resolutions Two others, which threatened resistance and the coercion of any who should venture to uphold the home Government, failed to pass, but the whole seven were published broadcast through the Colonies. The calling of a general congress was proposed by the House of Representatives of Massachusetts Prominent among its members was James Otis, who had already distinguished himself by radical opposition to measures of the Government, especially in the case against writs of assistance which was argued before the superior court in 1761 Samuel Adams, already a prominent man, was now elected a member of the House from Boston He almost immediately became its leader, drafting its most important resolutions and papers, and to a large extent directing its policy With the aid of others he was able greatly to increase the activity of the town-meeting in Boston, and in the course of a few years to develop it on occasion into a great popular convention Throughout New England the town and its institutions served well the purposes of opposition and facilitated its extension over large areas The intense Puritan spirit, with its century and a half of pronounced independence, both in polity and temper, was lacking outside New England; though on the frontiers of the provinces from Pennsylvania southward was a Scottish-Irish population which exhibited many of the New England characteristics But the tenant farmers of New York, the German pietist sects of Pennsylvania, the Quakers wherever they had settled, and in general the adherents of the English Church were inclined toward indifference or, as the controversy progressed, toward positive loyalism Hence the mixture of nationalities in the middle colonies greatly increased the difficulty of rousing that section to concerted action In Pennsylvania the issues were obscured by a struggle on the part of the western counties to secure equal representation with those of the east This helped to make loyalists of the Quakers Special grievances also produced among the frontier settlements of North and South Carolina quite as much dislike of the officials and social leaders of the tide-water region as they could possibly feel toward Crown and Parliament. Throughout the struggle New England and Virginia exhibited a unity and decision in action which were not equalled elsewhere

Increased Opposition.—But to return to the Stamp Act. Before the meeting of the congress at New York outbreaks of mob violence in Boston had forced the stamp distributor there to resign, and had wrecked the house of Thomas Hutchinson, the chief justice Owing largely to the indecision of the elective council, the Government had proved powerless to check the disorder The resolutions passed by the Congress, as well as its petitions to the home Government, gave authoritative form to the claims of the colonial opposition in general, though the body which issued them, like all the congresses which followed until 1776, was extra-legal In these utterances, as later, the colonists sought to draw their arguments from British precedents and their own history The two British rights which, it was claimed, were violated by the Stamp Act were the right to trial by jury and the right to be taxed only by an assembly in which they were represented The first grievance was simply an incident of the second, and was occasioned by the extension of the jurisdiction of the admiralty courts The tax was a direct grievance For purposes of legislation like this these bodies denied that Parliament was representative of the whole empire For purposes of taxation, their assemblies, they affirmed, were the only representative bodies they had known Therefore, ignoring the earlier and tentative measures by which Parliament had actually taxed the Colonies, and falling back upon the sweeping declarations of their assemblies, they denied the right of Parliament to tax them They declared that the recent policy of Parliament was wholly an innovation and insisted upon a return to the constitution as it was before 1763 The doctrine of natural right and compact was also resorted to with increasing emphasis in New England utterances.

Repeal of the Stamp Act.—The decisive blows, however, were struck by the mobs in the Colonies and by the Government itself in England As the time for the execution of the Stamp Act approached, more or less violent demonstrations occurred in New York and in many other localities The stamp distributors were forced to resign Everywhere in the original continental Colonies the use of stamped papers was prevented, except to a slight extent in Georgia Business requiring the use of stamps was in part suspended, but far more generally it was carried on

without their use. Without the aid of the militia, which in no case was invoked, the colonial executives proved indisposed or powerless to enforce the act and it was effectively nullified. In England the petitions of the colonists produced little effect. There the decisive events were the accession of the Rockingham ministry to power and the clamours of the merchants which were caused by the decline in American trade. The serious lack of adjustment between British politics and colonial government is illustrated by the fact that, more than three months before the Stamp Act was to go into effect, the ministry whose measure it was resigned, and a cabinet which was indifferent, if not hostile, to it was installed in office. Preparations were soon made for its repeal. The slight extent to which relations with the Colonies had been defined is indicated by the fact that the debates over the repeal contain the first serious discussion in parliament of the constitution of the British empire. While the Colonies were practically united in their views a great variety of opinions was expressed in parliament. On the question of right Lord Mansfield affirmed the absolute supremacy of parliament in dominions, while Camden and Pitt drew the same sharp line of distinction between taxation and legislation upon which the colonists insisted, and denied the right of parliament to tax the Colonies. Motives of expediency, arising both from conditions in the colonies and in England, proved decisive, and in the spring of 1766 the Stamp Act was repealed, while its repeal was accompanied with the passage of a statute (The Declaratory Act) affirming the principle that Great Britain had the right to bind the Colonies in all cases whatsoever. This measure was received with joy in the Colonies, but the prestige of the home Government had received a severe blow, and the colonists were quick to resent further alleged encroachments.

Townshend Acts.—These soon came in the form of a colonial Mutiny Act and of the so-called Townshend Acts (1767). The Mutiny Act was intended largely to meet the needs of the troops stationed in the west and in the new Colonies, but it also affected the older Colonies where garrisons of regular soldiers existed. The act provided for a parliamentary requisition for barrack supplies, and partly because it included certain articles which were not required for the soldiers in Europe, the New York legislature at first refused to make the necessary appropriation. Partly through the influence of the governor it later came to think better of it and in a non-committal way appropriated the supplies required. But meantime in England the Pitt-Grafton ministry had come into office, in which the brilliant but reckless Charles Townshend was chancellor of the exchequer. Pitt himself was disabled by illness, and the ministry, lacking his control, steadily disintegrated. Townshend availed himself of this situation to spring upon his colleagues and upon Parliament a new measure for colonial taxation, and with it a bill legalizing writs of assistance and establishing a board of commissioners of the customs in America, and a third bill suspending the functions of the assembly of New York until it should comply with the terms of the Mutiny Act. These bills all became law. Before the last-mentioned one reached the colonies, the New York Assembly had complied, and therefore the necessity for executing this Act of Parliament was avoided. The establishment of a customs board at Boston did not, of itself, provoke much criticism. But the Act of Trade and Revenue, which provided for the collection in the Colonies of duties on glass, lead, painters' colours, paper and tea, and that out of the revenue raised therefrom salaries should be paid to the governors and judges in America, opened anew the controversy over taxation.

John Dickinson, in his *Letters of a Farmer* (1767–68), denied *in toto* the authority of Parliament to tax the Colonies, and his argument was widely accepted. Massachusetts petitioned the home Government, and in a circular letter conveyed its views to the other colonies and asked an expression of theirs in return. The activity of the customs officials at Boston in seizing John Hancock's sloop, "Liberty," occasioned rioting, which in turn was followed by the transfer of two regiments to Boston. Several vessels of war were also stationed in its harbour (autumn of 1768). Deprived of their assembly, the towns of Massachusetts chose deputies, who met in convention, but without important result. Favourable replies to its circular letter were, however, received from a majority of the Colonies. Resolutions against the new act were passed by many colonial assemblies, and in several cases petitions were sent to England. The King and ministers expressed the view that the Americans were opposed to all restrictions, and that in Massachusetts treason or misprision of treason had already been committed. In this they had the support of large majorities in Parliament. The statute of 35 Henry

BY COURTESY OF THE N.Y. HISTORICAL SOCIETY

THE BOSTON "MASSACRE," MARCH 5, 1770, AFTER AN ENGRAVING ATTRIBUTED TO PAUL REVERE (1735–1818), REVOLUTIONARY PATRIOT

VIII., for the punishment in England of such offences when committed outside the realm, was now revived, and the royal officials in Massachusetts were instructed to collect evidence against suspected popular leaders with a view to their deportation across sea for trial. Though sufficient evidence was not found, nothing could have been better calculated to increase the exasperation of the colonists than a threat of this kind. It drew from the Virginia burgesses strong addresses and resolutions of protest. Fear lest the English Church would induce the Government to establish a colonial episcopate caused much discussion at this time, especially in New England, and led to plans for joint action on the part of Dissenters, in self-defence. In the course of 1769 the policy of commercial non-intercourse was again revived, and resolutions in favour of its enforcement were passed by many local bodies. But it was found difficult to enforce these, and, as the Colonies were prosperous, trade, open and illicit, with Europe continued to be large. The British merchants did not clamour for relief, as they had done at the time of the Stamp Act, but gave loyal support to the policy of the Government. The King was also steadily gaining an ascendancy, which in 1770 was permanently established by the accession of Lord North to the premiership. Thus, on both sides of the ocean, parties were bracing themselves for a struggle, the one for and the other against the principle of the Declaratory Act. The question of revenue was now largely obscured by that of right and power.

The Tea Tax.—It cannot be said that the Townshend Revenue Act was nullified, for to a certain limited extent it was executed. But in 1770, on the specious plea that the duties were uncommercial because they were levied on British manufactures, all except the duty on tea—3d. per lb.—were repealed, and a drawback of one-fourth and later of three-fifths of this duty was granted on the re-exportation of tea to the Colonies. But the preamble of the act was retained, and with it the principle of taxation. For this reason opposition continued and non-importation agreements, especially against tea, were maintained. But after the collision which occurred between the troops and the people in Boston, in

March 1770, the soldiers were removed from that town and affairs became more quiet. For more than a year it seemed as if the controversy was wearing itself out and that the old relations would be restored. But the conduct of certain naval officers and small vessels of war which had been trying to suppress illegal trade in Narragansett bay led, in June 1772, to the destruction of the schooner "Gaspee" The inquiry which necessarily followed this, together with legislation for the protection of the royal dockyards, ships and supplies, again revealed the possibility that colonists might be removed to England for trial. About the same time provision was made for the payment by the home Government of the salaries of the governors and of the judges of the superior court of Massachusetts while those officials continued to hold at the pleasure of the Crown These events occasioned a movement in Massachusetts and Virginia which led at once to the organization of committees of correspondence, and these ultimately extended far and wide throughout the Colonies. At the same time in England the East India Company appealed to Parliament for relief from the losses caused by the transfer of the American trade so largely to the Dutch, and in response the Tea Act was passed authorizing the company to import its teas into the Colonies and providing that the English duties should be wholly drawn back on exportation, and that no compensation need be made to the Government for consequent loss of revenue. This, it was expected, would enable the company to out-compete the Dutch But popular uprisings prevented the reception or sale of the tea at any of the ports and culminated in the destruction (Dec 16, 1773) of 340 chests at Boston As the King and the North ministry were now fully entrenched in power, coercion was at once resorted to and affairs were thus brought to a crisis.

The Quebec Act.—Those among the colonists who were intelligent enough to watch the course of events had long felt that they were being enveloped in a network of relations over which they had no control This was a result of the development of the empire, with its world-wide interests The Quebec Act, which was passed by Parliament near the close of the session of 1774, furnished a case in point Owing to the failure of the Imperial Government to secure the revenue which it had hoped to collect under the Stamp Act and the later statutes, it had been forced to abandon its plans for the vigorous administration of Indian affairs and of the West. In view of these facts, it was thought wisest and cheapest to commit the immediate charge of the west to the province of Quebec, and therefore to extend its bounds southward to the Ohio The Roman Catholic religion was recognized as legal within Quebec, and no provision was made for an assembly Its extension also indicated a purpose to prevent the westward movement of population across the mountains, which was already beginning from the middle and southern Colonies

First Continental Congress.—But the acts of the session of 1774 which were of most immediate importance were those which directly affected Massachusetts, where lay the centre of disturbance One of these closed the port of Boston, another substituted an appointed for an elected council in Massachusetts and took the selection of jurors out of the hands of the people, and a third made possible the removal from Massachusetts of the trials of persons indicted for capital offences committed in support of the Government into neighbouring Colonies or to Great Britain, where a fair hearing was considered possible. Gen. Thomas Gage, who had been commander-in-chief in America, was now appointed governor of Massachusetts, with authority to uphold the new acts with military force. As soon as knowledge of the fate impending over Boston reached the other Colonies, conventions, local and provincial, were held, and the plan of a general congress, as proposed by Massachusetts and Virginia, was adopted. Delegates were chosen from all the Colonies except Georgia, though that province fell into line when the second Congress met. The members were instructed to the general effect that they should consult together and adopt such measures as were best calculated to secure the just rights of the colonists. Voting by Colonies, but occasionally listening to utterances which implied that Americans were now thrown into a single mass, this body sent addresses to the King, to the people of the Colonies, of Quebec and of Great Britain, and prepared a declaration of rights It is a significant fact that no address was sent to either of the Houses of Parliament In its statement of rights the Congress (known as the First Continental Congress) limited itself to those which it believed had been infringed since 1763 These acts they described as innovations, and claimed themselves to be the true conservatives who only desired peace on the basis of the former constitution The opposition which Massachusetts was making to the recent Acts of Parliament was approved, and the view was expressed that, if an attempt were made to execute them by force, all America should support Massachusetts Though the work of this Congress was deliberative, it performed one positive act which contained the germ out of which new governments were to develop That was the issue of the Association, or non-importation and non-exportation agreement, accompanied with resolutions for the encouragement of agriculture and home manufactures and for the organization of committees to carry these measures into effect. Coercion, according to the principle of the boycott, was to be applied by the Colonies and other local bodies to all who declined to accept and obey the terms of the Association. This policy had been followed at intervals since the time of the Stamp Act It had been revived by many local and provincial bodies for the past few months The Association became the touchstone by which loyalty to the Colonies, or to the King, was determined. Those whose loyalty to the King forbade their submission to the new regulations now felt the power of committees, even to the extent of virtual trial, imprisonment or banishment From this action the First Continental Congress derived its chief significance.

Increase of Friction.—The Association, with its threats and dependence upon extra-legal bodies for enforcement, was a direct blow at the commercial system of the empire and could scarcely help provoking retaliation When the Congress adjourned, some of its members predicted war In New England the impression that war was inevitable was widespread In Massachusetts a provincial congress was at once organized, which assumed the reins of government and began to prepare for defence A committee of safety was chosen to carry on the work during recesses of the Congress. Thomas Gage, the governor, began fortifying Boston, while he looked about for opportunities to seize military stores which the colonists were accumulating. The raising of voluntary militia companies was soon begun in Virginia In South Carolina, as earlier in Boston and New York, a quantity of tea was now actually destroyed, and a general committee assumed practical control of the province. From New York city and Philadelphia, as centres, the process of revolutionizing the two most conservative provinces was carried on. When Parliament met, at the close of 1774, the King and ministers declared that a most daring spirit of resistance existed in Massachusetts, which was countenanced by the other Colonies, where unlawful combinations against the trade of Great Britain were already widely extended In these opinions the Government had the support of the majority in the two Houses, and in a joint address the rebellion in Massachusetts was declared to be a fact As a conciliatory measure Chatham proposed that Parliament agree by resolution not to levy any tax upon the Colonies, but that the Continental Congress be required to make a free grant of a perpetual revenue which should be fully at the disposition of Parliament, the Congress fixing the quota which should be paid by each province. But the imperialist and mercantilist ideas of Chatham were expressed in the further provisions that the system of trade and navigation should not be changed and that the Army might be lawfully kept in any part of the dominions, though it should never be used to violate the just rights of the people. Edmund Burke, in his great speech on conciliation, advocated a return to the system of requisitions and did not consider a representation of the colonists in Parliament as a possibility. But these motions were rejected, and a resolution introduced by Lord North was passed. This contained no recognition of extra-legal bodies, but provided that when the assembly of any Colony should engage to support civil government within the Colony and contribute according to its ability to the common defence, the King and Parliament would then forbear to levy any more taxes on that province except what

were necessary for the regulation of trade. The Colonies, with the exception of New York, North Carolina and Georgia, were excluded from the fisheries, as a counterstroke to the Association. North's resolution proved futile, and the two parties drifted steadily toward war, though the British Government in its military estimates made no adequate provision for meeting the crisis.

Lexington and Concord.—On April 19, 1775, hostilities began in Massachusetts A force was sent overland to Concord, 20m from Boston, to seize or destroy the military stores which the colonists had brought together at that village. The minutemen were warned to oppose the approaching force, and at Lexington, a village situated on the road to Concord, occurred a skirmish in which the first blood of the American War of Independence was shed. The troops marched on to Concord and destroyed such of the stores as had not been removed or concealed On their return march they were pursued by a galling fire from behind fences and buildings, and had it not been for the arrival of a relieving force the command would have been destroyed before it reached the protection of the British vessels of war at Boston. The "Lexington alarm" brought in throngs of militiamen from all parts of New England Officers were appointed by the provincial congress of Massachusetts and by similar bodies in the other Colonies, and immediately the so-called siege of Boston began Cannon, as well as every other form of military equipment, were now in great demand. In order to secure supplies and at the same time strike a telling blow at British authority in the north, Ticonderoga was surprised and taken on May 10 Men from Connecticut, Massachusetts, and the New Hampshire Grants (later Vermont) co-operated in this enterprise It was soon followed by a dash into Canada, by steps which involved New York in the affair, and by the organization of a military force under Gen Philip Schuyler for permanent service on the northern frontier Meantime reinforcements reached Boston, led by Howe, Clinton and Burgoyne, and it was resolved to extend the British lines by occupying the heights of Dorchester on the south and those of Charlestown on the north

Bunker Hill.—The Americans, hearing of this, seized Breed's Hill, overlooking Charlestown, where they hastily threw up a redoubt on the night of June 16 The British might easily have entrapped them, but instead on the next day the American position was assaulted on the left and carried, though with much difficulty and after a loss to the assailants of more than 1,000 men. Such was the battle of Bunker Hill, one of the most dramatic encounters in the war. In connection with all these events the Americans claimed to be acting on the defensive But it was not difficult to perceive that, especially in New England, this claim only imperfectly concealed an intensely aggressive spirit.

Second Continental Congress.—The news of the outbreak of hostilities aroused strong feeling throughout the Colonies. The Second Continental Congress met under its influence. Its members, however, had been chosen and instructed before the clash of arms, and for that reason the course which had been workedout for them differed only slightly, if at all, from that which had been followed by their predecessors To a certain extent the new body adhered to the former course of action. But a state of war now existed in New England and on the Canadian border. Troops were expected soon to arrive at New York Reports of these events were thrust upon the attention of Congress at once, and the provinces involved asked for advice as to what course they should pursue. As a result of these events in the Colonies generally, the Association was being changed from a system of co-operation against British trade into a union for purposes of defence. This new situation the Congress was forced to meet. This it did largely by resolutions of advice to the Colonies, but also by positive orders Of the former class were the resolutions about the procuring of military supplies, the assumption of powers of government by the various Colonies, and concerning defence at New York city, on the northern frontier and, later, in the highlands of the Hudson. Of a more decisive character was the appointment of officers for the army, George Washington being made commander-in-chief, the prescribing of their pay, the issue of continental bills of credit, the issue of articles of war, the regulation of trade and of Indian affairs, and the establishment of postal communication. As the revolutionary movement progressed through 1775 and the early months of 1776, executive authority in the royal and proprietary provinces collapsed. The assemblies were either dissolved or ceased to meet. The governors, their authority gone, retired on board British vessels of war, returned to England or, perchance, found themselves prisoners. This gradual fall of the old governments, imperial and colonial, was the revolution on its negative side. The rise of the system of congresses, conventions and committees, deriving their authority from the people, was the revolution on its positive side, and foreshadowed the new federal system which was rising on the ruins of the half-federated empire.

Collapse of the Royal Governments.—In Connecticut and Rhode Island the corporate system of government, which they had inherited from the 17th century, necessitated no change. The general assemblies always had been the centres of power, and the leading officials were elective for short terms and were subject to the control of the electorate. So far as the internal organization of the Colonies was concerned that was all which the revolution demanded. In the two proprietary provinces—Pennsylvania and Maryland—the executives were not so directly interested and pledged to support the Imperial Government as were those of the royal provinces But Governor Robert Eden of Maryland was so tactful that, though the last assembly met in 1774, he was able, with the courts, to keep up some form of government there in the name of the Crown and proprietor until the early summer of 1776. In Pennsylvania the proprietors, though in sympathy with the British Government, never sought actively to influence events in their province. In the royal provinces the prorogation of the legislatures for indefinite or prolonged periods caused them early to disappear—that of Massachusetts in October, 1774. The burgesses of Virginia last met for business in May, 1774. They were prorogued to several later dates, but the governor was never again able to meet them. The long and important session of January–March, 1775, was the last ever held by the New York assembly. In April, 1775, Governor John Martin of North Carolina met the assembly for the last time, and even then the provincial convention was in session at the same time and place and the membership of the two bodies was the same In May, 1775, disappeared the assembly of Georgia; in June those of New Hampshire and South Carolina met for the last time Governor William Franklin was able to meet the assembly of New Jersey as late as November, but months before that date the provincial convention had practically assumed the control of affairs

Washington in Command.—After Bunker Hill the command at Boston had been transferred from Gage to Sir William Howe In July, Washington took command of the colonists and gradually established some degree of order and discipline among them. Though the American levies were raw and ever fluctuating in numbers, the British never seriously attempted to break through their lines. Indeed, it was not the plan of the British to make New England the chief seat of war As early as Aug 2, 1775, Lord Dartmouth wrote to General Gage on "the obvious advantages that would attend the taking Possession of New York and the hazard of the Army's continuing at Boston." Rhode Island was considered as a convenient naval station, and steps were soon taken to secure possession of it and its surrounding waters. The British wished to so plan the war as to secure the maximum of advantage from their fleet. This would give them an easy command of the entire coast, and enable them to secure a foothold at strategic centres. Hence it was that, though the arrival of a fresh supply of cannon enabled Washington to fortify Dorchester Heights, this simply enabled him to hasten a process for which Howe had long been preparing. The evacuation occurred on March 17, 1776, and the British force withdrew temporarily to Halifax. Meantime the bold expeditions of Arnold and Montgomery against Canada had met with only a partial success Montreal had been occupied, but the assault upon Quebec had failed.

The view, as it was now repeatedly expressed by King and Parliament, was that the colonists were in open rebellion. North's offer of conciliation was peremptorily rejected by Congress. The acts of Parliament were being openly resisted, and Congress in its

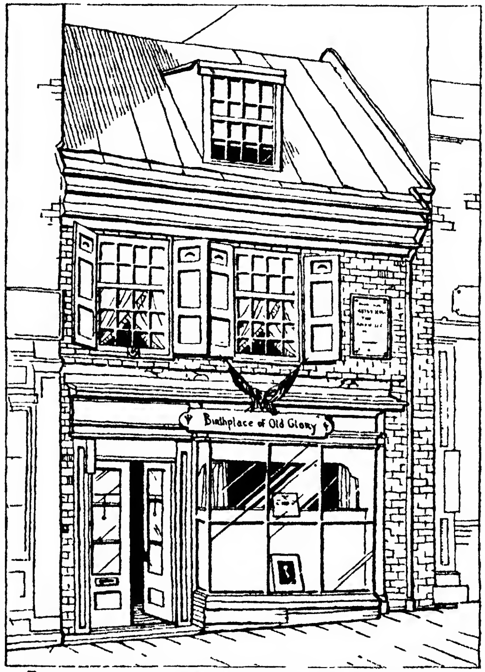
manifestos had ignored the two houses Therefore the British Government stood committed to coercion That was the meaning of the legislation of the winter of 1776—the prohibition of trade with the rebellious Colonies, the increase of the estimates for the Army and Navy, the employment of German auxiliaries for service in America Preparations were made to send a large military and naval force the following season, which should operate in part against the insurgents in New York and the southern Colonies and in part through Canada New England was no longer to be the direct object of attack The Howes, as commanders of the royal Army and Navy, were appointed commissioners to grant assurance of peace and pardon and the repeal of the obnoxious acts, provided submission was made and some way could be found by Parliament in which an imperial revenue for purposes of defence could be secured from the Colonies Military operations, meanwhile, should be directed against points of least resistance, and in that way, if possible, the union of the Colonies should be broken. The trend of British policy indicated that an invasion from Canada might be attempted and an effort made to hold Charleston, Philadelphia, and especially New York as strategic points on the coast

The course of events in the Colonies by which this situation was met was the erection of a system of feeble defences about New York and the removal thither of the Army of about 9,000 men in the spring of 1776; the fitting out of privateers to prey on British commerce, the disarming of loyalists; the opening of American ports to the trade of all peoples who were not subject to the British Crown, and the tentative opening of relations with France. As the result of a combination of ill luck, bad management and American energy the British suffered a repulse at Charleston, South Carolina, in June, which was analogous to the affair of the year before at Bunker Hill, and which necessitated a postponement of their plans in the south

The Congress and the various revolutionary bodies in the Colonies were forced to carry on war upon a constantly increasing scale They had to assume powers of government and gradually to perfect their organization for the purpose Committees in Congress became more permanent Conditions approximating to those which existed the year before in New England extended through the Colonies generally.

The Declaration of Independence.—On May 15, 1776, as the result of various earlier applications and especially of one from certain Whigs in New York, the Congress recommended to the assemblies and conventions of the Colonies where no Government sufficient to the exigencies of their affairs had been established, "to adopt such government as shall, in the opinion of the representatives of the people, best conduce to the happiness of their constituents in particular and of America in general" The preamble to this resolution set forth as facts the statements that the Colonies had been excluded from the protection of the Crown, that no answer had been given to their petitions for redress, and that the whole force of the kingdom was to be used for their destruction, and therefore that it was no longer reasonable or honest for the colonists to take the oaths or affirmations necessary for the support of Government under the Crown. Though the preamble was warmly debated, it was adopted And this act marked a turning-point, for the progress of events from that time to the Declaration of Independence was rapid and decisive. The Colonies—now becoming States—one after another, in response to letters from Philadelphia, empowered their delegates to concur in declaring independence. On June 7, R H. Lee of Virginia introduced in Congress a resolution "that these United Colonies are and of right ought to be free and independent states," that it was expedient forthwith to take effectual measures for securing foreign allies, and that a plan of confederation should be formed The debate showed that the delegates from the middle colonies and South Carolina could not act, and the decision was postponed for three weeks. In the interval steps were taken to draft a plan of treaties and articles of confederation. A board of war and ordnance, the earliest germ of an executive department, was also created by Congress

At the end of the three weeks the delegates from all the Colonies except Georgia, South Carolina and New York had received instructions favourable to independence The two former left their delegates free, and under the influence of the British attack on Charlestown they voted for independence News had just come that Howe had landed with a large force at Sandy Hook. Under the impression of these stirring events the Declaration, substantially in the form given to it by Thomas Jefferson, was agreed to (July 4, 1775), only three adverse votes being cast The delegates from New York took no part, but a few days later the act was approved by the convention of that State The signing of the document by



THE HOME OF BETSY ROSS, MAKER OF THE FIRST AMERICAN FLAG
The little house on Arch Street, Philadelphia, where Mrs. Ross lived at the time she is said to have made the first American flag (1777), was converted into public property by the Betsy Ross Memorial Association in 1905 and has since been known as the American Flag House

the members took place at a later time. Thus triumphed the tendencies toward self-government which had been predominant in the continental Colonies from the first, and which the system of imperial control had only superficially modified and restrained But the most significant part of the document for the future was the preamble, in which the democratic aspirations of the new nation were set forth, the spirit to which Thomas Paine had just made so powerful an appeal in his *Common Sense* Governments, it was said, derive their just powers from the consent of the governed, and when any system becomes destructive of these ends it is the right of the people to abolish it and to institute a new Government, establishing it upon such principles and under such forms as seem most likely to effect their safety and happiness (*See* DECLARATION OF INDEPENDENCE)

Weakness of the General Government.—Viewed from one standpoint, the Declaration of Independence was apparently an act of the utmost recklessness. The people were by no means a unit in its support, and in several of the States widespread indifference to it, or active sympathy with the British, prevailed The United States, as yet, had no international status, and it would seem that that must be secured, if at all, by a series of victories which would ensure independence But how could these be won against the greatest naval power on the globe, supported

by veteran armies of continental and British troops? The Colonies had no money; the few vessels which, as a collective body, they did send out, were more like privateers than anything else Their Army was an undisciplined throng of militiamen, serving on short enlistments, without organized commissariat, and for the most part under inexperienced officers Its numbers, too, were far inferior to those of the British Taxation by the Continental Congress for the support of the war was not among the possibilities of the case A strong tendency toward the provision for immediate needs by the issue of bills of credit had been inherited from the period of the French wars, and that device was again resorted to The battle of Bunker Hill had been immediately followed by an order of Congress for the issue of $2,000,000 in that form of currency Issues followed in rapidly increasing amounts, until by the close of 1779 $241,000,000 had been authorized The States put out nearly as much ($209,000,000) The continental paper money depreciated until it became worthless, as to a large extent did that of the States also The States decreed it to be legal tender, and dire threats were uttered against those who refused to receive the bills; but all to no purpose The Congress also tried to induce the States to tax themselves for the general cause and was forced to rely on requisitions for the purpose These measures proved as complete a failure as when resorted to by the Crown The revolution was therefore never financed It early became necessary to resort to loans and that chiefly from foreign sources It was therefore an absolute necessity that the Colonies should secure international recognition and status Then loans were obtained from the Government of France and Spain and from private bankers in Holland to the amount of about $7,830,000

The collapse of royal Government left the Colonies in a chaotic state. The old institutions had disappeared and new ones could not be immediately developed to take their place But the institutions of local Government, the town and county systems, were left intact, and upon these as a basis the new fabrics were erected It was therefore easier to construct the Governments of the States than to define and develop the general Government At first little else was intended than that the Congress should be the mouthpiece of the patriot party It proceeded mainly by way of recommendation, and looked to the States, rather than to itself, as the ultimate sources of authority Upon them it depended for the execution of its measures As the war proceeded the States grew jealous of the central body and tried to prevent appeals to it from the State courts in prize cases Under the pressure of war, moreover, the enthusiasm, which had been strong at the outset, declined, and it became increasingly difficult to secure co-operation or sacrifice toward any general enterprise

Difficulty of Congress.—At the same time, war devolved upon Congress an enormous burden of work It was forced to devise general policies and provide for their execution, and also to attend to an infinite number of administrative details Most of the able members were drawn off into the Army, into diplomatic service or official service in the States Sectional and State jealousies also developed and became intense As the Congress voted by States the smaller commonwealths were often moved by jealousy of their larger rivals to thwart important measures But, above all, the conduct of the war and foreign relations occasioned infinite jealousies and cabals, while many of the most important measures seemed to meet with downright indifference. Washington's correspondence abounds in evidence of these facts, while it is well known that he was the object against whom one of the cabals of the time was directed Benjamin Franklin was the object of somewhat similar jealousies. But, as time passed, rudimentary executive departments, beginning with the board of war and the postmaster general, were developed, and some advance was made toward a working and permanent system In 1781 the offices of foreign secretary, superintendent of finance, secretary of war and secretary of marine were created.

Military Disasters.—Until almost its very close the campaign of 1776 was a disheartening failure. The battle of Long Island was lost by the Americans and, as at Bunker Hill, it would have been quite possible for the British to have captured the entire force which opposed them on Long Island Howe compelled Washington to evacuate New York city. On Nov. 16 the practical abandonment of the State of New York by the main army was necessitated by the capture of Ft Washington Earlier in the year the Americans had been compelled to retire from Canada, while the Tories in northern New York were contributing valuable aid to the British.

The Tide Turns.—But there was another side to the picture, and already certain faint outlines of it were being discerned The British commander was, at practically every step failing to seize the advantages that were within his reach, while Washington was learning to play a losing game with consummate patience and tact After Washington had crossed the Delaware, Howe, instead of seizing Philadelphia and driving Congress and the American Army to some remote places of refuge, as he might have done, prepared for winter quarters Washington seized the opportunity to return across the Delaware and surprise the British outposts at Trenton (Dec. 26, 1776) and Princeton (Jan. 3, 1777), and thus secured a safe post of observation for the winter at Morristown. Confidence was to an extent restored, the larger part of New Jersey was regained, and many loyalists were compelled to take the oath of allegiance Howe's plan for the next campaign involved the strengthening of his army by large reinforcements With this force he proposed to capture Philadelphia and thereby to bring the War of Independence to an end in Pennsylvania, New Jersey and New York New England and the states farther south could then be dealt with in detail. But Howe was overruled by Lord George Germain, the colonial secretary, whose plan included an invasion from Canada, in which Tories and Indians should share, while Howe should advance up the Hudson and meet the northern forces at Albany. If this ambitious scheme should succeed, the British would occupy the valley of the Hudson and New England would be cut off from the rest of the colonies Gen. Burgoyne was appointed to command the northern expedition But the failure of the plan was almost ensured from the outset by the neglect on the part of British officials to instruct Gen Howe as to his part in its execution Burgoyne was forced to surrender near Saratoga on Oct 17 Meanwhile, Howe, who had long waited for instructions respecting the northern expedition, was finally informed that he might undertake the Pennsylvania campaign, but with the hope that at its close he would still be able to march up the Hudson Thereupon, embarking his army, Howe sailed for Chesapeake Bay, at the head of which he landed and advanced towards Philadelphia Washington's army opposed his march at the Brandywine (Chad's Ford), but was defeated (Sept. 11, 1777) and forced to retire beyond Philadelphia The British then entered the city (Sept 26) and the Congress withdrew to Lancaster, and later to York, in the interior of Pennsylvania The British fleet had in the meantime arrived in Delaware Bay, and, after a prolonged and brave defence, had captured Forts Mercer and Mifflin. When winter began the Delaware, as well as lower New York and Rhode Island, was in the possession of the British With the fragments of an army Washington retired to Valley Forge

French Alliance.—But the influence of Burgoyne's surrender in Europe was to prove a turning-point in the war. Since 1763 a strong sentiment at the French court had been favourable to a resumption of war with Great Britain An opportunity was now presented by the colonial revolt In February 1776 Silas Deane was sent to Paris, ostensibly as a business agent, and with the connivance of the French Government supplies were sent to America and American vessels were received into French ports Soon American privateers were bringing their prizes into French harbours, and British commerce began to suffer from these attacks. On the French side Beaumarchais and others actively co-operated in this. In the autumn of 1776 Congress appointed three commissioners to France, and resolved that Spain, Prussia, Austria and other European States should be approached with a view to securing recognition and aid. In December 1776 Franklin, who, with Deane and Arthur Lee, had been appointed commissioner to France, arrived at Paris, bringing with him proposals for treaties of commerce and alliance But, though the attitude of the French court toward the Americans was friendly,

and though it continued to send secret aid, and to exert a favourable influence upon Spain, yet it could not be induced to abandon its outward appearance of neutrality until after the news of Burgoyne's surrender arrived. Then the real purpose of the French Government was revealed. On Feb. 6, 1778, the treaties were signed, and in the following summer war between France and England began The influence of France under the Family Compact, brought Spain into the alliance in April 1779 In October 1779 Henry Laurens was elected minister to the Netherlands, and sailed for Europe, taking with him a plan of a commercial treaty But Laurens and his papers were captured by the British at sea, and partly by that event the Netherlands were forced into war with England With the other States of northern Europe they undertook to defend the interests of neutrals against the arrogant enforcement by Great Britain of the rights of search at sea. Thus the conflict expanded into a commercial and naval war, Great Britain being confronted by the larger part of Europe

Philadelphia Recaptured.—The conclusion of the treaty of alliance by France was immediately followed by the equipment of a fleet under the comte d'Estaing, which sailed from Toulon in April 1778. Sir Henry Clinton had now succeeded Howe in command of the British army. The certainty that a French fleet would soon appear in American waters made it necessary for the British to evacuate Philadelphia and return to a point on the coast where the army could be in easy communication with the fleet. This fact shows how the French alliance had changed the nature of the war It now became to a large extent a contest between the two navies, the principal evolutions of which occurred in West Indian and European seas In the north the British now relatively neglected the land war, and refrained from sending such forces to the eastern coast as had supported Howe in 1776 The Americans, on the other hand, had a naval force upon which they relied, in the hope that the blockade of their coasts might be raised and trade routes opened more freely On the evacuation of Philadelphia in June Washington's army pursued the British as they retired toward New York, and the indecisive battle of Monmouth was fought on June 28 It did not prevent Clinton from reaching New York, and that city continued to be the centre of British power and operations in the north until the close of the war The Congress returned to Philadelphia Washington's army came gradually to occupy a line of forts, of which West Point in the highlands of the Hudson was the citadel From there as a centre it was possible to communicate with Newport on the east and with the Delaware region on the south, and at the same time to prevent the British from gaining access to the interior of the country Though the fleet of D'Estaing carried a heavier equipment of cannon than did that of Admiral Howe, the French commander did not choose to risk an attack on New York, but passed eastward to Newport Howe followed him, while Washington and his generals planned active co-operation with the new allies by land But a sudden storm so dispersed and injured the fleets that the French admiral retired to Boston for repairs and later sailed for the West Indies

State Constitutions.—While the war and foreign relations were thus developing, the States were organizing their governments and Congress was beginning to consider articles of confederation between the States In this way an effort was made to gather up and make permanent the positive results of the revolution As under the chartered and royal governments of the colonial period the source of political authority had been the Crown, now by a necessary reaction this was sought in the people This principle had been stated in the Declaration of Independence, and had been implied throughout the earlier controversy. The Colonies had insisted on a more precise definition of the powers of government; they had opposed Parliament because its powers were undefined and therefore dangerous. Following these ideas, the States now described their institutions of government and defined their powers by means of written constitutions These were formulated by the provincial congresses—which had now become the legislatures—or, as they came to insist upon a more specific expression of the popular will, by conventions chosen for the purpose by the electors. Connecticut and Rhode Island retained their colonial charters In the earlier days of hasty and temporary devices, the constitutions, like statutes, had been promulgated by the legislatures which formed them and had been put into force by their authority alone But as time passed and more permanent arrangements became necessary an express popular approval of the instruments was obtained before they were put into force The establishment of State governments in this way began before the issue of the Declaration of Independence It was actively continued during 1776 and the early months of the following year, by which time all of the States had secured at least a temporary constitution Of the constitutions of the revolutionary period the two most striking features were the bills of rights and the provisions which were made concerning the executives and their relations to the legislatures The men of that generation were jealous of government They insisted upon individual rights, not as acquired and guaranteed by the State, but as original, natural and inhering in time prior to all governments Governments were instituted for the common benefit, protection and security Officials were trustees and were accountable to the people There should be no hereditary title to office or power There should be no titles of nobility, and in Virginia the system of entails was swept away Monopolies were declared to be inconsistent with the spirit of a free State. Freedom of the press and of conscience was asserted, and no obstacles to fair and speedy jury trials were to be tolerated Elections should be free and frequent, and a preference was expressed for short terms of office The legislature was universally regarded as the most important department of government Although the principle of the separation of powers was recognized, in eight States provision was made that the executives should be elected by the legislatures, 11 withheld from them the veto, and the States generally provided for a council to advise them So manifold and important, however, were the restrictions on suffrage that the States were as yet far from being democracies

The Articles of Confederation.—The first draft of the Articles of Confederation between the States was prepared by John Dickinson in the early summer of 1776 and was reported Owing to the pressure of war it was then laid aside until the autumn of 1777 By that time the feeling in favour of State sovereignty had so increased that the impossibility of securing assent to the articles in any form had begun to be feared But the document was completed and submitted to the States in November 1777, when all were encouraged by the news of Burgoyne's surrender The system for which provision was made in this document was a "confederacy," or "firm league of friendship" between the States The Congress was to be continued, and was to consist of delegates annually appointed by the legislature of each State and paid by their States. No attempt was made to create an executive for the confederacy, though authority was given to Congress to appoint a council of State which should manage general affairs, especially during recesses of Congress To Congress various general powers were entrusted, as deciding on peace and war and superintending the conduct of the same, building a navy, controlling diplomatic relations, coining money and emitting bills of credit, establishing post offices, regulating Indian trade, adjusting boundary disputes between the States The financial powers entrusted to Congress included those of borrowing money and determining necessary expenditures, but not the power to tax For supplies the general government had to depend on requisitions from the States The same system also had to suffice for the raising and equipment of troops Congress could not make its laws or orders effective in any matter of importance This was simply a continuation of the policy under which the revolution was being conducted The control of trade was practically left with the States, the Americans in this matter failing to live up to the requirements of the British system. The predominance of the States was further ensured by the provision that no votes, except those for daily adjournment, could be carried without the assent of a majority of all the States, and no important measure without the consent of nine States But a common citizenship was declared to exist, and Congress received authority to establish a court of appeal which might pass finally

on all disputes between States. Taken as a whole, the Articles of Confederation would bear favourable comparison with other schemes of their kind, and they fairly represented the stage of development to which the American States had then attained.

The West.—We have seen that, on the whole, the attitude of Great Britain, after the peace of 1763, was not favourable to the colonization of the Mississippi valley. To the colonists the Quebec Act gained in offensiveness by seeming to imply that it was intended to exclude them from the West But all such plans were swept away by the outbreak of the War of Independence Already, before the beginning of hostilities, emigrants had begun to flock across the mountains. Plans were on foot for the establishment of a number of commonwealths, or proprietary provinces, as the case might be. Daniel Boone and his associates pushed farther west into the Kentucky region, and there it was proposed to establish the commonwealth of Transylvania. Other similar projects were started, all repeating in one form or another the political methods which were used when the seaboard colonies were first settled The backwoodsmen who managed these enterprises were extreme individualists, believed in the propriety of resistance to governments, and were in full sympathy with the War of Independence. The States which had claims in the West opposed the founding of independent settlements there and, if possible, induced the settlers to be content with the status of counties within some one of the eastern States. After the beginning of the War of Independence, the British from Detroit incited Indian raids for the purpose of destroying or driving out the settlers, especially in Kentucky. These provoked the important expeditions of George Rogers Clark in 1778 and 1779. With a force of Virginians he seized Kaskaskia and later, after a long march, captured Vincennes and compelled General Henry Hamilton, who had come with a relief force from Detroit, to surrender. This secured to the Americans a permanent hold upon the north-west But Spain, after she entered upon the war, was determined, if possible, to wrest the valley of the Mississippi from the British and to keep all, or the larger part of it, for herself. To that end, operating from New Orleans, her troops took possession of Natchez, and other posts on the lower Mississippi, and occupied Mobile and Pensacola.

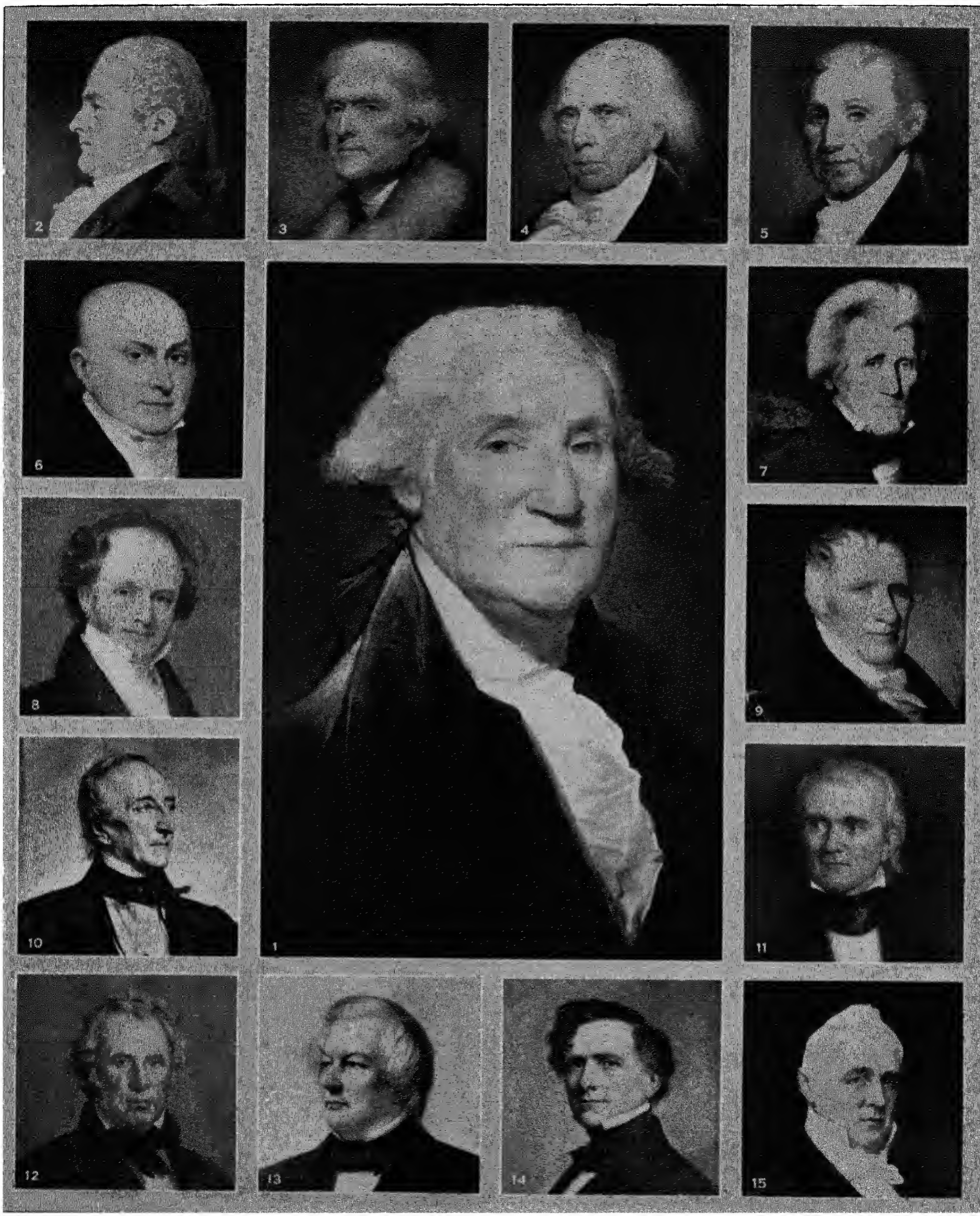
Articles of Confederation Ratified.—Within the Confederacy a fundamental line of cleavage was that between the large and small States. It was jealousy on the part of the small ones, their fear lest they might be absorbed by their larger neighbours, which had necessitated the adoption of the plan that in the Congress the delegates should vote by States. When the articles were referred to the States for ratification, the difficulty reappeared. Massachusetts, Connecticut and New York, with Virginia and the three States to the south of it, had large claims to territory between the Appalachians and the Mississippi. New Hampshire, Rhode Island, New Jersey, Delaware and Maryland, which were without hope of westward extension, hesitated to enter the Confederacy, if the large States were to be still further increased by additions to their areas of vast stretches of western country. They insisted that before ratification the States which had claims to western lands should surrender these for the common benefit of the United States. Maryland insisted upon this until, in the end, the cause of State equality and of nationality triumphed. Congress declared that the ceded lands should be formed into States, which should become members of the union with the same rights as other States. When in 1781 the course of action had become possible, Maryland ratified the articles and they came into effect.

War in the South.—So far as the north American continent was concerned, the character of the last stage of the struggle with Great Britain was determined by the fact that the British resolved to transfer the main seat of war to the southern States, in the hope that Georgia and South Carolina might be detached from the union. At the close of 1778 Savannah was captured. In September 1779 D'Estaing returned and assaulted Savannah, but, failing to capture it, sailed for France. In 1780 Clinton sailed from New York, besieged Charleston with a force much superior to that of Lincoln, and captured it (May 12). State government in South Carolina ceased. But the chance of detaching those States from the union and of bringing the war in that region to an end was finally lost by the British. This was chiefly due to an order which recalled the paroles of many of those who had surrendered at Charleston and required that they should perform military service under the British. The attempt to enforce this order, with the barbarities of Colonel Banastre Tarleton and certain Tory bands, provoked a bloody partisan conflict in the upper districts, especially of South Carolina, which contributed more than any other cause to run the scale against the British in the remote south. By the winter of 1781 they were forced back to Charleston and Savannah.

Yorktown.—During the summer of 1780, Washington was prevented from accomplishing anything in the north by the demoralized condition of the finances and by the decline of public spirit. It was very difficult to secure recruits or supplies. The pay of the troops had fallen so into arrears that some of them had already begun to mutiny. A second French squadron and military force, under De Ternay and Rochambeau, landed at Newport, but they were at once shut up there by the British Clinton and Cornwallis were now planning that Cornwallis, having put down resistance in the remote south, should march through North Carolina and Virginia to Baltimore and Philadelphia and that a junction of the two British forces should be effected which, it was believed, would complete the ruin of the American cause. But the turn of the tide in favour of the Americans began with the partisan warfare in South Carolina, which delayed the northward march of Cornwallis, who retired to Wilmington and thence marched north with a small force into Virginia, and in July retired to Yorktown, in the peninsula of Virginia. Washington and Rochambeau had meantime been planning a joint move against the British at New York, or possibly in Virginia, and a letter was sent to De Grasse, the French admiral in the West Indies, suggesting his co-operation. De Grasse replied that he would sail for the Chesapeake. This confirmed Washington and Rochambeau in the opinion that they should march at once for Virginia and, after junction with the force of Lafayette, co-operate with De Grasse against Cornwallis. By well-timed movements the forces were brought together before Yorktown and Cornwallis was forced to surrender on Oct. 19, 1781.

Treaty of Peace.—This proved to be the last important operation of the war in America The King was compelled to give way. Rockingham was called into office at the head of a cabinet which considered the recognition of American independence to be indispensable. The negotiations fell into the hands of Shelburne, the friend of Franklin and disciple of Adam Smith Richard Oswald was the leading British agent, while Franklin, Jay, John Adams and Henry Laurens were the American negotiators. From the first the acknowledgment of independence, the settlement of the boundaries and the freedom of fishing were insisted on as necessary terms by the Americans The three points were early conceded by the British. They also agreed to restrict Canada to its ancient limits. But discussions later arose over the right to dry fish on the British coasts, over the payment of debts due to British subjects prior to the war and over the compensation of the loyalists. Adams vigorously insisted upon the right to dry and cure fish on British coasts, and finally this concession was secured. Franklin was opposed to the demands of the loyalists, and they had to be content with a futile recommendation by Congress to the States that their claims should be adjusted. It was also agreed that creditors on either side should meet with no lawful impediment to the collection of their debts. Both France and Spain considered the claims of the Americans to be excessive, and were not inclined to yield to them. But the Americans negotiated directly with the British and the articles were signed without consultation with the French government. Peace was formally ratified on Sept. 3, 1783.

The American army was now disbanded. Since the close of active military operations both officers and men had been striving to secure their pay, which was hopelessly in arrears. Congress had voted half-pay to the officers for life, and many had agreed to accept a commutation of this in the form of full pay for a certain number of years. Certificates for these amounts were issued. But



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UNITED STATES PRESIDENTS FROM 1789 TO 1861

1. George Washington (term of office, 1789–1797). Portrait by Gilbert Stuart. 2. John Adams (1797–1801) by James Sharpless. 3. Thomas Jefferson (1801–1809) by Rembrandt Peale. 4. James Madison (1809–1817) by Asher B. Durand. 5. James Monroe (1817–1825) by Gilbert Stuart. 6. John Quincy Adams (1825–1829) by Chester Harding. 7. Andrew Jackson (1829–1837) by E. F. Andrews. 8. Martin Van Buren (1837–1841) by Henry Inman. 9. William Henry Harrison (1841 for 1 month) by George Catlin. 10. John Tyler (1841–1845) by George P. A. Healy. 11. James Knox Polk (1845–1849) by George P. A. Healy. 12. Zachary Taylor (1849–1850) by George P. A. Healy. 13. Millard Fillmore (1850–1853) by George P. A. Healy. 14. Franklin Pierce (1853–1857) by George P. A. Healy. 15. James Buchanan (1857–1861) by E. F. Andrews

in this, as in other cases, it was found impossible to procure the money for the purpose from the States. Parts of the army repeatedly mutinied, and it was only the influence of Washington which prevented a general outbreak. When the disbandment was finally effected the officers found their certificates depreciated in value and the States indisposed to honour them. They consequently received only a small part of their due, and the privates scarcely anything. The country was left in a most demoralized condition, the result of the long war and the general collapse of public and private credit which had accompanied it. (H. L. O.)

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Standard Historical Works: Among the general works covering the colonies as a whole *see* H. L. Osgood, *The American Colonies in the Seventeenth Century* (3 vols., 1904–07) and *The American Colonies in the Eighteenth Century* (4 vols, 1924), best for the institutional history; J. A. Doyle, *The English in America* (5 vols., 1882–1907); J. Windsor, *Narrative and Critical History of America* (8 vols, 1886–1889), for exploration, cartography and bibliography; the first 3 vols. of E. Channing's *History of the United States* (1905 *sqq*); and the earlier volumes of *The American Nation* (28 vols, 1903–18), edited by A. B Hart and the *Chronicles of America* (50 vols, 1918–21), edited by Allen Johnson, both co-operative histories. John Fiske popularized the history of the times in a number of excellent works and Francis Parkman's *France and England in North America* (12 vols., 1898 ed) is a classic in its field. *See* also G. L. Beers, *Origins of the British Colonial System, 1578–1660* (1908), *The Old Colonial System, 1660–74* (1912), and *British Colonial Policy, 1754–1765* (1905), E B Greene, *The Provincial Governor* (1898) and Foundations of American Nationality (1922), C. M. Andrews, *The Colonial Period* (1912); C. L. Becker, *Beginnings of the American People* (1915); M W. Jernegan, *The American Colonies* (1929); C. W. Alvord, *The Mississippi Valley in British Politics* (1917); V. W. Crane, *The Southern Frontier, 1670–1732* (1928); T. J. Wertenbaker, *The First Americans* (1927); J. T Adams, *Provincial Society* (1927); *The Founding of New England* (1921) and *Revolutionary New England* (1923); P. A. Bruce, *Economic History of Virginia in the Seventeenth Century* (1896), *Institutional History of Virginia in the Seventeenth Century* (1910), *Social History of Virginia in the Seventeenth Century* (1907); W. B. Weeden, *Economic and Social History of New England* (1896); V. L. Parrington, *Main Currents of American Thought* (1927). For the Revolutionary period *see* G. O. Trevelyan, *The American Revolution* (5 vols., 1899–1914), a brilliant literary performance; W. E. H. Lecky, *The American Revolution* (1898); S. G. Fisher, *Struggle for American Independence* (1908); M. C. Tyler, *The Literary History of the American Revolution* (1897); C. H. Van Tyne, *The Loyalists in the American Revolution* (1902); and *The Causes of the War of Independence* (1922); R. G. Adams, *Political Ideas of the American Revolution* (1922); J. F. Jameson, *The American Revolution considered as a Social Movement* (1926); A. M. Schlesinger, *The Colonial Merchants and the American Revolution* (1918); C. Becker, *The Declaration of Independence* (1922); and A. Nevins, *The American States During and After the Revolutions* (1924). Biographies of colonial and revolutionary leaders will be found listed after articles on these men in this edition of the *Encyclopædia Britannica.* Valuable state and local histories too numerous to list here may be found by consulting Hart, Channing and Turner, *Guide to the Study of American History* (2nd ed rev., 1912) and G. G. Griffin, *Writings on American History* (annually since 1906). (X.)

STRUGGLE FOR NATIONAL GOVERNMENT, 1783-1865

The long struggle to secure the ratification of the Articles of Confederation had given time for careful consideration of the new scheme of government. Maryland's persistent criticism had prepared men to find defects in them Conventions of New England States, pamphlets, and private correspondence had found flaws in the new plan, but a public trial of it was a necessary preliminary to getting rid of it The efforts of the individual States to maintain the war, the disposition of each State to magnify its own share in the result, the popular jealousy of a superior power, transferred now from parliament to the central government, were enough to ensure the articles some lease of life.

Territorial Cessions.—Congress and its committees had already begun to declare that it was impossible to carry on a government efficiently under the articles. Its expostulations were to be continued for several years before they were heard. In the meantime it did not neglect the great subject which concerned the essence of nationality—the western territory. Virginia had made a first offer to cede her claims, but it was not accepted. A committee of Congress now made a report (1782) maintaining the validity of the rights which New York had transferred to Congress; and in the next year Virginia made an acceptable offer. Her deed was accepted (March 1, 1784); the other claimant States followed, and Congress, which was not authorized by the articles to hold or govern territory, became the sovereign of a tract of some 430,000 square miles

In this territory Congress had now on its hands the same question of colonial government in which the British Parliament had so signally failed. The manner in which Congress dealt with it has made the United States the country that it is. The leading feature of its plan was the erection, as rapidly as possible, of States, similar in powers to the original States. The power of Congress over the territories was to be theoretically absolute, but it was to be exerted in encouraging the development of thorough self-government, and in granting it as fast as the settlers should become capable of exercising it. Copied in succeeding acts for the organization of territories, and still controlling the spirit of such acts, the ordinance of 1787 (July 13, 1787) is the foundation of almost everything which makes the modern American system peculiar.

Difficulties of the Confederation.—In the interval of the settlement of the territorial question the affairs of the "league of friendship," known as the United States, had been going from bad to worse, reaching a crisis in 1786. The public debt amounted in 1783 to about $42,000,000, of which $8,000,000 was owed abroad—in Holland, France and Spain. Congress had no power to levy taxes for the payment of interest or principal; it could only make requisitions on the States. In the four years ending in 1786 requisitions had been made for $10,000,000 and the receipts from them had amounted to but one-fourth of what had been called for. Even the interest on the debt was falling into arrears, and the first instalment of the principal fell due in 1787. To pay this, and subsequent annual instalments of $1,000,000, was quite impossible. Robert Morris, the financier of the War of Independence, resigned in 1783 rather than "be the minister of injustice," hoping thus to force upon the States the necessity of granting taxing powers to Congress. Washington, on retiring from the command-in-chief, wrote a circular letter to the governors of all the States, urging the necessity of granting to Congress some power to provide a national revenue. Congress (April 18, 1783) appealed to the States for power to levy specific duties on cer-

tain enumerated articles, and 5% on others It was believed that with these duties and the requisitions, which were now to be met by internal taxation, $2,500,000 per annum could be raised. The proposal never received the necessary ratification of all the States. The obedience to the requisitions grew more lax In 1786 a committee of Congress reported that any further reliance on requisitions would be "dishonourable to the understandings of those who entertain such confidence."

The States and Congress.—In the States the case was even worse. Some of them had been seduced into issuing paper currency in such profusion that they were almost bankrupt. Great Britain, in the treaty of peace, had recognized the independence of the individual States, naming them in order; and her Government followed the same system in all its intercourse with its late Colonies. Its restrictive system was maintained, and the States, competing with each other for more commerce, could adopt no system of counteracting measures. Every possible burden was thus shifted to American commerce; and Congress could do nothing, for, though it asked for the power to regulate commerce for 15 years, the States refused it Several States, towards the end of this period, began to prepare or adopt systems of protection of domestic productions or manufactures, aimed at preventing competition by neighbouring States The Tennessee settlers were in insurrection against the authority of North Carolina; the Kentucky settlers were disposed to cut loose from Virginia Poverty, with the rigid execution of process for debt, drove the farmers of western Massachusetts into an insurrection (Shays's Insurrection) which the State had much difficulty in suppressing; and Congress was so incompetent to aid Massachusetts that it was driven to the expedient of imagining an Indian war in that direction, in order to transfer troops thither Congress itself was in danger of disappearance from the scene The necessity for the votes of nine of the 13 States for the passage of important measures made the absence of a State's delegation quite as effective as a negative vote Congress even had to make repeated appeals to obtain a quorum for the ratification of the treaty of peace with Great Britain In 1784 Congress broke up in disgust, and the French minister reported to his government—"There is now in America no general government—neither Congress, nor president, nor head of any one administrative department"

Congress was evidently incompetent to frame a new plan of national government; its members were too dependent on their States, and would be recalled if they took part in framing anything stronger than the articles The idea of a convention of the States, independent of Congress, was in the minds and mouths of many; Thomas Paine had suggested it as long ago as his *Common Sense* pamphlet: "Let a continental conference be held . . . to frame a continental charter"

Convention of 1786.—The country drifted into a convention by a roundabout way. The navigation of Chesapeake Bay and the Potomac needed regulation, and the states of Maryland and Virginia, having plenary power in the matter, appointed delegates to arrange such rules The delegates met (1785) at Alexandria (Va), and at Washington's house, Mount Vernon (Va), in adopting their report, proposed that Pennsylvania and Delaware be asked to nominate commissioners Virginia went further and proposed a meeting of commissioners from all the States to frame commercial regulations for the whole. The convention met (1786) at Annapolis (Md), but only five States were represented, and their delegates adjourned, after recommending another convention at Philadelphia in May 1787.

Constitutional Convention.—Congress had failed in its last resort—a proposal that the States should grant it the impost power alone; New York's veto had put an end to this last hope. Confessing its helplessness, Congress approved the call for a second convention; 12 of the States (all but Rhode Island) chose delegates; and the convention met at Philadelphia (May 25, 1787) with an abler body of men than had been seen in Congress since the first two Continental Congresses Among others, Virginia sent Washington, James Madison, Edmund Randolph, George Mason and George Wythe; Pennsylvania: Franklin, Robert, Gouverneur Morris and James Wilson; Massachusetts: Rufus King, Elbridge Gerry and Caleb Strong; Connecticut: William S. Johnson, Roger Sherman and Oliver Ellsworth; New York: Alexander Hamilton; New Jersey: William Paterson; and South Carolina the two Pinckneys and John Rutledge. With hardly an exception the 55 delegates were clear-headed, moderate men, with positive views of their own and firm purpose, but with a willingness to compromise.

The Virginia Plan.—Washington was chosen to preside, and the convention began the formation of a new Constitution, instead of proposing changes in the old one. Two parties were formed at once The Virginia delegates offered a plan proposing a Congress, of two houses, having power to legislate on national subjects, and to compel the States to fulfil their obligations. This was a "large-State" plan, proposed by those States which had or hoped for a large population It meant to base representation in both houses on population, so that the large States could control both of them, and it left the appointment of the president or other executive and the Federal judges to Congress—so that the whole administration of the new government would fall under large-State control.

The New Jersey Plan.—On behalf of the "small States" Paterson of New Jersey brought in another plan It continued the old Confederation, with its single house and equal State vote, but added the power to regulate commerce and raise a revenue, and to compel the States to obey requisitions. The large States had a general majority of six to five, but the constant dropping off of one or more votes, on minor features, from their side to that of the small States prevented the hasty adoption of any radical measures Nevertheless, the final collision could not be evaded, the basis of the two plans was in the question of one or two houses, of equal or proportionate State votes, of large-State supremacy or of State equality In July the large States began to show a disposition to force their plan through, and the small States began to threaten a concerted withdrawal from the convention

The Compromise.—The Connecticut delegates, from their first appearance in the convention, had favoured a compromise They had been trained under the New England system, in which the assemblies were made up of two houses, one representing the people of the whole State, according to population, and the other giving an equal representation to the towns. They proposed that the new Congress should be made up of two houses, one representing the States in proportion to their population, the other giving an equal vote to each State. At a deadlock the convention referred the proposition to a committee, and it reported in favour of the Connecticut compromise Connecticut had been voting in the large-State list, and the votes of her delegates could not be spared from their slender majority; now another of the large States, North Carolina, came over to Connecticut's proposal, and it was adopted Thus the first great struggle of the convention resulted in a compromise, which took shape in an important feature of the Constitution, the Senate

The small States were still anxious, in every new question, to throw as much power as possible into the hands of their special representative, the Senate; and that body thus obtained its power to act as an executive council as a restraint on the President in appointments and treaties. This was the only survival of the first alignment of parties, but new divisions arose on almost every proposal introduced The election of the President was given at various times to Congress and to electors chosen by the State legislatures; and the final mode of choice, by electors chosen by the States, was settled only two weeks before the end of the convention, the office of vice president coming in with it. The opponents and supporters of the slave trade compromised by agreeing not to prohibit it for 20 years Another compromise included three-fifths of the slaves in enumerating population for representation. This provision gave the slave-holders abnormal power as the number of slaves increased.

Any explanation of the system introduced by the Constitution must start with the historical fact that, while the national Government was practically suspended, from 1776 until 1789, the only power to which political privileges had been given by the people was the States, and that the State legislatures were, when

the convention met, politically omnipotent, with the exception of the few limitations imposed on them by the early State constitutions. The general rule, then, is that the Federal Government has only the powers granted to it by the Federal Constitution, while the State has all governmental powers not forbidden to it by the State or the Federal Constitution. But the phrase defining the Federal Government's powers is no longer "expressly granted," as in the Articles of Confederation, but merely "granted," so that powers necessary to the execution of granted powers belong to the Federal Government, even though not directly named in the Constitution. This question of the interpretation or "construction" of the Constitution is at the bottom of real national politics in the United States.

The Constitution.—Popular sovereignty, then, is the basis of the American system But it does not, as does the British system, choose its legislative body and leave unlimited powers to it. It makes its "Constitution" the permanent medium of its orders or prohibitions to all branches of the Federal Government and to many branches of the State Governments. they must do what the Constitution directs and leave undone what it forbids. The people, therefore, are continually laying their commands on their governments; and they have instituted a system of Federal courts to ensure obedience to their commands. A British court must obey the Act of parliament; the American court is bound and sworn to obey the Constitution first, and the Act of Congress or of the State legislature only so far as it is warranted by the Constitution But the American court does not deal directly with the act in question; it deals with individuals who have a suit before it. One of these individuals relies on an Act of Congress or of a State legislature, the act thus comes before the court for examination, and it supports the act or disregards it as "unconstitutional," or in violation of the Constitution If the court is one of high rank, or one to which a decision may be appealed, as the U S Supreme Court, other courts follow the precedent, and the law falls to the ground.

The preamble states that "we, the people of the United States," establish and ordain the Constitution. Events have shown that it was the people of the whole United States that established the Constitution, but the people of 1787 seem to have inclined to the belief that it was the people of each State for itself. This belief was never changed in the south; and in 1861 the people of that section believed that the ordinances of secession were merely a repeal of the enacting clause by the power which had passed it, the people of the State For an account of the form of Government established by the Constitution *see* UNITED STATES: *Constitution and Government.*

The Constitution's leading difference from the Confederation is that it gives the national government power over individuals The Federal courts are the principal agents in securing this essential power; without them, the Constitution might easily have been as dismal a failure as the Confederation It has also been a most important agent in securing to the national government its supremacy over the States. From this point of view the most important provision of the Constitution is the grant of jurisdiction to Federal courts in cases involving the construction of the Constitution or of laws or treaties made under it The 25th section of the Judiciary Act of 1789 permitted any Supreme Court justice to grant a writ of error to a State court in a case in which the constitutionality of a Federal law or treaty had been denied, or in which a State law objected to as in violation of the Federal Constitution had been maintained In such cases, the defeated party had the right to carry the "Federal question" to the Federal courts. It was not until 1816 that the Federal courts undertook to exercise this power; it raised a storm of opposition, but it was maintained, and has made the Constitution what it professed to be—"the supreme law of the land."

Sovereignty.—The system of the United States is almost the only national system, in active and successful operation, as to which the exact location of the sovereignty is still a mooted question. The contention of the Calhoun school—that the separate States were sovereign before and after the adoption of the Constitution, that the Union was purely voluntary, and that the whole people, or the people of all the other States, had no right to maintain or enforce the Union against any State—has been ended by the Civil War. But that did not decide the location of the sovereignty. The prevalent opinion is still that first formulated by Madison· that the States were sovereign before 1789; that they then gave up a part of their sovereignty to the Federal Government; that the Union and the Constitution were the work of the States, not of the whole people; and that reserved powers are reserved to the people of the States, not to the whole people.

By whatever sovereignty the Constitution was framed and imposed, it was meant only as a scheme in outline, to be filled up afterwards, and from time to time, by legislation The idea is most plainly carried out in the Federal judiciary the Constitution only directs that there shall be a Supreme Court, and marks out the general jurisdiction of all the courts, leaving Congress, under the restriction of the President's veto power, to build up the system of courts But the same idea is visible in every department, and it has carried the Constitution safely through a period which has radically altered every other civilized Government It has combined elasticity with the limitations necessary to make democratic government successful over a vast territory, having infinitely diverse interests, and needing, more than almost anything else, positive opportunities for sober second thought by the people. A sudden revolution of popular thought or feeling is enough to change the House of Representatives from top to bottom; it must continue for several years before it can make a radical change in the Senate, and for years longer before it can carry this change through the judiciary, which holds for life; and all these changes must take place before the full effects upon the laws or Constitution are accomplished But minor changes are reached easily and naturally in the course of legislation.

Submission to Congress.—The convention adjourned on Sept 17, 1787, having adopted the Constitution Its last step was a resolution that the Constitution be sent to the Congress of the Confederation, with the recommendation that it be submitted to conventions elected by the people of each State for ratification or rejection, that, if nine States should ratify it, Congress should appoint days for the popular election of electors, and that then the new Congress and President should, "without delay, proceed to execute this Constitution" Both Congress and the convention were careful not to open the dangerous question, How was a Government which was not to be changed but by the legislatures of all the States to be entirely supplanted by a different system through the approval of conventions in three-fourths of them?

Action of the States.—Before the end of the year Delaware, Pennsylvania and New Jersey had ratified, and Georgia, Connecticut and Massachusetts followed during the first two months of 1788. Thus far the only strong opposition had been in Massachusetts, a "large State" In it the struggle began between the friends and the opponents of the Constitution, with its introduction of a strong Federal power; and it raged in the conventions, legislatures, newspapers and pamphlets In a classic series of papers, the *Federalist,* Alexander Hamilton, with the assistance of James Madison and John Jay, explained the new Constitution and defended it

The seventh and eighth States—Maryland and South Carolina—ratified in April and May 1788, and, while the conventions of Virginia and New York were still wrangling over the great question, the ninth State, New Hampshire, ratified, and the Constitution passed out of theory into fact. The Anti-Federalists of the Virginia and New York conventions offered conditional ratifications of all sorts; but the Federalists stubbornly refused to consider them, and at last, by very slender majorities, these two states ratified North Carolina refused to ratify the Constitution, and in Rhode Island it was referred to the several towns instead of to a convention and was rejected by an overwhelming majority, the Federalists, who advocated the calling of a convention, refraining from voting. Congress named the first Wednesday of January 1789 as the day for the choice of electors, the first Wednesday in February for the choice of President and vice president, and the first Wednesday in March for

the inauguration of the new Government, at New York city The last date fell on March 4, which has been the limit of each President's term since that time.

When the votes of the electors were counted before Congress, it was found that Washington had been unanimously elected President, and that John Adams, standing next on the list, was vice president. Long before the inauguration the Congress of the Confederation had expired of mere inanition, its attendance simply ran down until (Oct 21, 1788) its record ceased, and the United States got on without any national government for nearly six months. The struggle for nationality had been successful, and the old order faded out of existence

Slavery.—The first census (1790) followed so closely upon the inauguration of the Constitution that the country may fairly be said to have had a population of near four millions in 1789 Something over half a million of these were slaves, of African birth or blood. Slavery of this sort had taken root in almost all the Colonies its original establishment being everywhere by custom. When the custom had been sufficiently established statutes came in to regulate a relation already existing. But it is not true, as the Dred Scott decision held long afterwards, that the belief that slaves were chattels simply, things, not persons, held good at the time of the adoption of the Constitution. Times had changed somewhat. The peculiar language of the Constitution itself, describing a slave as a "person held to service or labour," under the laws of any State, puts the general feeling exactly: slaves were persons from whom the laws of some of the States withheld personal rights for the time In accordance with this feeling most of the Northern States were on the high road towards abolition of slavery. Vermont had never allowed it In Massachusetts it was swept out by a summary court decision that it was irreconcilable with the new State Constitution. Other States soon began systems of gradual abolition, which finally extinguished slavery north of Maryland, but so gradually that there were still 18 apprentices for life in New Jersey in 1860, the last remnants of the former slave system In the new States north of the Ohio slavery was prohibited by the ordinance of 1787 and the prohibition was maintained in spite of many attempts to get rid of it and introduce slavery

The sentiment of thinking men in the south was exactly the same, or in some cases more bitter from their personal entanglement with the system. Jefferson's language as to slavery is irreconcilable with the chattel notion; no abolitionist agitator ever used warmer language than he Washington, George Mason and other southern men were almost as warm against slavery as Jefferson, and there were societies for the abolition of slavery in the south In the Constitutional Convention of 1787 the strongest opposition to an extension of the period of non-interference with the slave trade from 1800 to 1808 came from Virginia, whereas every one of the New England States voted for this extension Like most slave laws, the laws of the southern states were harsh. rights were almost absolutely withheld from the slave, and punishments of the severest kind were legal; but the execution of the system was milder than its legal possibilities might lead one to imagine The country was as yet so completely agricultural that southern slavery kept all the patriarchal features possible to such a system.

Industries.—Indeed, the whole country was almost exclusively agricultural, and, in spite of every effort to encourage manufactures by State bounties, they formed the meagrest element in the national production. Connecticut, which now teems with manufactures, was just beginning the production of tinware and clocks; Rhode Island and Massachusetts were just beginning to work in cotton from models of jennies and Arkwright machinery surreptitiously obtained from England, and other States, beyond local manufactures of paper, glass and iron, were almost entirely agricultural, or were engaged in industries directly dependent on agriculture.

Population.—There were but five cities in the United States having a population of more than 10,000—New York (33,000), Philadelphia (28,500), Boston (18,000), Charleston (16,000) and Baltimore (13,000). The revenues of the new Government in 1790 were only $4,000,000; the expenditures, excluding interest on the public debt, but $1,000,000. It is not easy for the modern American to realize the poverty and weakness of his country at the inauguration of the new Government.

Travel.—Outside the cities communication was slow. One stage a week was enough for the connection between the great cities, and communication elsewhere depended on private conveyance. The western settlements were just beginning to make the question more serious Enterprising land companies were the moving force which had impelled the passage of the ordinance of 1787; and the first column of their settlers was pouring into Ohio and forming connection with their predecessors in Kentucky and Tennessee. Marietta and Cincinnati had been founded. But the intending settlers were obliged to make the journey down the Ohio river from Pittsburgh in bullet-proof flat-boats, for protection against the Indians, and the return trip depended on the use of oars. For more than 20 years these flat-boats were the chief means of river commerce in the West; and in the longer trips, as to New Orleans the boats were generally broken up at the end and sold for lumber. John Fitch and others were already experimenting on what was soon to be the steamboat; but the statesman of 1789, looking at the task of keeping under one government a country of such distances, with such difficulties of communication, naturally felt anxiety as to the future.

Literature.—The comparative isolation of the people everywhere, the lack of books, the poverty of the schools and newspapers, were all influences which worked strongly against any pronounced literary development Poems, essays and paintings were feeble imitations of European models, history was annalistic, if anything, and the drama hardly existed In two points the Americans were strong, and had done good work Such men as Jonathan Edwards had excelled in various departments of theology, and American preaching had reached a high degree of quality and influence, and, in the line of politics, the American State papers rank among the very best of their kind Having a very clear perception of their political purposes, and having been restricted in study and reading to the great masters of pure and vigorous English, and particularly to the English translators of the Bible, the American leaders came to their work with an English style which could hardly have been improved. The writings of Franklin, Washington, the Adamses, Hamilton, Jefferson, Madison, Jay and others show the secret of their strength in every page Much the same reasons, with the influences of democracy, brought oratory, as represented by Patrick Henry, Fisher Ames, John Randolph and others, to a point not very far below the mark afterwards reached by Daniel Webster. The effect of these facts on the subsequent development of the country is not often estimated at its full value

Limits of Settlement.—The cession of the "North-west Territory" by Virginia and New York had been followed by similar cessions by Massachusetts (1785), Connecticut (1786) and South Carolina (1787). North Carolina did not cede Tennessee until early in 1790, nor Georgia her western claims until 1802 Settlement in all these regions was still very sparse. The centres of western settlement, in Tennessee and Kentucky, had become more firmly established, and a new one, in Ohio, had just been begun. The whole western limits of settlement of the old 13 States had moved much nearer their present boundaries; and the acquisition of the western title, with the liberal policy of organization and government which had been begun, was to have its first clear effects during the first decade of the new government. Almost the only obstacle to its earlier success had been the doubts as to the attitude which the Spanish authorities, at New Orleans and Madrid, would take towards the new settlements. They had already asserted a claim that the Mississippi was an exclusively Spanish stream from its mouth up to the Yazoo, and that no American boat should be allowed to sail on this part of it. To the western settler the Alleghenies and bad roads were enough to cut him off from any other way to a market than down the Mississippi; and it was not easy to restrain him from a forcible defiance of the Spanish claim. The northern States were willing to allow the Spanish claim for

a period of years in return for a commercial treaty; the southern States and the western settlers protested angrily; and once more the spectre of dissolution appeared, not to be laid again until the new Government had made a treaty with Spain in 1795 securing common navigation of the Mississippi.

The Development of Democracy, 1789–1801.—All the tendencies of political institutions in the United States had been towards democracy; but the leading men were not unanimous in their agreement with this tendency Not a few of them were pronounced republicans even before 1775, but the mass of them had no great objections to a monarchical form of government until the war spirit had converted them The Declaration of Independence had been directed rather against *the* King than against *a* king. Even after popular sovereignty had pronounced against a king, class spirit was for some time a fair substitute for aristocracy As often happens, democracy at least thought of a Caesar when it apprehended class control Certain discontented officers of the Continental Army proposed to Washington that he become king, but he promptly and indignantly put the offer by

The State constitutions were democratic, except for property or other restrictions on the right of suffrage, or provisions carefully designed to keep the control of at least one house of the State legislature "in the hands of property" The Federal Constitution was so drawn that it would have lent itself kindly either to class control or to democracy The electoral system of choosing the President and vice president was altogether anti-democratic, though democracy has conquered it: not an elector, since 1796, has disobeyed the purely moral claim of his party to control his choice Since the Senate was to be chosen by the State legislatures, "property," if it could retain its influence in those bodies, could control at least one house of Congress. Whether the Constitution was to have a democratic or an anti-democratic interpretation was to be settled in the next 12 years

Immigration.—The States were a strong factor in the final settlement, from the fact that the Constitution had left to them the control of the elective franchise they were to make its conditions what each of them saw fit Religious tests for the right of suffrage had been quite common in the Colonies; property tests were almost universal The religious tests disappeared shortly after the War of Independence, the property tests survived in some of the States far into the constitutional period But the desire to attract immigration was always a strong impelling force to induce States, especially frontier States, to make the acquisition of full citizenship and political rights as easy and rapid as possible This force was not so strong at first as it was after the great stream of immigration began about 1848, but it was enough to tend constantly to the development of democracy

Organization of the New Government.—The Anti-Federalists had been a political party, but a party with but one principle. The absolute failure of that principle deprived the party of all cohesion; and the Federalists controlled the first two Congresses almost entirely Their pronounced ability was shown in their organizing measures, which still govern the American system very largely The departments of State, of the Treasury, of War, of Justice and of the Post Office were rapidly and successfully organized; acts were passed for the regulation of seamen, commerce, tonnage duties, lighthouses, intercourse with the Indians, territories and the militia; a national capital was selected; a national bank was chartered; the national debt was funded, and the State debts were assumed as part of it The first four years of the new system showed that the States had now to deal with a very different power from the impotent Congress of the Confederation. The new power was even able to exert pressure upon the two States which had not ratified the Constitution As a first step, the higher duties imposed on imports from foreign countries were expressly directed to apply to imports from North Carolina and Rhode Island North Carolina having called a second convention, her case was left to the course of nature; the second convention ratified the Constitution (Nov 21, 1789). The Rhode Island legislature asked that their State might not be considered altogether foreigners, made their duties agree with those of the new government, and reserved the proceeds for "continental" purposes. Still no further steps were taken. A bill was therefore introduced, directing the President to suspend commercial intercourse with Rhode Island, and to demand from her her share of the continental debt This was passed by the Senate, and needed but two steps further to become law Newspaper proposals to divide the little State between her two nearest neighbours were stopped by her ratification of the Constitution (May 29, 1790). The "old 13" were thus united under the Constitution; and yet, so strong is the American prejudice for the autonomy of the States that these last two were allowed to enter in the full conviction that they did so in the exercise of sovereign freedom of choice.

Protection.—Protection was begun in the first tariff act, whose object, said its preamble, was the protection of domestic manufactures. The duties, however, ranged only from 7½ to 10%, averaging about 8½% The system, too, had rather a political than an economic basis Until 1789 the States had controlled the imposition of duties The separate State feeling was a factor so strong that secession was a possibility which every statesman had to take into account Hamilton's object, in introducing the system, seems to have been to create a class of manufacturers, running through all the States, but dependent for prosperity on the new Federal Government and its tariff. This would be a force which would make strongly against any attempt at secession The same feeling seems to have been at the bottom of his establishment of a national bank, his assumption of State debts, and most of the general scheme which his influence forced upon the Federalist Party.

The First Cabinet.—In forming his cabinet Washington had paid attention to the opposing elements which had united for the temporary purpose of ratifying the Constitution The national element was represented by Hamilton, secretary of the Treasury, and Henry Knox, secretary of War, the particularist element (using the term to indicate support of the States, not of a State) by Jefferson, secretary of State, and Edmund Randolph, Attorney General At the end of 1792 matters were in train for the general recognition of the existence of two parties, whose struggles were to decide the course of the Constitution's development The occasion came in the opening of 1793, when the new nation was first brought into contact with the French Revolution.

Jefferson.—The controlling tendency of Jefferson and his school was to the maintenance of individual rights at the highest possible point, as the Hamilton school was always ready to assert the national power to restrict individual rights for the general good. The Jefferson school supported the States, in the belief that they were the best bulwarks for individual rights When the French Revolution began its course in America by agitation for the "rights of man," it met a sympathetic audience in the Jefferson party and a cold and unsympathetic hearing from the Hamilton school of Federalists, who were far more interested in securing the full recognition of the power and rights of the nation than in securing the individual against imaginary dangers, as they thought them For ten years the surface marks of distinction between the two parties were to be connected with the course of events in Europe

Hamilton.—The new Government was not yet four years old; it was not familiar, nor of assured permanency The only national governments of which Americans had had previous experience were the British Government and the Confederation: in the British they had had no share, and the Confederation had had no power. The only places in which they had had long-continued, full and familiar experience of self-government were their State Governments The governing principle of the Hamilton school, that the construction or interpretation of the terms of the Constitution was to be such as to broaden the powers of the Federal Government, necessarily involved a corresponding trenching on the powers of the States. It was natural, then, that the Jefferson school should look on every feature of the Hamilton programme as "anti-republican" The disposition of the Jefferson school to claim for themselves a certain peculiar title to the position of "republicans" developed into the appearance of the first Repub-

lican, or the Democratic-Republican, Party, about 1793.

Parties.—Many of the Federalists were shrewd and active business men, who naturally took prompt advantage of the opportunities which the new system offered. The Republicans therefore believed and asserted that the whole Hamilton programme was dictated by selfish or class interest; and they added this to the accusation of monarchical tendencies These charges, with the fundamental differences of mental constitution, exasperated by the passion which differences as to the French Revolution seemed to carry with them everywhere, made the political history of this decade a very unpleasant record The provision for establishing the national capital on the Potomac (1790) was declared to have been carried by a corrupt bargain, and accusations of corruption were renewed at every opportunity In 1793 a French agent, Edmond Charles Edouard Genet (1765–1834), appeared to claim the assistance of the United States for the French republic, and went to the length of commissioning privateers, and endeavouring to secure recruits Washington decided to issue a proclamation of neutrality, the first act of the kind in American history. It was the first indication, also, of the policy which has made the course of every President, with the exception of Polk, a determined leaning to peace, even when the other branches of the Government have been intent on war. Genet, however, continued his activities, and made outrageous demands upon the Government, so that finally Washington demanded and secured (1794) his recall. The proclamation of 1793 brought about the first distinctly party feeling, and it was intensified by Washington's charge that popular opposition in western Pennsylvania (1794) to the new excise law (*see* WHISKY INSURRECTION) had been fomented by the extreme French party Their name, Democrat, was applied by the Federalists to the whole Republican Party as a term of contempt, but it was not accepted by the party for some 20 years, then the compound title "Democratic-Republican" became, as it long remained, the official title of the party There was no party opposition, however, to the re-election of Washington in 1792, or to the admission of Vermont (1791), Kentucky (1792) and Tennessee (1796) as new States

Jay's Treaty.—The British Government had accredited no minister to the United States, and it refused to make any commercial treaty or to give up the forts in the western territory of the United States, through which its agents still exercised a commanding influence over the Indians In the course of its war with France, the neutral American vessels, without the protection of a national navy, fared badly A treaty negotiated in 1794 by Chief Justice John Jay settled these difficulties for the following 12 years But, as it engaged the United States against any intervention in the war on behalf of France, was silent on the subject of the right of search, and agreed to irksome limitations on the commercial privileges of the United States, the Republicans made it very unpopular, and the bitter personal attacks on Washington grew out of it In spite of occasional Republican successes, the Federalists retained a general control of national affairs, they elected John Adams President in 1796, though Jefferson was chosen vice president with him, and the national policy of the Federalists kept the country out of entangling alliances with any of the European belligerents To the Republicans, and to the French republic, this last point of policy was only a practical intervention against France and against the rights of man

At the end of Washington's Administration the French Directory broke off relations with the United States, demanding the abrogation of Jay's treaty and a more pronounced sympathy with France Adams sent three envoys, C. C Pinckney, John Marshall and Elbridge Gerry, to endeavour to re-establish the former relations; they were met by demands for "money, a great deal of money," as a prerequisite to peace They refused; their letters home were published, and the Federalists at last had the opportunity of riding the whirlwind of an intense popular desire for war with France. Intercourse with France was suspended by Congress (1798), the treaties with France were declared at an end; American frigates were authorized to capture French vessels guilty of depredations on American commerce, and the President was authorized to issue letters of marque and reprisal; and an American Army was formed, Washington being called from his retirement at Mount Vernon to command it. The war never went beyond a few sea fights, in which the little American Navy did itself credit, and Napoleon, seizing power the next year, renewed the peace which should never have been broken

Decline of the Federalists.—The reaction in Great Britain against the indefinite "rights of man" had led Parliament to pass an alien law, a sedition law suspending the writ of *habeas corpus* and an act giving wide and loosely defined powers to magistrates for the dispersion of meetings to petition for redress of grievances The Federalists were in control of a Congress of limited powers; but they were strongly tempted by sympathies and antipathies of every sort to form their programme on the model furnished from England The measures which they actually passed were based only on that construction of the Constitution which is at the bottom of all American politics, they only tended to force the Constitution into an anti-democratic direction But it was the fixed belief of their opponents that they meant to go farther, and to secure control by some wholesale measure of political persecution

The Alien and Sedition Laws.—Three alien laws were passed in June and July, 1798 The first (repealed in April, 1802) raised the number of years necessary for naturalization from five to 14 The third permitted the arrest or removal of subjects of any foreign power with which the United States should be at war The second, which is usually known as the Alien Law, was limited to a term of two years, it permitted the President to arrest or order out of the country any alien whom he should consider dangerous to the country As many of the Republican editors and local leaders were aliens, this law really put a large part of the Republican organization in the power of the President The Sedition Law (to be in force until March, 1801, and not renewed) made it a crime, punishable by fine and imprisonment, to publish or print any false, scandalous and malicious writings against the Government of the United States, either house of Congress, or the President, or to stir up sedition or opposition to any lawful act of Congress or of the President, or to aid the designs of any foreign power against the United States In its first form the bill was even more sweeping than this and alarmed the opposition

Most of the ability of the country was in the Federalist ranks, the Republicans had but two first-rate men—Jefferson and Madison In the sudden issue thus forced between individual rights and national power, Jefferson and Madison could find but one bulwark for the individual—the power of the States; and their use of it gave their party a pronounced list to State sovereignty from which it did not recover for years They objected to the Alien Law on the grounds that aliens were under the jurisdiction of the State, not of the Federal Government; that the jurisdiction over them had not been transferred to the Federal Government by the Constitution, and that the assumption of it by Congress was a violation of the Constitution's reservation of powers to the States; and, further, because the Constitution reserved to every "person," not to every citizen, the right to a jury trial. They objected to the Sedition Law on the grounds that the Constitution had specified exactly the four crimes for whose punishment Congress was to provide; that criminal libel was not one of them; and that the 1st amendment forbade Congress to pass any law restricting freedom of speech or of the press.

Virginia and Kentucky Resolutions.—The Republican objections might have been made in court, on the first trial. But the Republican leaders had strong doubts of the impartiality of the Federal judges, who were Federalists They resolved to entrench the party in the State legislatures The Virginia legislature in 1798 passed a series of resolutions prepared by Madison, and the Kentucky legislature in the same year passed a series prepared by Jefferson. Neglected or rejected by the other States, they were passed again by their legislatures in 1799. The leading idea expressed in both was that the Constitution was a "compact" between the States, and that the powers (the States) which had made the compact had reserved the power to restrain the creature of the compact, the Federal Government, whenever it undertook

to assume powers not granted to it. Madison's idea seems to have been that the restraint was to be imposed by a second convention of the States. Jefferson's idea is more doubtful; if it meant that the restraint should be imposed by any state which should feel aggrieved, his scheme was merely Calhoun's idea of nullification; but there are some indications that he agreed with Madison

The first Congress of Adams's term of office ended in 1799. Its successor, elected in the heat of the French war excitement, kept the Federalist policy up to its first pitch Out of Congress the execution of the objectionable laws had taken the shape of political persecution. Men were arrested, tried and punished for writings which the people had been accustomed to consider within legitimate political methods The Republican leaders made every trial as public as possible, and gained votes constantly, so that the Federalists began to be shy of the very powers which they had sought Every new election was a storm signal for the Federalist Party, and the danger was increased by schism in their own ranks

Election of 1800.—Hamilton was now a private citizen of New York; but he had the confidence of his party more largely than its nominal head, the President, and he maintained close and confidential relations with the cabinet which Adams had taken unchanged from Washington The Hamilton faction saw no way of preserving and consolidating the newly acquired powers of the Federal Government but by keeping up and increasing the war feeling against France, Adams had the instinctive leaning of an American President towards peace Amid cries of wrath and despair from his party he accepted the first overtures of the new Napoleonic Government, sent envoys to negotiate a peace, and ordered them to depart for France when they delayed Then, discovering flat treachery in his cabinet, he dismissed it and blurted out a public expression of his feeling that Hamilton and his adherents were "a British faction" Hamilton retorted with a circular letter to his party friends, denouncing the President; the Republicans intercepted it and gave it a wider circulation than its author had intended The result depended on the electoral vote of New York; and Aaron Burr, who had introduced the drill and machinery of a modern American political party there, had made the State Republican and secured a majority for the Republican candidates These (Jefferson and Burr) received the same number of electoral votes (73) and the House of Representatives (controlled by the Federalists) was thus called upon to decide which should be President There was an effort by the Federalists to disappoint the Republicans by making Burr President; but Jefferson obtained that office, Burr becoming vice president for four years This disputed election, however, led to the adoption in 1804 of the 12th amendment to the Constitution, which prescribed that each elector should vote separately for president and vice president, and thus prevent another tie vote of this kind

The "Revolution of 1800" decided the future development of the United States The new dominant party entered upon its career weighted with the theory of State sovereignty; and a civil war was necessary before this dogma, put to use again in the service of slavery, could be banished But the democratic development never was checked As the Republicans obtained control of the States they altered the State constitutions so as to cut out all the arrangements that favoured property or class interests, and reduced political power to the dead level of manhood suffrage In most of the States outside of New England this process was completed before 1815; but New England tenacity was proof against the advancing revolution until about 1820 For 20 years after its downfall of 1800 the Federalist party maintained its hopeless struggle, and then it faded away into nothing, leaving as its permanent memorial the excellent organization of the Federal Government, which its successful rival hardly changed. Its two successors—the Whig and the second Republican party—have also been broad-constructionist parties, but they have admitted democracy as well.

The New Capital.—The disputed election of 1800 was decided in the new capital city of Washington, to which the Government had just been removed, after having been for ten years at Philadelphia. Its streets and parks existed only on paper. The Capitol had been begun; the Executive Mansion was unfinished, and its audience room was used by Mrs Adams as a drying room for clothes; the congressmen could hardly find lodgings The inconveniences were only an exaggeration of the condition of other American cities Their sanitary conditions were bad, and yellow fever and cholera from time to time reduced several of them almost to depopulation More than once during this decade the fever visited Philadelphia and New York, drove out most of the people, and left grass growing in the streets The communication between the cities was still wretched The traveller was subject to every danger that bad roads, bad carriages, bad horses, bad inns and bad police protection could combine to inflict upon him

The West.—About this time the term "the West" appears It meant then the western part of New York, the new territory north of the Ohio, and Kentucky and Tennessee In settling land boundaries New York had transferred (1786) to Massachusetts, whose claims crossed her territory, the right to (but not jurisdiction over) a large tract of land in central New York, and to another large tract in the Erie basin The sale of this land had carried population considerably west of the Hudson Between 1790 and 1800 the population of Ohio had risen from almost nothing to 45,000, that of Tennessee from 36,000 to 106,000, and that of Kentucky from 74,000 to 221,000—the last-named State now exceeding six of the "old 13" in population The difficulties of the western emigrant, however, were still enormous He obtained land of his own, fertile land and plenty of it, but little else. The produce of the soil had to be consumed at home, or near it, ready money was scarce and distant products scarcer, and comforts, except the very rudest substitutes of home manufacture, were unobtainable. The number of post offices rose during these ten years from 75 to 903, the miles of post routes from 1,900 to 21,000, and the revenue from \$38,000 to \$231,000

Patents.—The power of Congress to regulate patents was already bearing fruit Until 1789 this power was in the hands of the States, and the privileges of the inventor were restricted to the territory of the patenting State Now he had a vast and growing territory within which all the profits were his own Twenty patents were issued in 1793, and 23,471 100 years later One of the inventions of 1793 was Eli Whitney's cotton gin

Cotton.—When the Constitution was adopted it was not known that the cultivation of cotton could be made profitable in the southern States The "roller gin" could clean only 6 lb a day by slave labour In 1784 eight bags of cotton, landed in Liverpool from an American ship, had been seized on the ground that so much cotton could not be the produce of the United States Eli Whitney invented the saw-gin, by which the cotton was dragged through parallel wires with openings too narrow to allow the seeds to pass; and one slave could now clean 1,000 lb a day The exports of cotton leaped from 189,000 lb in 1791 to 21,000,000 lb in 1801, and doubled in three years more The influence of this one invention, combined with the wonderful series of British inventions which had paved the way for it, can hardly be estimated in its commercial aspects. Its political influences were even wider, but more unhappy The introduction of the commercial element into the slave system of the South robbed it at once of the patriarchal features which had made it tolerable, while it developed in slaveholders a new disposition to defend a system of slave labour as a "positive good"

Slavery.—The development of a class whose profits were merely the extorted natural wages of the black labourer was certain; and its political power was as certain, though it never showed itself clearly until after 1830 And this class was to have a peculiarly distorting effect on the political history of the United States. Aristocratic in every sense but one, it was ultra-Democratic (in a purely party sense) in its devotion to State sovereignty, for the legal basis of the slave system was in the laws of the several States. In time the aristocratic element got control of the party which had originally looked to State rights as a bulwark of individual rights; and the party was finally committed to the employment of its original doctrine for an entirely different purpose—the suppression of the black labourer's wages.

Democracy and Nationality, 1801–29.—When Jefferson took office in 1801 his party, ignoring the natural forces which

tied the States together even against their wills, insisted that the legal basis of the bond was in the power of any State to withdraw at will This was no nationality; and foreign nations naturally refused to take the American national coin at any higher valuation than that at which it was current in its own country. The urgent necessity was for a reconciliation between democracy and nationality; and this was the work of this period. An underlying sense of all this has led Democratic leaders to call the war of 1812–15 the "Second War of Independence"; the result was independence of past ideas as the first had been of Great Britain

Louisiana.—The first force in the new direction was the acquisition of Louisiana in 1803. Napoleon had acquired it from Spain, and, fearing an attack upon it by Great Britain, offered it to the United States for $15,000,000. The Constitution gave the Federal Government no power to buy and hold territory, and the party was based on a strict construction of the Constitution. Possession of power forced the strict-construction party to broaden its ideas, and Louisiana was bought, though Jefferson quieted his conscience by talking for a time of a futile proposal to amend the Constitution so as to grant the necessary power. The acquisition of the western Mississippi basin more than doubled the area of the United States, and gave them control of all the great river systems of central North America. The difficulties of using these rivers were removed almost immediately by Robert Fulton's utilization of steam in navigation (1807). Within four years steamboats were at work on western waters; and thereafter the increase of steam navigation and that of population stimulated one another. The centre of population during this period advanced from about the middle of Maryland to its earlier extreme western limit; that is, the centre of population was in 1830 nearly at the place which had been the western limit of population in 1770.

The Oregon Country.—Jefferson also laid the basis for a further acquisition in the future by sending an expedition under Meriwether Lewis and William Clark to explore the territory north of the then Spanish territory of California and west of the Rocky Mountains—the "Oregon country" as it was afterwards called The explorations of this party (1804–06), with Capt. Robert Gray's discovery of the Columbia river (1792), made the best part of the claims of the United States to the country 40 years later.

Election of 1804.—Jefferson was re-elected in 1804 His great success as President was the acquisition of Louisiana, which was a violation of his party principles; but all his minor successes were, like this, recognitions of the national sovereignty which he disliked so much After a short and brilliant naval war the Barbary pirates were reduced to submission (1805). The long-continued control of New Orleans by Spain, and the persistent intrigues of the Spanish authorities, looking towards a separation of the whole western country from the United States, had been ended by the acquisition of Louisiana. There still existed a dangerous ignorance of Federal power and control, of which Aaron Burr took advantage (1806–07). Organizing an expedition in Kentucky and Tennessee, probably for the conquest of the Spanish colony of Mexico, he was arrested on the lower Mississippi and brought back to Virginia. He was acquitted; but the incident opened up a vaster view of the national authority than democracy had yet been able to take.

Jefferson and his party persistently refused to recognize the inherent power of the nation in international affairs. The Jay treaty expired in 1806 and American commerce was left to the course of events, Jefferson refusing to accept the only treaty which the British Government was willing to make. All the difficulties which followed may be summed up in a few words. the British Government was then the representative of the ancient system of restriction of commerce, and had a powerful Navy to enforce its ideas; the American Government was endeavouring to force into international recognition the system of neutral rights and unrestricted commerce, but its suspicious democracy refused to give it a navy sufficient to command respect.

Neutral Commerce.—Great Britain was now at war, from time to time, with almost every other nation of Europe. In time of peace European nations followed generally the old restrictive principle of allowing another nation, like the United States, no commercial access to their colonies; but, when they were at war with Great Britain, whose Navy controlled the ocean, they were very willing to allow the neutral American merchantmen to carry away their surplus colonial produce. Great Britain had insisted for 50 years that the neutral nation, in such cases, was really intervening in the war as an ally of her enemy; but she had so far modified her claim as to admit that "transhipment," or breaking bulk, in the United States was enough to qualify the commerce for recognition. The neutral nation thus gained a double freight, and grew rich in the traffic; the belligerent nations no longer had commerce afloat for British vessels to capture; and the "frauds of the neutral flags" became a standing subject of complaint among British merchants and naval officers. About 1805 British prize courts began to disregard transhipment and to condemn American vessels which made the voyage from a European colony to the mother country by way of the United States.

Impressment.—The question of expatriation, too, furnished a good many burning grievances Great Britain maintained the old German rule of perpetual allegiance, though she had modified it by allowing the right of emigration. The United States, founded by immigration, was anxious to establish the right of the subject to divest himself of allegiance by naturalization under a foreign jurisdiction. Four facts thus tended to break off friendly relations. (1) Great Britain's claim to allegiance over American naturalized subjects; (2) her claim to the belligerent right of search of neutral vessels; (3) her claim of right to impress for her vessels of war her subjects who were seamen wherever found; and (4) the difficulty of distinguishing native-born American from British subjects, even if the right to impress naturalized American subjects were granted British naval officers even undertook to consider all who spoke the English language as British subjects, unless they could produce proof that they were native-born Americans. The American sailor who lost his papers was thus open to impressment. A particularly flagrant case of seizure of Americans occurred in 1807. On June 27 the British ship "Leopard" fired upon the American frigate "Chesapeake," which, after having lost three men killed and 18 wounded, hauled down its flag; the British commander then seized four of the "Chesapeake's" crew. This action aroused intense anger throughout the country, and but for the impotence of the Government would undoubtedly have led to immediate war. The American Government in 1810 published the cases of such impressments since 1803 as numbering over 4,000, about one-third of the cases resulting in the discharge of the impressed man.

In May, 1806, the British Government, by orders in council, declared a blockade of the whole continent of Europe from Brest to the Elbe, about 800 miles. In November, after the battle of Jena, Napoleon answered by the "Berlin decree," in which he assumed to blockade the British Isles, thus beginning his "continental system." A year later the British Government answered by further orders in council, forbidding American trade with any country from which the British flag was excluded, allowing direct trade from the United States to Sweden only, in American products, and permitting American trade with other parts of Europe only on condition of touching in England and paying duties Napoleon retorted with the "Milan decree," declaring good prize any vessel which should submit to search by a British ship; but this was evidently a vain fulmination

The Navy.—The Democratic Party of the United States was almost exclusively agricultural and had little sympathy with commercial interests; it was pledged to the reduction of national expenses and the debt, and did not wish to take up the responsibility for a navy; and, as the section of country most affected by the orders in council, New England, was Federalist, a tinge of political feeling could not but colour the decisions of the dominant party. Various ridiculous proposals were considered as substitutes for a necessarily naval war; and perhaps the most ridiculous was adopted. Since the use of non-intercourse agreements as revolutionary weapons against Great Britain, an overweening confidence in such measures had sprung up, and one of them was now resorted to—the embargo of Dec. 22, 1807, forbidding foreign commerce altogether. It was expected to starve Great Britain

into a change of policy; and its effects may be seen by comparing the $20,000,000 exports of 1790, $49,000,000 of 1807 and $9,000,000 of 1808. It does not seem to have struck those who passed the measure that the agricultural districts also might find the change unpleasant; but that was the result, and their complaints reinforced those of New England. The pressure had been slightly relieved by the substitution of the Non-Intercourse Law of March 1, 1809; it prohibited commercial intercourse with Great Britain and France and their dependencies, leaving other foreign commerce open, prohibited the importation from any quarter of British and French goods, and forbade the entrance of British or French vessels, public or private, into any port of the United States. Madison, Jefferson's secretary of State, who succeeded Jefferson in 1809, assumed in the Presidency a burden which was not enviable. New England was in a ferment, and was suspected of designs to resist the restrictive system by force; and the Administration did not face the future with confidence

The War of 1812.—The Non-Intercourse Law was to be in force only "until the end of the next session of Congress" and was to be abandoned as to either belligerent which should abandon its attacks on neutral commerce, and maintained against the other In 1810 the American Government was led to believe that France had abandoned its system Napoleon continued to enforce it in fact, but his official fiction served its purpose of limiting the non-intercourse for the future to Great Britain, and thus straining relations between that country and the United States still further. The elections of 1811–12 resulted everywhere in the defeat of "submission men" and in the choice of new members who were determined to resort to war against Great Britain. Henry Clay, John C Calhoun, William H Crawford and other new men seized the lead in the two houses of Congress, and forced Madison, it is said, to agree to a declaration of war as a condition of his renomination in 1812 Madison sent to Congress a confidential "war message" on June 1 and on the 18th war was declared The national democracy meant to attack Great Britain in Canada, partly to gratify its western constituency, who had been harassed by Indian attacks, asserted to have been instigated from Canada Premonitions of success were drawn from the battle of Tippecanoe, in which William Henry Harrison had defeated in 1811 the north-western league of Indians formed by Tecumseh Between the solidly settled Atlantic States and the Canadian frontier was a wide stretch of unsettled or thinly settled country, which was itself a formidable obstacle to war. Ohio had been admitted as a State in 1802, and Louisiana was admitted in 1812; but their admission had been due to the desire to grant them self-government rather than to their full development in population and resources Cincinnati was a little settlement of 2,500 inhabitants; the fringe of settled country ran not very far north of it; all beyond was a wilderness The case was much the same with western New York. It would have been far less costly, as events proved, to have entered at once upon a naval war; but the crusade against Canada had been proclaimed all through Kentucky and the west, and their people were determined to wipe out their old scores before the conclusion of the war (For the military and naval events of the war *see* AMERICAN WAR OF 1812)

The war opened with disaster—Gen. William Hull's surrender of Detroit; and disaster attended it for two years. Political appointments to positions in the regular army were numerous and such officers were worse than useless Futile attempts at invasion were followed by defeat or abortion, until the political officers were weeded out at the end of the year 1813, and Jacob Brown, Winfield Scott, E. W. Ripley and others who had fought their way up were put in command. Then for the first time the men were drilled and brought into effective condition; two successful battles in 1814—Chippewa and Lundy's Lane—threw some glory on the end of the war. So weak were the preparations even for defence that a British expedition in 1814 met no effective resistance when it landed and burned Washington.

The American Navy was but a puny adversary for the British Navy, which had captured or shut up in port all the other navies of Europe. But the small number of American vessels, with the superabundance of trained officers, gave them one great advantage: the training and discipline of the men, and the equipment of the vessels, had been brought to the very highest point. "The art of handling and fighting the old broadside sailing frigate" had been carried in the little American Navy to an excellence which unvarying success and a tendency to fleet-combats had now made far less common among British captains Altogether the American vessels gave a remarkably good account of themselves

Hartford Convention.—The home dislike to the war had increased steadily with the evidence of incompetent management by the administration. The Federalists, who had always desired a navy, pointed to the naval successes as the best proof of folly with which the war had been undertaken. New England Federalists complained that the Federal Government utterly neglected the defence of their coast, and that southern influence was far too strong in national affairs They showed at every opportunity a disposition to adopt the furthest stretch of State sovereignty, as stated in the Kentucky resolutions, and every such development urged the national democracy unconsciously further on the road to nationality When the New England States sent delegates to meet at Hartford (Conn), and consider their grievances and the best remedies, treason was suspected, and a readiness to suppress it by force was plainly shown. The recommendations of the convention came to nothing; but the attitude of the dominant party towards it is one of the symptoms of the manner in which the trials of actual war were steadily reconciling democracy and nationality The object which Hamilton had sought by high tariffs and the development of national classes had been attained by more natural and healthy means.

Peace.—In April, 1814, the first abdication of Napoleon took place, and Great Britain was able to give more attention to her American antagonist The main attack was to be made on Louisiana, the weakest and most distant portion of the Union A fleet and army were sent thither, but the British assault was completely repulsed (Jan. 8, 1815) by the Americans under Andrew Jackson Peace had been made at Ghent 15 days before the battle was fought, but the news of the battle and the peace reached Washington almost together.

The United States secured a fairly good treaty. It is true that it said not a word about the questions of impressment, search and neutral rights, the grounds of the war; Great Britain did not abandon her position on any of them But everybody knew that circumstances had changed The new naval power whose frigates alone in the past 20 years had shown their ability to fight English frigates on equal terms was not likely to be troubled in future with the question of impressment; and in fact, while not renouncing the right, the British Government no longer attempted to enforce it.

End of Federal Party.—The remainder of this period is one of the barrenest in American history. The opposition of the Federalist Party to the war completed the measure of its unpopularity, and it had only a perfunctory existence for a few years longer Scandal, intrigue and personal criticism became the most marked characteristics of American politics until the dominant party broke at the end of the period, and real party conflict was renewed But the seeds of the final disruption are visible from the peace of 1814. The old-fashioned Republicans looked with intense suspicion on the new form of Republicanism generated by the war, a type which instinctively bent its energies toward the further development of national power Clay was the natural leader of the new Democracy, but John Quincy Adams and others of Federalist antecedents or leanings took to the new doctrines kindly; and even Calhoun, Crawford and others of the southern interest were at first strongly inclined to support them. One of the first effects was the revival of protection and of a national bank

The Bank.—The charter of the national bank had expired in 1811, and the dominant party had refused to recharter it. The attempt to carry on the war by loans resulted in almost a bankruptcy and in a complete inability to act efficiently. As soon as peace gave time for consideration, a second bank was chartered (April 10, 1816) for 20 years with a capital of $35,000,000, one-fifth of which was to be subscribed for by the national Govern-

ment. It was to have the custody of the Government revenues, but the secretary of the Treasury could divert the revenues to other custodians, giving his reasons for such action to Congress.

Protection.—Protection was advocated again on national grounds, but not quite on those which had moved Hamilton. The additional receipts were now to be expended for fortifications and other national defences, and for national roads and canals. The war and blockade had been an active form of protection, under which American manufactures had sprung up. As soon as peace was made English manufacturers drove their American rivals out of business or reduced them to desperate straits Their cries for relief had a double effect. They gave the spur to the nationalizing advocates of protection, and, as most of the manufacturers were in New England or New York, they developed in the citadel of Federalism a class which looked for help to a Republican Congress This was the main force which brought New England into the Republican fold before 1825. An increase in the number of spindles from 80,000 in 1811 to 500,000 in 1815, and in cotton consumption from 500 bales in 1800 to 90,000 in 1815, the rise of manufacturing towns, and the rapid development of the mechanical tendencies of a people who had been hitherto almost exclusively agricultural, were influences which were to be reckoned with in the politics of a democratic country

Tariff of 1816.—The tariff of 1816 imposed a duty of about 25% on imports of cotton and woollen goods, and specific duties on iron imports, except pig-iron, on which there was an *ad valorem* duty of 20% In 1818 this duty also was made specific (50 cents a cwt) The *ad valorem* duties carried most of the manufacturers through the financial crisis of 1818–19, but the iron duties were less satisfactory In English manufacture the substitution of coke for charcoal in iron production led to continual decrease in price. As the price went down the specific duties were continually increasing the absolute amount of protection Thus spared the necessity for improvements in production, the American manufacturers felt English competition more keenly as the years went by, and called for more protection.

Era of Good Feeling.—James Monroe succeeded Madison as President in 1817, and, re-elected with hardly any opposition in 1820, he served until 1825 So complete was the supremacy of the Republican Party that this is often called "the era of good feeling." It came to an end when a successor to Monroe was to be elected; the two sections of the dominant party then had their first opportunity for open struggle During Monroe's two terms of office the nationalizing party developed the policy on which it proposed to manage national affairs. This was largely the product of the continually swelling western movement of population. The influence of the steamboat was felt more and more every year, and the want of a similar improvement in land transport was correspondingly evident. The attention drawn to western New York by the war had filled that part of the State with a new population The southern Indians had been completely overthrown by Andrew Jackson during the war of 1812, and forced to cede their lands The admission of the new States of Indiana (1816), Mississippi (1817), Illinois (1818), Alabama (1819), Maine (1820) and Missouri (1821)—all but Maine the product and evidence of western growth—were the immediate results of the development consequent upon the war. All the territory east of the Mississippi, except the northern part of the North-west Territory, was now formed into self-governing States; the State system had crossed the Mississippi; all that was needed for further development was the locomotive engine. The 4,000,000 of 1790 had grown into 13,000,000 in 1830

The "American System."—The urgent demand of western settlers for some road to a market led to a variety of schemes to facilitate intercourse between the east and the west—the most successful being that completed in New York in 1825, the Erie canal. The Hudson river forms the great natural breach in the barrier range which runs parallel to the Atlantic coast. When the traveller has passed up the Hudson through that range he sees before him a vast champaign country extending westward to the Great Lakes, and perfectly adapted by nature for a canal. Such a canal, to turn western traffic into the lake rivers and through the lakes, the canal, and the Hudson to New York city, was begun by the State through the influence of De Witt Clinton. It was derisively called "Clinton's big ditch" until its completion laid the foundations for the great commercial prosperity of New York State and city. Long before it was finished the evident certainty of its success had enticed other States into far less successful enterprises of the kind and had established as a nationalizing policy the combination of high tariffs and expenditures for internal improvements which was long known as the "American system." The tariffs or duties on imports were to be carried as high as revenue results would justify; the superabundant revenues were to be expended on enterprises which would tend to aid the people to subdue the continent. Protection was now to be for national benefit, not for the benefit of classes Western farmers were to have manufacturing towns at their doors, as markets for the surplus which had hitherto been rotting on their farms; competition among manufacturers was to keep down prices; and Henry Clay's eloquence was to commend the whole policy to the people. The old democracy, particularly in the south, insisted that the whole scheme really had its basis in benefits to classes, that its communistic features were not such as the Constitution meant to cover by its grant of power to Congress to levy taxation for the general welfare The dissatisfaction in the South rose higher when the tariffs were increased in 1824 and 1828 The proportion of customs revenue to dutiable imports rose to 37% in 1825 and to 44% in 1829; and the ratio to aggregate imports to 33% in 1825 and 37% in 1829

The Monroe Doctrine.—In international relations the action of the Government was strong, quiet and self-respecting Its first weighty action took place in 1823 It had become pretty evident that the Holy Alliance meant to aid Spain in bringing her revolted South American colonies to obedience. Great Britain had been drifting steadily away from the alliance, and George Canning, the new secretary, determined to call in the weight of the transatlantic power as a check upon it A hint to the American minister was followed by a few pregnant passages in Monroe's annual message in December. "We could not view," he said, "any interposition for the purpose of oppressing them [the South American States], or controlling in any other manner their destiny by any European power, in any other light than as the manifestation of an unfriendly disposition towards the United States" If both the United States and Great Britain were to take this ground the fate of a fleet sent by the Alliance across the Atlantic was not in much doubt, and the project was at once given up.

It was supposed at the time that Spain might transfer her colonial claims to some stronger power; and Monroe therefore said that "the American continents, by the free and independent condition which they have assumed and maintained, are henceforth not to be considered as subjects for future colonization by any European powers" This declaration and that quoted above constitute together the "Monroe Doctrine" as originally proclaimed The doctrine has remained the rule of foreign intercourse for all American parties

Oregon.—By a treaty with Russia (1825) that power gave up all claims on the Pacific coast south of the present limits of Alaska. The northern boundary of the United States had been defined by the treaty of 1783; and, after the acquisition of Louisiana, a convention with Great Britain (1818) settled the boundary on the line of 49° N. lat as far west as the Rocky Mountains. West of these mountains the so-called Oregon country, on whose limits the two powers could not agree, was to be held in common possession for ten years. This common possession was prolonged by another convention (1827) indefinitely, with the privilege to either power to terminate it, on giving 12 months' notice. This arrangement lasted until 1846.

Election of 1824.—Monroe's term of office came to an end in March 1825. He had originally been an extreme Democrat, who could hardly speak of Washington with patience; he had slowly modified his views, and his tendencies were now eagerly claimed by the few remaining Federalists as identical with their own. All the candidates for the Presidency in 1824—Andrew Jackson, a private citizen of Tennessee; William H. Crawford, Monroe's

secretary of the treasury; John Quincy Adams, his secretary of State; and Henry Clay, the Speaker of the House of Representatives—claimed to be Republicans alike; but the personal nature of the struggle was shown by the tendency of their supporters to call themselves "Adams men" or "Jackson men," rather than by any real party title. Calhoun was supported by all groups for the vice presidency, and was elected without difficulty. The choice of a president was more doubtful.

Party Changes.—None of the four candidates had anything like a party organization behind him. Adams and Clay represented the nationalizing element, as Crawford and Jackson did not, but there the likeness among them stopped. The strongest forces behind Adams were the new manufacturing and commercial interests of the East; behind Clay were the desires of the West for internal improvements· and the two elements were soon to be united into the National Republican or Whig Party. Crawford was the representative of the old Democratic Party, with all its Southern influences and leanings. Jackson was the personification of the new democracy—not very cultured, perhaps, but honest, and hating every shade of class control instinctively As he became better known the whole force of the new drift of things turned in his direction Crawford was taken out of the race, just after the electors had cast their votes, by physical failure, and Adams, later, by the revival of ancient quarrels with the Federalists of New England, and the future was to be with Clay or with Jackson But in 1824 the electors gave no one a majority; and the House of Representatives, voting by States, gave the presidency to Adams.

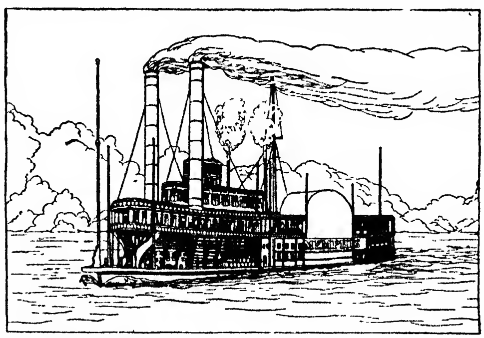
Adams' election in 1825 was due to the fact that Clay's friends in the House—unable to vote for him, as he was the lowest in the electoral vote, and only three names were open to choice in the House—very naturally gave their votes to Adams As Adams appointed Clay to the leading position in his cabinet, the defeated party at once raised the cry of "bargain and intrigue," one of the most effective in a democracy, and it was kept up throughout Adams' four years of office Jackson had received the largest number of electoral votes, though not a majority and the hazy notion that he had been injured because of his devotion to the people increased his popularity. Though demagogues made use of it for selfish purposes, this feeling was an honest one, and Adams had nothing to oppose to it. He tried vigorously to uphold the "American system," and succeeded in passing the tariff of 1828; he tried to maintain the influence of the United States on both the American continents; but he remained as unpopular as his rival grew popular In 1828 Adams was easily displaced by Jackson, the electoral vote being 178 to 83. Calhoun was reelected vice president.

Triumph of Jackson.—Jackson's inauguration in 1829 closes this period, as it ends the time during which a disruption of the Union by the peaceable withdrawal of any State was even possible. The party which had made State sovereignty its bulwark in 1798 was now in control of the Government again; but Jackson's proclamation in his first term, in which he warned South Carolina that "disunion by armed force is treason," and that blood must flow if the laws were resisted, speaks a very different tone from the speculations of Jefferson on possible future divisions of the United States. Even the sudden attempt of South Carolina to exercise independent action shows that some interest dependent upon State sovereignty had taken alarm at the drift of events, and was anxious to lodge a claim to the right before it should slip from its fingers for ever.

Slavery.—When the vast territory of Louisiana was acquired in 1803 the new owner found slavery already established there. Congress tacitly ratified existing law by taking no action; slavery continued legal, and spread further through the territory; and the State of Louisiana entered as a slave State in 1812. The next State to be carved out of the territory was Missouri, admitted in 1821. A territory, on applying for admission as a State, brings a Constitution for inspection by Congress; and when it was found that the new State of Missouri proposed to recognize and continue slavery, a vigorous opposition spread through the North and West, and carried most of the senators and representatives from those sections with it In the House of Representatives these two sections had a greatly superior number of members; but, as the number of Northern and Southern States had been kept about equal, the compact Southern vote, with one or two Northern allies, generally retained control of the Senate. Admitted by the Senate and rejected by the House, Missouri's application hung suspended for two years until it was successful by the admission of Maine, a balancing Northern State, and by the following arrangement, known as the Missouri Compromise of 1820· Missouri was to enter as a slave State; slavery was forever prohibited throughout the rest of the Louisiana Purchase north of lat 36° 36′, the main southern boundary of Missouri; and, though nothing was said of the territory south of the compromise line, it was understood that any State formed out of it was to be a slave State, if it so wished. Arkansas entered under this provision in 1836.

The question of slavery was thus set at rest for the present, though a few agitators were roused to more zealous opposition to the essence of slavery itself In the next decade these agitators succeeded only in the conversion of a few recruits, but these recruits were the ones who took up the work at the opening of the next period It is plain now, however, that North and South had already drifted so far apart as to form two sections, and it became evident during the next forty years that the wants and desires of these two sections were so divergent that it was impossible for one Government to make satisfactory laws for both

The Settled Area.—The vast flood of human beings which had been pouring westward for years had now pretty well occupied the territory east of the Mississippi, while, on the west side of that stream, it still showed a disposition to hold to the river valleys The settled area had increased from 240,000sq m in 1790 to 633,000sq m in 1830, with an average of 20·3 persons to the sq mile There was still a great deal of Indian territory in the Southern States of Georgia, Alabama, Mississippi and Florida, for the Southern Indians were among the finest of their race; they had become semi-civilized, and were formidable antagonists to the encroaching white race The States interested had begun preparations for their forcible removal, in public defiance of the attempts of the Federal Government to protect the Indians



BY COURTESY OF S KENNEDY AND CO

A MISSISSIPPI RIVER STEAM BOAT IN THE EARLY DAYS

Before the advent of the steamboat the river trip from Louisville to New Orleans consumed from three to four months In 1820 steamboats made the trip in less than 20 days; and in 1838, in 6 days. This improved facility of transportation was influential in increasing the population of the Mississippi Valley

(1827); but the removal was not completed until 1835. In the North, Wisconsin and Michigan, with the northern halves of Illinois and Indiana, were still very thinly settled, but everything indicated early increase of population. The first lake steamboat, the "Walk-in-the-Water," had appeared at Detroit in 1818, and the opening of the Erie canal in 1825 added more vessels.

The land system of the United States had much to do with the early development of the West From the first settlement, the universally recognized rule had been that of absolute individual property in land, with its corollary of unrestricted competitive

or "rack" rents; and this rule was accepted fully in the national land system. The public lands were to be divided into "hundreds" each ten miles square and containing 100 mile-square plots. The hundred was called a "township," and was afterwards reduced to six miles square, of 36 mile-square plots of 640ac. each. From time to time principal meridians and east and west base lines have been run, and townships have been determined by their relations to these lines. The price fixed in 1790 as a minimum was $2 per ac ; in 1820 it was reduced to $1.25 per ac.; it has tended to decrease, and no effort has ever been made to gain a revenue from it. When the nation acquired its western territory it secured its title to the soil, and always made it a fundamental condition of the admission of a new State that it should not tax United States lands. To compensate the new States for the freedom of unsold public lands from taxation, one township in each 36 was reserved to them for educational purposes; and the excellent public school systems of the Western States have been founded on this provision. The cost of obtaining a quarter section (160ac), under the still later homestead system of granting lands to actual settlers, came to be only about $26 to cover fees for filing claim and granting title; the interest on this, at 6%, represents an annual rent of one cent per acre—making this, says F A. Walker, as nearly as possible the "no-rent land" of the economists.

The bulk of the early westward migration was of home production; the great immigration from Europe did not begin until about 1847. The West as well as the East thus had its institutions fixed before being called upon to absorb an enormous foreign element.

Industrial Development and Sectional Divergence, 1829–50.—The years 1829–37 have been called "the reign of Andrew Jackson"; his popularity, long struggle for the presidency, and his feeling of his official ownership of the subordinate offices gave to his administration at least an appearance of Caesarism. But it was a strictly constitutional Caesarism; the restraints of written law were never violated, though the methods adopted within the law were new to national politics. Since about 1800 State politics in New York and Pennsylvania had been noted for the systematic political use of the offices. The presence of New York and Pennsylvania politicians in Jackson's cabinet taught him to use the same system. Removals, except for cause, had been relatively rare before; but under Jackson men were removed almost exclusively for party purposes and a clean sweep was made in the civil service. Other parties adopted the system, and it remained the rule at a change of administration until near the end of the century.

Parties.—The system brought with it a semi-military reorganization of parties. Hitherto nominations for the more important offices had been made mainly by legislative caucuses; candidates for president and vice-president were nominated by caucuses of congressmen, and candidates for the higher State offices by caucuses of the State legislatures. Late in the preceding period "conventions" of delegates from the members of the party in the State were held in New York and Pennsylvania; and in 1831–32 this became the rule for presidential nominations. It rapidly developed into systematic State, county and city "conventions"; and the result was the appearance of that complete political machinery, the American political party. The Democratic machinery was the first to appear, in Jackson's second term (1833–37). Its workers were paid in offices, or hopes of office, so that it was said to be built on the "cohesive power of public plunder"; but its success was immediate and brilliant. The opposing party, the Whig Party, had no chance of victory in 1836; and its complete overthrow drove its leaders into the organization of a similar machinery of their own, which scored its first success in 1840.

Bank of the U.S.—The Bank of the United States had hardly been heard of in politics until the new Democratic organization came into hostile contact with it. A semi-official demand upon it for a political appointment was met by a refusal; and the party managers called Jackson's attention to an institution which he could not but dislike the more he considered it. His first message spoke of it in unfriendly terms, and every succeeding message brought a more open attack. The old party of Adams and Clay had by this time taken the name of Whigs, probably from the notion that they were struggling against "the reign of Andrew Jackson," and they adopted the cause of the bank with eagerness. The bank charter did not expire until 1836, but in 1832 Clay brought up a bill for a new charter. It was passed and vetoed; and the Whigs made the veto an important issue of the presidential election of that year. They were beaten; Jackson was re-elected, receiving 219 electoral votes, and Clay, his Whig opponent, only 49, and the bank party could never again get a majority in the House of Representatives. But the President could not obtain a majority in the Senate. He determined to take a step which would give him an initiative, and which his opponents could not induce both houses to unite in overriding or punishing. Taking advantage of the provision that the secretary of the Treasury might order the public funds to be deposited elsewhere than in the bank or its branches, he directed the secretary to deposit *all* the public funds elsewhere. Thus deprived of its great source of dividends, the bank fell into difficulties, became a State bank after 1836, and then went into bankruptcy.

All the political conflicts of Jackson's terms of office were close and bitter. Loose in his ideas before 1829, Jackson showed a steady tendency to adopt the strictest construction of the powers of the Federal Government, except in such official perquisites as the offices He grew into strong opposition to all traces of the "American system," and vetoed bills for internal improvements unsparingly; his feeling of dislike to all forms of protection is as evident, though he took more care not to make it too public.

Nullification. Calhoun and Jackson.—Calhoun and Jackson were of the same stock—Scottish-Irish—much alike in appearance and characteristics, Calhoun representing the trained and educated logic of the race, Jackson its instincts and passions. Jackson was led to break off his friendly relations with Calhoun in 1830, and he had been led to do so more easily because of the appearance of the doctrine of nullification which was generally attributed, correctly enough, to Calhoun Asserting, as the Republican Party of 1798 had done, the sovereign powers of each State, Calhoun held that, as a means of avoiding secession and violent struggle upon every occasion of the passage of an act of Congress which should seem unconstitutional to any State, the State might properly suspend or "nullify" the operation of the law within its jurisdiction. The passage of the tariff act of 1832, which organized and systematized the protective system, forced his party into action. A State convention in South Carolina on Nov. 24, 1832, declared the tariff act null, and made ready to enforce the declaration.

But the time was past when the power of a single State could withdraw it from the Union. The President issued a proclamation, warning the people of South Carolina against any attempt to carry out the ordinance of nullification; he ordered a naval force to take possession of Charleston Harbour to collect the duties under the act; he called upon Congress for additional executive powers, and Congress passed what nullifiers called the "bloody bill," putting the land and naval forces at the disposal of the president; and he is said to have announced, privately and profanely, his intention of making Calhoun the first victim of any open conflict. Affairs looked so threatening that an unofficial meeting of "leading nullifiers" agreed to suspend the operation of the ordinance until Congress should adjourn; whence it derived the right to suspend has never been stated.

Tariff of 1833.—The President had already asked Congress to reduce the duties; and many Democratic members of Congress, who had yielded to the popular clamour for protection, were very glad to use "the crisis" as an excuse for now voting against it. A compromise tariff act, scaling down all duties over 20% by one-tenth of the excess every two years until 1842, when the remaining excess over 20% should be dropped, was introduced by Clay and became law. Calhoun and his followers claimed this as all that the nullification ordinance had aimed at; and the ordinance was formally repealed. But nullification had received its death-blow, even those southern leaders who maintained the right of secession refused to recognize the right of a State to remain in the Union while nullifying its laws.

Railways.—All the internal conditions of the United States were completely altered by the introduction of railways. For 20

years past the Americans had been pushing in every direction which offered a hope of the means of reconciling vast territory with enormous population. Stephenson's invention of the locomotive came just in time, and Jackson's two terms of office marked the outburst of modern American life. The miles of railway were 23 in 1830, 1,098 in 1835, some 2,800 in 1840, and thereafter they about doubled every five years until 1860.

A railway map of 1840 shows a fragmentary system, designed mainly to fill the gaps left by the means of communication in use in 1830. One or two short lines run back into the country from Savannah and Charleston; another runs north along the coast from Wilmington to Baltimore; several lines connect New York with Washington and other points; and short lines elsewhere mark the openings which needed to be filled at once—a number in New England and the Middle States, three in Ohio and Michigan, and three in Louisiana. Year after year new inventions came in to increase and aid this development. The anthracite coal of the Middle States was now successfully applied to railways (1836), and to the manufacture of iron (1837) Steam navigation across the Atlantic was established in 1838. The telegraph came next, S. F B Morse's line being erected in 1844 No similar period in American history of the 19th century is so extraordinary for material development as the decade 1830–40. At its beginning the country was an overgrown type of colonial life; at its end American life had been shifted to entirely new lines, which it has since followed

Western Settlements.—The steamboat had aided western development, but the railway aided it far more The steamboat influenced the railway, and the railway gave the steamboat new powers Vacant places in the States east of the Mississippi were filling up; the long lines of emigrant wagons gave way to the new and better methods of transport. Chicago was but a frontier fort in 1832, within a half-dozen years it was a flourishing town, with eight steamers connecting it with Buffalo, with dawning ideas of its future development of railway connections Two new States, Arkansas and Michigan, were admitted (1836 and 1837). The population of Ohio grew from 900,000 to 1,500,000, that of Michigan from 32,000 to 212,000, and that of the country from 13,000,000 to 17,000,000, between 1830 and 1840.

Social Conditions.—With the change of material surroundings and possibilities came a steady amelioration of social conditions and a development of social ideals. Such features of the past as imprisonment for debt and the cruel indifference of old methods of dealing with crime began to disappear, the time was past when a State could use an abandoned copper mine as its State prison, as Connecticut had formerly done The domestic use of gas and anthracite coal, the introduction of expensive aqueducts for pure water, and the changing life of the people forced changes in the interior and exterior of American dwellings Wood was still the common building material; imitations of Greek architecture still retained their vogue; but the interiors were models of comfort in comparison with the houses even of 1810. In the "new" regions this was not yet the case, and here social restraints were still so few that society seemed to be reduced almost to its primitive elements. Western steamers reeked with gambling, swindling, duelling and every variety of vice Public law was almost suspended in some regions; and organized associations of counterfeiters and horse-thieves terrorized whole sections of the country. But this state of affairs was altogether temporary, as well as limited in its area; the older and more densely settled States had been well prepared for the change and had never lost command of the social forces, and the process of settling down went on, even in the newer States, with far more rapidity than could have been expected.

Literature.—A distinct American literature dates from this period. Most of the publications in the United States were still cheap reprints of foreign works; but native productions no longer followed foreign models with servility. Between 1830 and 1840 Whittier, Longfellow, Holmes, Poe, Hawthorne, Emerson, Bancroft and Prescott joined the advance-guard of American writers —Bryant, Dana, Halleck, Drake, Irving and Cooper; and even those writers who had already made their place in literature showed the influence of new conditions by their growing tendency to look less to foreign models and methods. Popular education was improved. The new States had from the first endeavoured to secure the best possible system of common schools The attempt came naturally from the political instincts of the class from which the migration came; but the system which resulted was to be of incalculable service during the years to come Their absolute democracy and their universal use of the English language have made the common schools most successful machines for converting the raw material of immigration into American citizens This supreme benefit is the basis of the system and the reason for its existence and development, but its incidental advantage of educating the people has been beyond calculation It was an odd symptom of the general change that American newspapers took a new form during these ten years. The old "blanket-sheet" newspaper, cumbrous to handle and slow in all its ways, met its first rival in the type of newspaper which appeared first in New York city, in the *Sun*, the *Herald* and the *Tribune* (1833, 1835 and 1841). Swift and energetic in gathering news, and fearless, sometimes reckless, in stating it, they brought into American life, with very much that is evil, a great preponderance of good.

Speculation.—The chaos into which a part of American society had been thrown had a marked effect on the financial institutions of the country, which went to pieces before it for a time. It had not been meant to make the public lands of the United States a source of revenue so much as a source of development. The sales had touched their high-water mark during the speculative year 1819, when receipts from them had amounted to $3,274,000, in other years they seldom went above $2,000,000 When the railway set the stream of migration moving faster than ever, and cities began to grow like mushrooms, it was natural that speculation in land should feel the effects. Sales rose to $3,200,000 in 1831, and to $25,000,000 in 1836. In 1835 the President announced to Congress that the public debt was extinguished, and that some way of dealing with the surplus should be found Calhoun's proposal, that after the year 1836 any surplus in excess of $5,000,000 should be divided among the States as a loan, was adopted, as regards the surplus (almost $37,000,000) of that year; and some $28,000,000 were actually distributed before the crisis of 1837 put an end to the surplus and to the policy The States had already taken a hand in the general speculation by beginning works of public improvement. Foreign, particularly English, capital was abundant, and States which had been accustomed to think a dozen times over a tax of $100,000 now began to negotiate loans of millions of dollars and to appropriate the proceeds to the digging of canals and the construction of railways. Their enterprises were badly conceived and badly managed. The imaginations of individuals ran riot. Every one wanted to buy, prices rose, and every one was growing richer on paper. The assessed value of real estate in New York city in 1832 was $104,000,000, in 1836 it had grown to $253,000,000. In Mobile the assessed value rose from $1,000,000 to $27,000,000

When Jackson in 1833 ordered the Government revenues to be deposited elsewhere than in the Bank of the United States, there was no Government agent to receive them. The secretary of the Treasury selected banks at various points in which the revenue should be deposited by the collecting officers, but these banks were organized under charters from their States The Democratic feeling was that the privilege of forming banking corporations should be open to all citizens, and it soon became so Moreover, it was not until after the crash that New York began the system of compelling such deposits as would really secure circulation. In most of the States banks could be freely organized with or without tangible capital, and their notes could be sent to the West for the purchase of Government lands, which needed to be held but a month or two to gain a handsome profit "Wild-cat banks" sprang up all over the country; and the "pet banks," as those chosen for the deposit of Government revenues were called, went into speculation as eagerly as the banks which hardly pretended to have capital.

Panic of 1837.—The Democratic theory denied the power of Congress to make anything but gold or silver coin legal tender There have been "paper-money heresies" in the party, but there was none such among the new school of Democratic leaders which came in in 1829, they were "hard-money men." In July 1836

Jackson's secretary of the Treasury ordered land agents to take nothing in payment for lands except gold or silver. In the following spring the full effects of the order became evident; they fell on the administration of Van Buren, Jackson's successor. Van Buren had been Jackson's secretary of State, the representative man of the new Democratic school, and it seemed to the Whigs poetic justice that he should bear the weight of his predecessor's errors The "specie circular" turned the tide of paper back to the East, and when it was presented for payment most of the banks suspended specie payment. There was no longer a thought of buying; everyone wanted to sell, and prices ran down with a rapidity even more startling than that with which they had risen Failures on a scale unprecedented in the United States made up the "panic of 1837." Many of the States had left their bonds in the hands of their agents, and, on the failure of the agents, found that the bonds had been hypothecated or disposed of, so that the States got no return from them except a debt which was to them enormous Saddled suddenly with such a burden, and unable even to pay interest, some of the States "repudiated" their obligations; and repudiation was made successful by the fact that a State could not be sued except by its own consent Even the U S Government felt the strain, for its revenues were locked up in suspended banks A little more than a year after Congress had authorized the distribution of its surplus revenues among the States, Van Buren was forced to call it into special session to provide some relief for the Government itself

The Sub-treasury.—Van Buren held manfully to the strictest construction of the powers of the Federal Government. He insisted that the panic would best right itself without Government interference, and, after a four years' struggle, he succeeded in making the "sub-treasury scheme" law (1840) It cut off all connection of the Government with banks, putting collecting and disbursing officers under bonds to hold money safely and to transfer it under orders from the Treasury, and restricting payments to or by the United States to gold and silver coin Its passage had been preceded by another commercial crisis (1839), more limited in its field, but more discouraging to the people

Election of 1840.—Van Buren's firmness was unpopular, and the Whig Party now adopted methods which were popular if somewhat demagogical It nominated William H. Harrison in 1840, it contrasted his homely frontier virtues with Van Buren's "ostentatious indifference to the misfortunes of the people" and after the first of the modern "campaigns" of mass meetings and processions Harrison was elected, receiving 234 electoral votes and Van Buren only 60. He died only a month after his inauguration, and the vice-president, John Tyler, became President.

Tyler was of the extreme Calhoun school, which had shown some disposition to grant to Van Buren a support which it had refused to Jackson, and the Whigs had nominated Tyler to retain his faction with them Now he was the nominal leader of the party, while his politics were opposite to theirs, and the real leader of the party, Clay, was ready to force a quarrel upon him. The quarrel took place, the Whig majority in Congress was not large enough to pass any measures over Tyler's veto, and the first two years of his administration were passed in barren conflict with his party. The "sub-treasury" law was repealed (1841); the tariff of 1842 introduced a modified protection; and there the Whigs were forced to stop. Their dissensions made Democratic success comparatively easy. The success of the Democratic machinery, and the reflex of its temporary check in 1840, with the influences brought to bear on it by the returning Calhoun faction, were such as to take the control of the party out of the hands of the leaders who had formed it They had had high regard for political principle, even though they were willing to use doubtful methods for its propagation, these methods had now brought out new men, who looked mainly to success, and to close connection with the controlling political element of the South as the easiest means of attaining success. When the Democratic convention of 1844 met it was expected to renominate Van Buren, but James K. Polk was nominated. The Whigs nominated Clay.

Abolitionist Movement.—The beginning of the abolitionist movement in the United States, the establishment of the *Liberator* (1831), and of the American Anti-slavery Society (1833), and the subsequent divisions in it, are dealt with elsewhere (*see* GARRISON, WILLIAM LLOYD). Up to that time "abolition" had meant *gradual* abolition; Garrison called for *immediate* abolition. The basis of the American system was in the reserved rights of the States, and slavery rested on their will. The mission of the Abolitionists was to force the people to think of the question; and, in spite of riots, assaults and persecution of every kind, they fulfilled it manfully. In truth, slavery was more and more out of harmony with the new economic conditions which were taking complete control of the North and West, but had hardly been felt in the South Thus the two sections, North and South, were more and more disposed to take opposite views of everything in which slavery was involved, and it had a faculty of involving itself in almost everything The status of slavery in the Territories had been settled in 1820; that of slavery in the States had been settled by the Constitution; but even in minor questions the intrusive element had to be reckoned with The Abolitionists sent their documents through the mails, and the South wished the Federal Government to stop the practice. The Abolitionists persisted in petitioning Congress for the passage of various measures which Congress regarded as utterly unconstitutional; and the disposition of Congress to deny or regulate the right of petition in such matters excited the indignation of Northern men who had no sympathy with abolition. But the first occasion on which the views of the two sections came into flat contrast was on the question of the annexation of Texas.

Texas and Oregon.—The United States had had a vague claim to Texas until 1819, when the claim was surrendered to Spain in part compensation for Florida On the revolt of Mexico, Texas became a part of that republic It was colonized by Americans, mainly southerners and slave-holders, seceded from Mexico in 1835, and defeated the Mexican armies and established its independence in the following year. Southern politicians desired its annexation to the United States. People in the North were either indifferent or hostile to the proposal, Van Buren had declared against it, and his action was a reason for his defeat in the Democratic convention On the other hand, there were indications that the joint occupation of the Oregon country could not last much longer American immigration into it had begun, while the Hudson's Bay Company, the British tenant of the soil was the natural enemy of immigration The two points were coupled; and the Democratic convention declared for the reannexation of Texas and the reoccupation of Oregon.

Election of 1844.—One of the cardinal methods of the political Abolitionists was to nominate candidates of their own against a doubtful friend, even though this secured the election of an open enemy. Clay's efforts to guard his condemnation of the Texas annexation project were just enough to push the Liberty party, the political Abolitionists, into voting for candidates of their own in New York; on a close vote their loss was enough to throw the electoral votes of that State to Polk, and its votes decided the result. Polk was elected (Nov 1844); and Texas was annexed to the United States in the following spring. At the next meeting of Congress (1845) Texas was admitted as a State.

West of Texas the northern prolongation of Mexico ran right athwart the westward movement of American population; and though the movement had not yet reached the barrier the Polk Administration desired further acquisitions from Mexico. The western boundary of Texas was undefined; a strip of territory claimed by Texas was settled exclusively by Mexicans; but the Polk Administration directed Gen. Zachary Taylor, the American commander in Texas, to cross the Nueces river and seize the disputed territory. Collisions with Mexican troops followed; they were beaten in the battles of Palo Alto and Resaca de la Palma, and were chased across the Rio Grande. Taylor followed and took the city of Monterrey.

War with Mexico.—On the news of the first bloodshed, Congress declared war against Mexico, over the opposition of the Whigs. A land and naval force took possession of California, and a land expedition occupied New Mexico, so that the authority of Mexico over all the soil north of her present boundaries was

abruptly terminated (1846). At the opening of 1847 Taylor fought the last battle in northern Mexico (Buena Vista), defeating the Mexicans, and Gen. Winfield Scott, with a new army, landed at Vera Cruz for a march upon the City of Mexico. Scott's march was marked by one successful battle after another, usually against heavy odds; and in September he took the capital city and held it until peace was made (1848) by the Treaty of Guadalupe Hidalgo. Among the terms of peace was the cession of the present California, Utah, Arizona and New Mexico, the consideration being a payment of $15,000,000 by the United States and the assumption of some $3,000,000 of debts due by Mexico to American citizens. With a subsequent rectification of frontier (1853) by the Gadsden Treaty (*see* GADSDEN, JAMES), this cession added some 500,000sq m to the area of the United States; Texas itself made up a large additional area. The settlement of the north-east and north-west boundaries by the Webster-Ashburton and Buchanan-Pakenham treaties (1842, 1846) with the Texas and Mexican cessions, gave the United States the complete territorial form retained until the annexation of Alaska in 1867.

Slavery in the New Territory.—In the new territory slavery had been forbidden under Mexican law, and its annexation brought up the question of its status under American law If slavery was to be excluded from the new territory, the States which should ultimately be formed out of it would enter as free States, and the influence of the South in the Senate would be decreased For the first time the South appears as a distinct *imperium in imperio*

"Squatter Sovereignty."—The first appearance of these difficulties brought out in the Democratic Party a solution which was so closely in line with the prejudices of the party that it bade fair to carry the party through the crisis without the loss of its Southern vote This was "squatter sovereignty," the notion that it would be best for Congress to leave the people of each Territory to settle the question of the existence of slavery for themselves. The broader and democratic ground for the party would have been that which it at first seemed likely to take—the "Wilmot Proviso," a condition proposed to be added to the act authorizing acquisitions of territory, providing that slavery should be forbidden in all territory to be acquired under the act In the end apparent expediency carried the dominant party off to "squatter sovereignty," and the Democratic adherents of the Wilmot Proviso, with the Liberty Party and the anti-slavery Whigs, united in 1848 under the name of the Free Soil Party The Whigs had no solution to offer; their entire programme consisted in a persistent effort to evade or ignore all difficulties connected with slavery

Election of 1848.—Taylor, after the battle of Buena Vista, resigned and came home, considering himself ill-used by the Administration He refused to commit himself to any party; and the Whigs were forced to accept him as their candidate in 1848. The Democrats nominated Lewis Cass; the "Free-Soilers" nominated Van Buren. Taylor was elected President, receiving 163 electoral votes, while Cass received 127. Taking office in March 1849, he had on his shoulders the whole burden of the territorial difficulties, aggravated by the discovery of gold in California and the sudden rise of population there. Congress was so split into factions that it could for a long time agree upon nothing; and the Californians, with the approval of the President, proceeded to form a Constitution and apply for admission as a State. They had so framed their Constitution as to forbid slavery, and this was really the application of the Wilmot Proviso to the richest part of the new territory, and the South felt that it had been robbed of the cream of what it alone had fought cheerfully to obtain.

Compromise of 1850.—The admission of California was not secured until Sept. 1850, soon after Taylor's sudden death (July 9), and then only by the addition of a bonus to Texas, the division of the rest of the Mexican cession into the Territories of Utah and New Mexico without prohibition of slavery, and the passage of a fugitive slave law. The slave trade, but not slavery, was forbidden in the District of Columbia. The whole was generally known as the Compromise Measures of 1850. Two of its features need notice As has been said, slavery was not mentioned in the act; and the status of slavery in the Territories was thus left uncertain. Congress can veto any legislation of a Territorial legislature but, in fact, the two houses of Congress were hardly ever able to unite on anything after 1850, and both these Territories did establish slavery before 1860, without a congressional veto The advantage here was with the South The other point, the fugitive slave law was a special demand of the South The Constitution contained clauses directing that fugitive criminals and slaves should be delivered up, on requisition, by the State to which they had fled. In the case of criminals the delivery was directed to be made by the executive of the State to which they had fled, in the case of slaves no delivering authority was specified, and an act of Congress in 1793 had imposed the duty on Federal judges or on local State magistrates. Some of the States had passed "personal liberty laws," forbidding or limiting the action of their magistrates in such cases, and the act of 1850 transferred the decision of such cases to United States commissioners, with the assistance of United States marshals.

Tariff of 1846.—The question of slavery had taken up so much time in Congress that its other legislation was comparatively limited The rates of postage were reduced to five and ten cents for distances less and greater than 300m. (1845); and the naval school at Annapolis was established in the same year. The military academy at West Point had been established as such in 1802. When the Democratic Party had obtained complete control of the Government, it re-established (by act of Aug 6, 1846), the "sub-treasury," or independent Treasury In the same year, a tariff bill was passed, it reduced duties, and moderated the application of the protective principle Apart from a slight reduction of duties in 1857, this remained in force till 1861.

New States.—Five States were admitted during the last ten years of this period. Florida (1845), Texas (1845), Iowa (1846), Wisconsin (1848) and California (1850). The early entrance of Iowa, Wisconsin and Florida had been due largely to Indian wars, after each of which the defeated Indians were compelled to cede lands The extinction of Indian titles in northern Michigan brought about the discovery of the great copper fields of that region Elsewhere settlement followed the lines already marked out, except in the new possessions on the Pacific coast, whose full possibilities were not yet known Railways in the Eastern States were beginning to show something of a connected system, in the South they had hardly changed since 1840, in the West they had been prolonged only on their original lines. The telegraph was brought into use in 1844; but it was not until the census of 1860 that its effects were seen in the fully connected network of railways which then covered the whole North and West.

Invention.—The sudden development of wealth in the country gave an impetus to the spirit of invention. Charles Goodyear's method of vulcanizing rubber (1839) had come into use Cyrus Hall McCormick had made an invention the results of which have been hardly less than that of the locomotive in their importance to the United States. He had patented a reaping machine in 1834, and this, further improved and supplemented by other inventions, had brought into play the whole system of agricultural machinery A successful sewing-machine came in 1846, the power-loom and the surgical use of anaesthetics in the same year; and the rotary press for printing in 1847.

The Mormons.—All the conditions of life were changing so rapidly it was natural that the minds of men should change with them This was the era of new sects, of communities, of transcendentalism in literature, religion and politics. The most successful of these was the sect of Mormons. They settled in Utah in 1847, calling their capital Salt Lake City, and spread through the neighbouring Territories They became a menace to the American system; their numbers were so great that it was against American instincts to deprive them of self-government, while their polygamy and total submission to their hierarchy made it impossible to erect them into a State having complete control of marriage and divorce. The difficulty was lessened by their renunciation of polygamy in 1890

The South.—The material development of the United States since 1830 had been extraordinary, but every year made it more evident that the South was not sharing in it It is plain now that

the fault was in her labour system: her only labourers were slaves, and a slave who was fit for anything better than field labour was *prima facie* a dangerous man. The divergence had as yet gone only far enough to awaken intelligent men in the South to its existence, and to stir them to efforts as hopeless as they were earnest, to find some artificial stimulus for Southern industries. In the next ten years the process was to show its effects on the national field

Slavery had put the South out of harmony with its surroundings Even in 1850, though they hardly yet were aware of it, the two sections had drifted so far apart that they were practically two different countries

The Slave Power.—The South remained much as in 1790; while other parts of the country had developed, it had stood still. The remnants of colonial feeling, of class influence, which advancing democracy had wiped out elsewhere, retained their force here. The ruling class had to maintain a military control over the labouring class, and a class influence over the poorer whites It had even secured in the Constitution provision for its political power in the representation given to three-fifths of the slaves. The 20 additional members of the House of Representatives were not simply a gain to the South; they were still more a gain to the "black districts," where whites were few, and the slave-holder controlled the district Slave-owners and slave-holders together, there were but 350,000 of them; but they had common interests, the intelligence to see them, and the courage to contend for them The first step of a rising man was to buy slaves, and this was enough to enroll him in the dominant class From it were drawn the representatives and senators in Congress, the governors and all the holders of offices over which the "slave power," as it came to be called, had control

Immigration.—Immigration into the United States was not an important factor in its development till about 1847. The immigrants, so late as 1820, numbered but 8,000 per annum; their number did not touch 100,000 till 1842, and then it fell for a year or two almost to half that number In 1847 it rose again to 235,000, in 1849 to 300,000, and in 1850 to 428,000; all told, more than 2,225,000 persons from abroad settled in the United States between 1847 and 1854 Leaving out the dregs of the immigration, which settled down in the seaboard cities, its best part was a powerful nationalizing force It had not come to any particular State, but to the United States, yet all the influences of this enormous immigration were confined to the North and West; the immigration avoided slave soil as if by instinct And as the sections began to differ further in aims and policy the North began to gain heavily in ability to ensure its success.

Congress.—Texas was the last slave State ever admitted; and, as it refused to be divided, the South had no further increase of numbers in the Senate. Until 1850 the admission of a free State had been so promptly balanced by the admission of a slave State that the senators of the two sections had remained about equal in number in 1860 the free States had 36 senators and the slave States only 30. As the representation in the House had changed from 35 free State and 30 slave State members in 1790 to 147 free State and 90 slave State in 1860, and as the number of presidential electors is the sum of the numbers of senators and representatives, political power had passed away from the South in 1850. If at any time the free States should unite they would be supreme

Tendencies to Disunion.—In circumstances so critical a cautious quiescence and avoidance of public attention was the only safe course for the "slave power," but that course had become impossible The numbers interested had become too large to be subject to complete discipline; not all could be held in cautious reserve; and when an advanced proposal came from any quarter of the slave-holding lines the whole army was shortly forced up to the advanced position. If collision came it must be on some question of the rights of the States; and on such a question the whole South would move as one man.

The Protestant churches of the United States had reflected in their organization the spirit of the political institutions under which they lived. Acting as purely voluntary associations, they had been organized into governments by delegates; much like the "conventions" which had been evolved in the political parties. The omnipresent slavery question intruded into these bodies, and split them. Only the Episcopal and Roman Catholic Churches retained their national character.

Party Changes.—The political parties showed the same tendency. Each began to shrivel up in one section or the other. The notion of "squatter sovereignty," attractive at first to the Western democracy, and not repudiated by the South, enabled the Democratic Party to pass the crisis of 1850 without losing much of its Northern vote, while Southern Whigs began to drift in, making the party continually more pro-slavery This could not continue long without beginning to decrease its Northern vote, but this effect did not become plainly visible until after 1852. The efforts of the Whig Party to ignore the great question alienated its anti-slavery members in the North, while they did not satisfy its Southern members. The Whig losses were not at first heavy, but, as the electoral vote of each State is determined by the barest plurality they were enough to defeat the party almost everywhere in the presidential election of 1852. The Whigs nominated Gen Winfield Scott and the Democrats Franklin Pierce; Pierce carried all but four of the 31 States, and was elected, receiving 254 out of the 296 electoral votes. This revelation of hopeless weakness was the downfall of the Whig Party; it maintained its organization for four years longer, but the life had gone out of it The future was with the Free Soil Party, though it had polled but few votes in 1852

During the Administration of Taylor (and vice-president Millard Fillmore, who succeeded him) Clay, Webster, Calhoun, Polk and Taylor were removed by death, and there was a steady drift of other political leaders out of public life. New men were pushing in everywhere, and in both sections they showed the prevailing tendency to disunion. The best of them were unprecedentedly radical Charles Sumner, William H Seward and Salmon P Chase came into the Senate, bringing the first accession of recognized force and ability to the anti-slavery feeling in that body The new Southern men, such as Jefferson Davis, and the Democratic recruits from the Southern Whig Party, such as Alexander H. Stephens, were ready to take the ground on which Calhoun had always insisted—that Congress was bound not merely to the negative duty of not attacking slavery in the Territories, but to the positive duty of protecting it. This, if it should become the general Southern position, was certain to destroy the notion of "squatter sovereignty," and thus to split the Democratic Party, which was almost the last national ligament that now held the two fragments of the Union together.

Progress of Disunion.—The social disintegration was as rapid. Northern men travelling in the South were naturally looked upon with increasing suspicion, and were made to feel that they were on a soil alien in sympathies Some of the worst phases of democracy were called into play in the South; and, in some sections, law openly yielded supremacy to popular passion in the cases of suspected Abolitionists. Southern conventions, on all sorts of subjects, became common, and, permeated by a dawning sense of Southern nationality, hardly any proposition looking to Southern independence of the North was met with disfavour.

Calhoun, in his last and greatest speech, called attention to the manner in which one tie after another was snapping. But he ignored the real peril of the situation—its dangerous facts: that the South was steadily growing weaker in comparison with the North, and more unable to secure a wider area for the slave system; that it was therefore being steadily forced into demanding active Congressional protection for slavery in the Territories; that the North would never submit to this; and that the South must submit or bring about a collision by attempting to secede.

Kansas-Nebraska Act.—Anti-slavery feeling in the North was stimulated by the manner in which the fugitive slave law was enforced immediately after 1850. The chase after fugitive slaves was prosecuted in many cases with circumstances of revolting brutality. The added feeling showed its force when the Kansas-Nebraska Act was passed by Congress (1854). It organized the two new Territories of Kansas and Nebraska. Both of them were

forever free soil by the terms of the Missouri Compromise. But the success of the notion of squatter sovereignty in holding the Democratic Party together while destroying the Whig Party had intoxicated Stephen A. Douglas and other Northern Democrats; and they now applied the doctrine to these Territories. They did not desire "to vote slavery up or down," but left the decision to the people of the two Territories.

The Republican Party.—The Kansas-Nebraska Act was the grossest political blunder in American history. The status of slavery had been settled, by the Constitution or by the compromises of 1820 and 1850, on every square foot of American soil; right or wrong, the settlement was made The new act took a great mass of territory out of the settlement and flung it down as a prize for which the sections were to struggle. The first result of the act was to throw parties into chaos. An American or "Know-Nothing" Party, a secret oath-bound organization, pledged to oppose the influence or power of foreign-born citizens, had been formed to take the place of the defunct Whig Party. It had been quite successful in State elections for a time, and was now beginning to have larger aspirations. It, like the Whig Party, intended to ignore slavery, but, after a few years of life, the questions complicated with slavery divided it also. Even in 1854 many of its leaders in the North were forced to take position against the Kansas-Nebraska Act, while hosts of others joined in the opposition without any party organization. No American party ever rose so swiftly as this; with no other party name than the awkward title of "Anti-Nebraska men," it carried the congressional elections of 1854 in the North, forced many of the former Know-Nothing leaders into union with it, and controlled the House of Representatives of the Congress which met in 1855 The Democratic Party, which had been practically the only party since 1852, had now to face the latest and strongest of its broad-constructionist opponents. It acknowledged, at first, no purpose aimed at slavery, only an intention to exclude slavery from the Territories, but, under such principles, it was the only party which was potentially an anti-slavery party. The new party had grasped the function which belonged of right to its great opponent, and it seized with it its opponent's original title. The name Democrat had quite taken the place of that first used—Republican—but Republican had never passed out of popular remembrance and liking in the North The new party took quick and skilful advantage of this by assuming the old name, and early in 1856 the two great parties of the present—Democratic and Republican—were drawn up against one another.

Foreign Relations.—The foreign relations during Pierce's term of office were overshadowed by the domestic difficulties, but were of importance. In the Koszta case (1853) national protection had been afforded on foreign soil to a person who had taken only the preliminary steps to naturalization. Japan had been opened to American intercourse and commerce (1854). But the question of slavery was more and more thrusting itself even into foreign relations. A great Southern republic, to be founded at first by the slave States, but to take in gradually the whole territory around the Gulf of Mexico and include the West Indies, was soon to be a pretty general ambition among slave-holders, and its first phases appeared during Pierce's administration. Efforts were begun to obtain Cuba from Spain; and the three leading American ministers abroad, meeting at Ostend, united in declaring the possession of Cuba to be essential to the well-being of the United States (1854). "Filibustering" expeditions against Cuba or the smaller South American States, intended so to revolutionize them as to lay a basis for an application to be annexed to the United States, became common. But these yielded in importance to the affairs in Kansas.

Kansas.—Nebraska was then supposed to be a desert, and attention was directed almost exclusively to Kansas. No sooner had its organization left the matter of slavery to be decided by its "people" than the anti-slavery people of the North and West felt it to be their duty to see that the "people" of the Territory should be anti-slavery in sympathy. Emigrant associations were formed, and these shipped men and families to Kansas, arming them for their protection in the new country. Southern newspapers called for similar measures in the South, but the call was less effective. Southern men without slaves, settling a new State, were uncomfortably apt to prohibit slavery, as in California Only slave-holders were trusty pro-slavery men; and such were not likely to take slaves to Kansas and risk their ownership But for the people of Missouri, Kansas would have been free soil at once. Lying across the direct road to Kansas, the Missouri settlers blockaded the way of free-State settlers, crossed into Kansas, and voted profusely at the first Territorial election The struggle passed into a real civil war, the two powers fighting battles, capturing towns and paroling prisoners The struggle was really over in 1857, and the South was beaten There were, however, many obstacles yet to be overcome before the new State of Kansas was recognized by Congress, after the withdrawal of the senators of the seceding States (1861)

Election of 1856.—In the heat of the Kansas struggle came the presidential election of 1856 The Democrats nominated James Buchanan, declaring, as usual, for the strictest limitations of the powers of the Federal Government and reaffirming the principle of the Kansas-Nebraska act—the settlement of slavery by the people of a Territory The remnant of the Whig Party, including the Know-Nothings of the North and those Southern men who wished no further discussion of slavery, nominated Millard Fillmore. The Republican Party nominated John C Frémont; the bulk of its manifesto was taken up with protests against attempts to introduce slavery into the Territories; but it showed its broad-construction tendencies by declaring for appropriations of Federal moneys for internal improvements The Democrats were successful in electing Buchanan; but the position of the party was quite different from the triumph with which it had come out of the election of 1852. It was no longer master of 27 of the 31 States; all the free States but five had gone against it; its candidate no longer had a majority of the popular vote. For the first time in the history of the country a distinctly anti-slavery candidate had obtained an electoral vote, and had even come near obtaining the Presidency Fillmore had carried but one State, Maryland, Buchanan had carried the rest of the South, with a few States in the North, and Frémont the rest of the North and none of the South.

Dred Scott.—Oddly enough the constitutionality of the Compromise of 1820 had never happened to come before the Supreme Court for consideration In 1856–57 it came up for the first time. One Dred Scott, a Missouri slave who had been taken in 1834 to Illinois, a free State, and in 1836 to Minnesota, within the territory covered by the compromise, and had some years after being taken back to Missouri in 1838 sued for his freedom, was sold (1852) to a citizen of New York Scott then transferred his suit from the State to the Federal courts, under the power given them to try suits between citizens of different States, and the case came by appeal to the Supreme Court Its decision, announced on March 6, 1857, put Scott out of court on the ground that a slave, or the descendant of slaves, could not be a citizen of the United States or have any standing in Federal courts The opinion of Chief Justice Taney went on to attack the validity of the Missouri Compromise, for the reasons that one of the Constitutional functions of Congress was the protection of property, that slaves had been recognized as property by the Constitution, and that Congress was bound to protect, not to prohibit, slavery in the Territories Most of the Northern people held that slaves were looked upon by the Constitution not as property but as "persons held to service or labour" by State laws A large part of the North flouted the decision of the Supreme Court, and the storm of angry dissent which it aroused did the disunionists good service in the South From this time the leading newspapers in the South maintained that the radical Southern view first advanced by Calhoun, and but slowly accepted by other Southern leaders, as to the duty of Congress to protect slavery in the Territories, had been confirmed by the Supreme Court; that the Northern Republicans had rejected it; even the "squatter sovereignty" of Northern Democrats could no longer be submitted to by the South.

John Brown.—The population of the United States in 1860

was over 31,000,000, an increase of more than 8,000,000 in ten years. As the decennial increases of population became larger, so did the divergence of the sections in population, and still more in wealth and resources. Two more free States came in during this period—Minnesota (1858) and Oregon (1859)—and Kansas was clamouring loudly for the same privilege. The free and slave States, which had been almost equal in population in 1790, stood now as 19 to 12 And of the 12,000,000 in slave States, the 4,000,000 slaves and the 250,000 free blacks were not so much a factor of strength as a possible source of weakness and danger No serious slave rising had ever taken place in the South, but John Brown's attack (1859) on Harper's Ferry, as the first move in a project to rouse the slaves and the alarm which it carried through the South, were tokens of a danger which added a new horror to the chances of civil war.

Democratic Party Split.—Northern Democrats, under the lead of Douglas, had been forced already almost to the point of revolt by the determination of Southern senators to prevent the admission of Kansas as a free State, if not to secure her admission as a slave State. When the Democratic convention of 1860 met at Charleston the last strand of the last national political organization parted; the Democratic Party itself was split by the slavery question The Southern delegates demanded a declaration in favour of the duty of Congress to protect slavery in the Territories It was all that the Douglas Democrats could then do to maintain themselves in a few Northern States; such a declaration meant political suicide everywhere, and they voted it down. The convention divided into two bodies. The Southern body adjourned to Richmond, and the Northern and border State convention to Baltimore Here the Northern delegates, by seating some delegates friendly to Douglas, provoked a further secession of border State delegates, who, in company with the Richmond body, nominated John C Breckinridge and Joseph Lane for President and vice-president. The remainder of the original convention nominated Douglas and H V Johnson.

The remnant of the old Whig and Know-Nothing parties, now calling itself the Constitutional Union Party, met at Baltimore and nominated John Bell and Edward Everett The Republican convention met at Chicago Its "platform" of 1856 had been somewhat broad-constructionist but a strong Democratic element in the party had prevented it from going too far The election of 1856 had shown that, with the votes of Pennsylvania and Illinois, the party would have then been successful, and the Democratic element was now ready to take almost anything which would secure the votes of these States This state of affairs will go to explain the nomination of Abraham Lincoln, of Illinois, for President, with Hannibal Hamlin, a former Democrat, for vice-president, and the declaration of the platform in favour of a protective tariff. The mass of the platform was still devoted to the necessity of excluding slavery from the Territories

Election of 1860.—No candidate received a majority of the popular vote, Lincoln standing first and Douglas second But Lincoln and Hamlin had a clear majority of the electoral vote, and so were elected, Breckinridge and Lane coming next It is worthy of mention that, up to the last hours of Lincoln's first term of office, Congress would always have contained a majority opposed to him but for the absence of the members from the seceding States The interests of the South and even of slavery were thus safe enough under an anti-slavery president. But the drift of events was too plain. Nullification had come and gone, and the nation feared it no longer Even secession by a single State was now almost out of the question; the letters of Southern governors in 1860, in consultation on the state of affairs, agree that no State would secede without assurances of support by others. If this crisis were allowed to slip by without action, even a sectional secession would soon be impossible.

Secession.—In Oct. 1860 Gov. W. H. Gist of South Carolina sent a letter to the governor of each of the other cotton States except Texas, asking co-operation in case South Carolina should resolve upon secession, and the replies were favourable. The democratic revolution which, since 1829, had compelled the legislature to give the choice of presidential electors to the people of the States had not affected South Carolina; her electors were still chosen by the legislature. That body, after having chosen the State's electors on Nov. 6, remained in session until the telegraph had brought assurances that Lincoln had been elected; it then (on the 10th) summoned a State convention and adjourned The State convention on Dec. 20 unanimously passed an "ordinance of secession," repealing the acts by which the State had ratified the Constitution and its amendments, and dissolving "the union now subsisting between South Carolina and other states, under the name of the 'United States of America.'" The convention took all steps necessary to prepare for war, and adjourned. Similar ordinances were passed by conventions in Mississippi (Jan 9, 1861), Florida (Jan 10), Alabama (Jan. 11), Georgia (Jan. 19), Louisiana (Jan. 26) and Texas (Feb 1)

The Confederate States.—The opposition in the South did not deny the right to secede, but the expediency of its exercise. Their effort was to elect delegates to the State conventions who would vote not to secede. They were beaten, says A H Stephens, by the cry, originally uttered by T. R R Cobb before his State legislature (Nov 12, 1860), "We can make better terms out of the Union than in it" That is, the States were to withdraw individually, suspend the functions of the Federal government within their jurisdiction for the time, consider maturely any proposals for guarantees for their rights in the Union, and return as soon as satisfactory guarantees should be given When the conventions of the seceding States had adopted the ordinances of secession, they proceeded to other business They appointed delegates, who met at Montgomery, the capital of Alabama, formed a provisional Constitution (Feb 8) for the "Confederate States," chose a provisional President and vice-president (Jefferson Davis and A H Stephens), and established an Army, Treasury, and other executive departments. The president and vice-president were inaugurated on Feb 18 The permanent Constitution, adopted on March 11, was copied from that of the United States, with variations meant to maintain state Sovereignty, to give the Cabinet seats in Congress, and to prevent the grant of bounties or any protective features in the tariff or the maintenance of internal improvements at general expense; and it expressly provided that in all the territory belonging to the Confederacy but lying without the limits of the several States "the institution of negro slavery, as it now exists in the Confederate States, shall be recognized and protected by Congress and by the Territorial Government"

Under what claim of constitutional right all this was done passes comprehension That a State convention should have the final power of decision on the question which it was summoned to consider is quite as radical doctrine as has yet been heard of; that a State convention, summoned to consider the one question of secession, should go on, with no appeal to any further popular authority or mandate, to send delegates to meet those of other States and form a new National Government, which could only exist by warring on the United States, is a novel feature in American constitutional law. It was revolution or nothing. Only in Texas, where the call of the State convention was so irregular that a popular vote could hardly be escaped, was any popular vote allowed Elsewhere the functions of the voter ceased when he voted for delegates to the State convention.

The Border States.—The border States were in two tiers—North Carolina, Tennessee and Arkansas next to the seceding States, and Delaware, Maryland, Virginia, Kentucky and Missouri next to the free States. None of these was willing to secede. There was, however, one force which might draw them into secession. A State which did not wish to secede, but believed in State sovereignty and the abstract right of secession, would be inclined to take up arms to resist any attempt by the Federal Government to coerce a seceding State. In the following spring, the original seven seceding States were reinforced by four border States.

In the North and West surprisingly little attention was given to the systematic course of procedure along the Gulf. The people of those sections were very busy; they had heard much of this talk before, and looked upon it as a kind of stage thunder. Republican politicians, with the exception of a few, were inclined to refrain from public declarations of intention. Some of them such

as Seward, showed a disposition to let the "erring sisters" depart in peace, expecting to make the loss good by accessions from Canada. A few, like Senator Zachariah Chandler, believed that there would be "blood-letting," but most of them were still doubtful as to the future. In the North the leaders and the people generally shrank from the prospect of war. Among the various proposals to this end, that offered in the Senate by John J Crittenden, of Kentucky, and known as the Crittenden compromise, was perhaps received with most favour. This took the form of six proposed amendments to the Constitution, of which two were virtually a re-phrasing of the essential feature of the Missouri Compromise and of the principle of squatter sovereignty, and others provided that the National Government should pay to the owner of any fugitive slave, whose return was prevented by opposition in the North, the full value of such slave, and prohibited the abolition of slavery in the District of Columbia "so long as it exists in the adjoining states of Virginia and Maryland or either." This proposed compromise was rejected by the Senate by a close vote on March 2, 1861. A peace congress, called by Virginia, met in Washington from Feb 4 to 27, 1861, 21 States being represented, and proposed a constitutional amendment embodying changes very similar to those of the Crittenden compromise, but its proposal was not acted upon by Congress Congress did nothing, except to admit Kansas as a free State and adopt the protective Morrill tariff; even after its members from the seceding States had withdrawn, those who remained made no preparations for conflict, and, at their adjournment in March 1861, left the Federal Government naked and helpless

The War Governors.—The only sign of life in the body politic, the half-awakened word of warning from the Democracy of the North and West, was its choice of governors of States A remarkable group of men, soon to be known as the "war governors"—Israel Washburn of Maine, Erastus Fairbanks of Vermont, Ichabod Goodwin of New Hampshire, John Albion Andrew of Massachusetts, William Sprague of Rhode Island, William Alfred Buckingham of Connecticut, Edwin Dennison Morgan of New York, Charles Smith Olden of New Jersey, Andrew Gregg Curtin of Pennsylvania, William Dennison of Ohio, Oliver Perry Morton of Indiana, Richard Yates of Illinois, Austin Blair of Michigan, Alexander Williams Randall of Wisconsin, Samuel Jordan Kirkwood of Iowa, and Alexander Ramsey of Minnesota —held the executive powers of the Northern States in 1861–62 Some of these governors, such as Andrew and Buckingham, as they saw the struggle come nearer, went so far as to order the purchase of warlike material for their States on their private responsibility, and their action saved days of time

U.S. Property Seized.—The little Army of the United States had been almost put out of consideration; wherever its detachments could be found in the South they were surrounded and forced to surrender and were transferred to the North. After secession, and in some of the States even before it, the forts, arsenals, mints, custom-houses, shipyards and public property of the United States had been seized by authority of the State, and these were held until transferred to the new Confederate States organization

Only a few forts, of all the magnificent structures with which the nation had dotted the Southern coast, remained to it—the forts near Key West, Fortress Monroe at the mouth of Chesapeake Bay, Ft. Pickens at Pensacola and Ft. Sumter in Charleston Harbour. Both the last-named were beleaguered by hostile batteries, but the Administration of President Buchanan, intent on maintaining the peace until the new Administration should come in, instructed their commanding officers to refrain from any acts tending to open conflict. The Federal officers, therefore, were obliged to look idly on while every preparation was made for their destruction, and even while a vessel bearing supplies for Ft Sumter was driven back by the batteries between it and the sea.

The divergence between the two sections of the country had thus passed into disunion, and was soon to pass into open hostility. The legal recognition of the custom of slavery, acting upon and reacted upon by every step in their economic development and every difference in their natural characteristics and institutions, had carried North and South farther and faster apart, until the elements of a distinct nationality had appeared in the South

Secession had taken away many of the men who had for years managed the Federal Government, and who understood its workings Lincoln's party was in power for the first time; his officers were new to the routine of Federal Administration; and the circumstances with which they were called upon to deal were such as to daunt any spirit The Government had become so nearly bankrupt in the closing days of Buchanan's Administration that it had escaped only by paying double interest The Army had been almost broken up by captures of men and material and by resignations of competent and trusted officers The Navy had come to such a pass that, in Feb 1861, a House committee reported that only two vessels, one of 20, the other of two guns, were available for the defence of the entire Atlantic coast. And, to complicate all difficulties, a horde of clamorous office-seekers crowded Washington

Civil War, 1861–65.—Soon after Lincoln's Administration began, the starting of an expedition to provision Ft Sumter brought on an attack by the batteries around the fort, and after a bombardment of 36 hours the fort surrendered (April 14, 1861). It is not necessary to rehearse the familiar story of the outburst of feeling which followed this event and the proclamation of President Lincoln calling for volunteers The 75,000 volunteers called for were supplied three or four times over.

There had been some belief in the South that the North-west would take no part in the impending conflict, and that its people could be persuaded to keep up friendly relations with the new nationality In the spring months of 1861 Douglas, who had long been denounced as the tool of the Southern slave-holders, was spending the closing days of life in expressing the determination of the North-west that it would never submit to have "a line of custom-houses" between it and the ocean The batteries which Confederate authority was erecting on the banks of the Mississippi were fuel to the flame. California, considered neutral by all parties, pronounced as unequivocally for the national authority.

The shock of arms put an end to opposition in the South as well The peculiar isolation of life in the South precluded the more ignorant voter from any comparisons of the power of his State with any other; to him it was almost inconceivable that his State should own or have a superior The better educated men, of wider experience, had been trained to think State sovereignty the foundation of civil liberty, and, when their State spoke, they felt bound to "follow their State" The president of the Confederate States issued his call for men, and it also was more than met

The Border States.—Lincoln's call for troops met with an angry reception wherever the doctrine of State sovereignty had a foothold The governors of the border States generally returned it with a refusal to furnish any troops. Two States, North Carolina and Arkansas, seceded and joined the Confederate States In two others, Virginia and Tennessee, the State politicians formed "military leagues" with the Confederacy, allowing Confederate troops to take possession of the States and then submitted the question of secession to "popular vote" The secession of these States was thus accomplished, and Richmond became the Confederate capital. The same process was attempted in Missouri, but failed, and the State remained loyal The politician class in Maryland and Kentucky took the extraordinary course of attempting to maintain neutrality, but the growing power of the Federal Government soon enabled the people of the two States to resume control of their governments and give consistent support to the Union. Kentucky, however, had troops in the Confederate armies; and one of her citizens, the late vice-president, John C Breckinridge, left the Senate and became an officer in the Confederate service Delaware cast her lot from the first with the Union.

Civil War.—The first blood of the war was shed in the streets of Baltimore, when a mob attempted to stop Massachusetts troops on their way to Washington (April 19) For a time there was difficulty in getting troops through Maryland because of the active hostility of a part of its people, but this was overcome, and the national capital was made secure The Confederate lines had been pushed up to Manassas Junction, about 30m from Washington. When Congress, called into special session by the President for

July 4, came together, the outline of the Confederate States had been fixed. The length of the line, including also the Atlantic and Gulf coasts, has been estimated at 11,000 miles. The territory within it comprised about 800,000sq.m., with a population of over 9,000,000 and great natural resources. Its cotton was almost essential to the manufactories of the world; in exchange for it every munition of war could be procured; and it was hardly possible to blockade a coast over 3,000m. in length, on which the blockading force had but one port of refuge, and that at about the middle of the line. Nevertheless, President Lincoln issued his first call for troops on April 15. President Davis then issued a proclamation (on the 17th) offering letters of marque and reprisal against the commerce of the United States to private vessels, and on the 19th Lincoln answered with a proclamation announcing the blockade of the Southern coast. The news brought out proclamations of neutrality from Great Britain and France.

The President found himself compelled to assume powers never granted to the executive authority, trusting to the subsequent action of Congress to validate his action He had to raise and support armies and navies; he even had to authorize seizures of necessary property, of railroad and telegraph lines, arrests of suspected persons, and the suspension of the writ of *habeas corpus* in certain districts. Congress supported him, and proceeded in 1863 to give the President power to suspend the writ anywhere in the United States; this power he promptly exercised. The Supreme Court, after the war, in the Milligan case (4 Wallace, 133) decided that no branch of the Government had power to suspend the writ in districts where the courts were open—that the *privilege* of the writ might be suspended as to persons properly involved in the war, but that the writ was still to issue, the court deciding whether the person came within the classes to whom the suspension applied.

When Congress met (July 4, 1861) the absence of Southern members had made it heavily Republican It decided to consider no business but that connected with the war, authorized a loan and the raising of 500,000 volunteers, and made confiscation of property a penalty of rebellion While it was in session the first serious battle of the war—Bull Run, or Manassas—took place (July 21), and resulted in the defeat of the Federal Army.

The "Trent" Case.—The over-zealous action of a naval officer in taking the Confederate envoys James M Mason and John Slidell out of the British steamer "Trent" sailing between two neutral ports almost brought about a collision between the United States and Great Britain in November. But the American precedents were all against the United States, and the envoys were given up.

The broad-construction tendencies of the Republican party showed themselves more plainly as the war grew more serious; there was an increasing disposition to cut every knot by legislation, with less regard to the constitutionality of the legislation. A paper currency commonly known as "greenbacks," was adopted and made legal tender (Feb. 25, 1862). Slavery was prohibited (April 16) in the District of Columbia and the Territories (June 19); the Army was forbidden to surrender escaped slaves to their owners; and slaves of insurgents were ordered to be confiscated. In addition to a homestead act giving public lands to actual settlers at reduced rates, Congress began a further development of the system of granting public lands to railways. Another important act (1862) granted public lands for the establishment of agricultural and mechanical colleges.

Railways.—The railway system of the United States was but 20 years old in 1850, but it had begun to assume some consistency. The day of short and disconnected lines had passed, and the connections which were to develop into railway systems had appeared. Consolidation of smaller companies had begun; the all-rail route across the State of New York was made up of more than a dozen original companies at its consolidation in 1853. The Erie railway, chartered in 1832, was completed from Piermont to Dunkirk (N.Y.), in 1851; and another line—the Pennsylvania—was completed from Harrisburg to Pittston (Pa.), in 1854. These were at least the germs of great trunk lines. The cost of American railways has been only from one-half to one-fourth of the cost of European railways; but an investment in a Far-western railway in 1850–60 was an extra-hazardous risk. Not only did social conditions make any form of business hazardous; the new railway often had to enter a territory bare of population, and there create its own towns, farms and traffic. Whether it could do so was so doubtful as to make additional inducements to capital necessary. The means attempted by Congress in 1850, in the case of the Illinois Central railroad, was to grant public lands to the corporation, reserving to the United States the alternate sections. At first grants were made to the States for the benefit of the corporations; the act of 1862 made the grant directly to the corporation

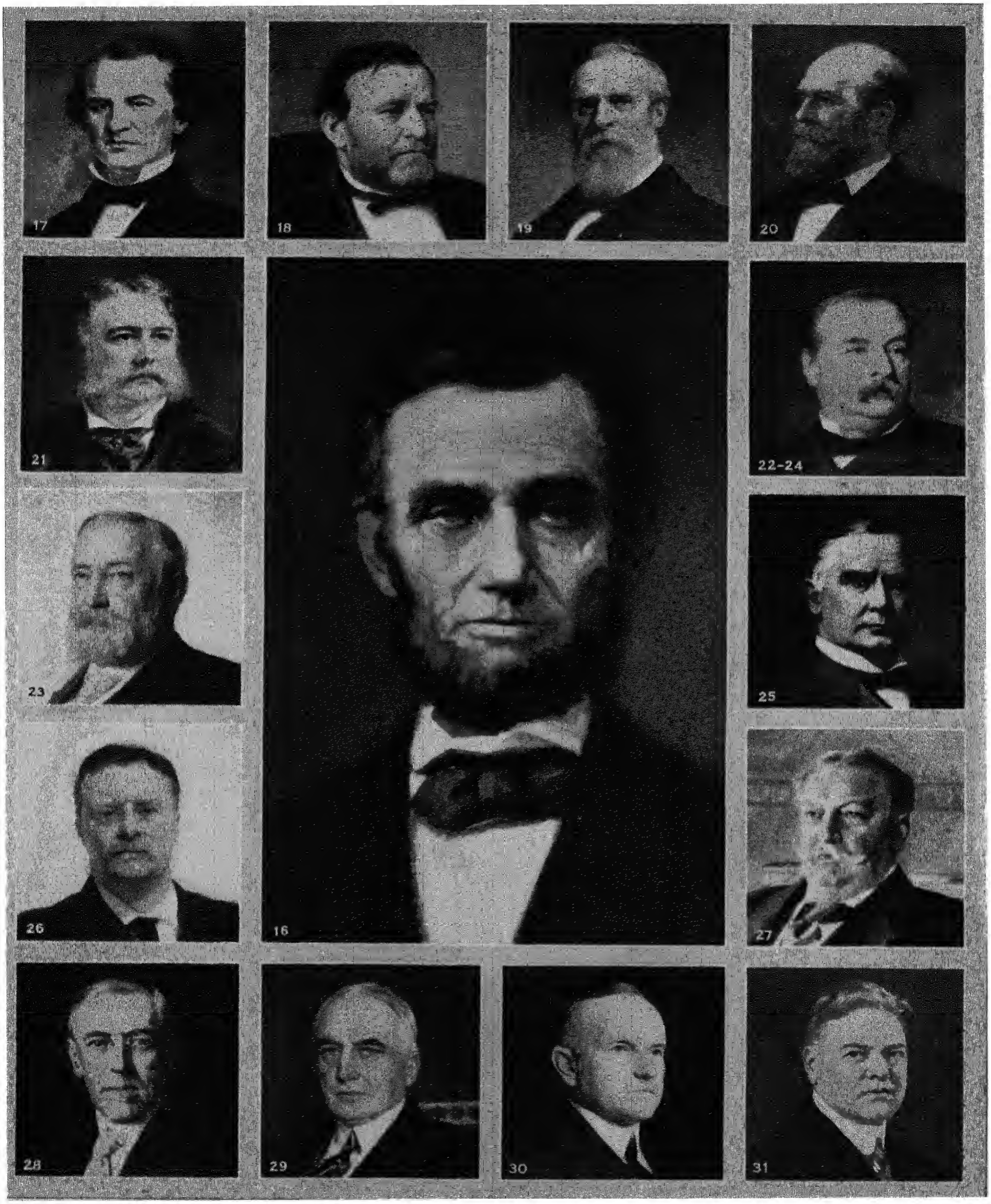
The vital military and political necessity of an immediate railway connection with the Pacific coast was hardly open to doubt in 1862; but the necessity scarcely justified the terms which were offered and taken. The Union Pacific railroad was incorporated; the United States Government was to issue to it bonds, on the completion of each 40m., to the amount of $16,000 per mile, to be a first mortgage; through Utah and Nevada the aid was to be doubled, and for some 300m of mountain building to be trebled; and, in addition to this, alternate sections of land were granted. The land-grant system, thus begun, was carried on extensively, the largest single grants being those of 47,000,000ac. to the Northern Pacific (1864) and of 42,000,000ac. to the Atlantic and Pacific line (1866).

Paper Prices.—Specie payments had been suspended almost everywhere towards the end of 1861; but the price of gold was but 102·5 at the beginning of 1862. About May its price in paper currency began to rise. It touched 170 during the next year, and 285 in 1864; but the real price probably never went much above 250 Other articles felt the influence in currency prices.

Tariff and Taxes.—The duties on imports were driven higher than the original Morrill tariff had ever contemplated The average rates, which had been 18% on dutiable articles and 12% on the aggregate in 1860–61, rose, before the end of the war, to nearly 50% on dutiable articles and 35% on the aggregate. Domestic manufactures sprang into new life under such encouragement, everyone who had spare wealth converted it into manufacturing capital. The probability of such a result had been the means of getting votes for an increased tariff, free traders had voted for it as well as protectionists For the tariff was only a means of getting capital into positions in which taxation could be applied to it, and the "internal revenue" taxation was merciless beyond precedent The annual increase of wealth from capital was then about $550,000,000; the internal revenue taxation on it rose in 1866 to $310,000,000, or nearly 60%

Bonds.—The stress of all this upon the poor must have been great, but it was relieved in part by the bond system on which the war was conducted While the armies and navies were shooting off large blocks of the crops of 1880 or 1890, work and wages were abundant for all who were competent for them It is true, then, that the poor paid most of the cost of the war; it is also true that the poor had shared in that anticipation of the future which had been forced on the country, and that, when the drafts on the future came to be redeemed, it was done mainly by taxation on luxuries. The destruction of a Northern railway meant more work for Northern iron mills and their workmen The destruction of a Southern road was an unmitigated injury; it had to be made good at once, by paper issues; the South could make no drafts on the future, by bond issues, for the blockade had put cotton out of the game, and Southern bonds were hardly salable. Every expense had to be met by paper issues; each issue forced prices higher. *A Rebel War-Clerk's Diary* gives the following as the prices in the Richmond market for May 1864: "Boot, $200; coats, $350; pantaloons, $100; shoes, $125; flour, $275 per barrel; meal, $60 to $80 per bushel; bacon, $9 per pound; no beef in market; chickens, $30 per pair; shad, $20; potatoes, $25 per bushel; turnip greens, $4 per peck; white beans, $4 per quart or $120 per bushel; butter, $15 per pound; wood, $50 per cord."

Manufactures.—The complete lack of manufactures told heavily against the South from the beginning. As men were drawn from agriculture in the North and West, the increased de-



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UNITED STATES PRESIDENTS FROM 1861 TO 1929

16. Abraham Lincoln (term, 1861–1865) by William E. Marshall. 17. Andrew Johnson (1865–1869) by E. F. Andrews. 18. Ulysses Simpson Grant (1869–1877) by Thomas LeClear. 19. Rutherford Birchard Hayes (1877–1881) by Daniel Huntington. 20. James Abram Garfield (1881–1881) by E. F. Andrews. 21. Chester Alan Arthur (1881–1885) by Daniel Huntington. 22–24. Grover Cleveland (1885–1889, 1393–1897) by Eastman Johnson. 23. Benjamin Harrison (1889–1893) by Eastman Johnson. 25. William McKinley (1897–1901) by William D. Murphy. 26. Theodore Roosevelt (1901–1909) by John Singer Sargent. 27. William Howard Taft (1909–1913) by Anders Zorn. 28. Woodrow Wilson (1913–1921) by Stanley G. Middleton. 29. Warren Gamaliel Harding (1921–1923) by Howard Chandler Christy. 30. Calvin Coolidge (1923–1929) by Ercole Carlotto. 31. Herbert Clark Hoover (1929–) by Edmund C. Tarbell

mand for labour was shaded off into an increased demand for agricultural machinery; every increased percentage of power in reaping-machines liberated so many men for service at the front. The reaping-machines of the South—the slaves—were incapable of any such improvement and, besides, required the presence of a portion of the possible fighting men at home to watch them. But no insurrection took place.

The pressing need for men in the Army made the Confederate Congress utterly unable to withstand the growth of executive power. Its bills were prepared by the Cabinet, and the action of Congress was quite perfunctory. The suspension of the writ of *habeas corpus*, and the vast powers granted to President Davis, or assumed by him, made the Confederate Government almost a despotism. It was not until the closing months of the war that the expiring Confederate Congress mustered up courage enough to oppose the President's will.

Banking.—Another act of Federal legislation—the National Bank Act (Feb 25, 1863; supplemented by the act of June 3, 1864)—should be mentioned here, as it was closely connected with the sale of bonds. The banks were to be organized and, on depositing United States bonds at Washington, were to be permitted to issue notes up to 90% of the value of the bonds deposited As the redemption of the notes was thus assured, they circulated without question all over the United States. By a subsequent act (1865) the remaining State bank circulation was taxed out of existence

West Virginia.—At the beginning of 1862 the lines of demarcation between the two powers had become plainly marked. The western part of Virginia had separated itself from the parent State, and was admitted as a State (1863) under the name of West Virginia. It was certain that Delaware, Maryland, Kentucky and Missouri had been saved to the Union, and that the battle was to be fought out in the territory to the south of them.

The Emancipation Proclamation.—At the beginning of the war the people and leaders of the North had not desired to interfere with slavery, but circumstances had been too strong for them. Lincoln had declared that he meant to save the Union as best he could—by preserving slavery, by destroying it or by destroying part and preserving part Just after the battle of Antietam (Sept. 17, 1862) he issued his proclamation calling on the revolted States to return to their allegiance before the next year, otherwise their slaves would be declared free men. No State returned and the threatened declaration was issued on Jan. 1, 1863. As President, Lincoln could issue no such declaration; as commander-in-chief of the armies and navies of the United States he could issue directions only as to the territory within his lines; but the Emancipation Proclamation applied only to territory outside of his lines. It has therefore been debated whether the proclamation was in reality of any force It may fairly be taken as an announcement of the policy which was to guide the Army and as a declaration of freedom taking effect as the lines advanced. At all events, this was its exact effect. Its international importance was far greater. The locking up of the world's source of cotton supply had been a general calamity, and the Confederate Government and people had steadily expected that the English and French Governments would intervene in the war. The conversion of the struggle into a crusade against slavery made intervention impossible.

Confederate Privateers.—Confederate agents in England were numerous and active. Taking advantage of every loophole in the British Foreign Enlistment Act, they built and sent to sea the "Alabama" and "Florida," which for a time almost drove Federal commerce from the ocean. Whenever they were closely pursued by United States vessels they took refuge in neutral ports until a safe opportunity occurred to put to sea again. Another, the "Georgia," was added in 1863. All three were destroyed in 1864. Confederate attempts to have iron-clads equipped in England and France were unsuccessful.

The Victory of the North.—The turning-point of the war was evidently in the early days of July 1863, when the victories of Vicksburg and Gettysburg came together. The National Government had at the beginning cut the Confederate States down to a much smaller area than might well have been expected; its armies had pushed the besieging lines far into the hostile territory; and the war itself had developed a class of generals who cared less for the conquest of territory than for destroying the opposing armies. The great drafts on the future which the credit of the Federal Government enabled the North to make gave it also a startling appearance of prosperity; so far from feeling the war, it was driving production of every kind to a higher pitch than ever before.

The war had not merely developed improved weapons and munitions of war; it had also spurred the people on to a more careful attention to the welfare of the soldiers, the fighting men drawn from their own number. The sanitary commission, the Christian commission, and other voluntary associations for the physical and moral care of soldiers, received and disbursed very large sums. The National Government was paying an average amount of $2,000,000 per day for the prosecution of the war and, in spite of the severest taxation, the debt grew to $500,000,000 in June 1862, to twice that amount a year later, to $1,700,000,000 in June 1864 and reached its maximum on Aug 31, 1865—$2,845,907,626. But this lavish expenditure was directed with energy and judgment. The blockading fleets were kept in perfect order and with every condition of success. The railway and telegraph were brought into systematic use for the first time in modern warfare. Late in 1863 Edwin M. Stanton, the secretary of War, moved two corps of 23,000 men from Washington to Chattanooga, 1,200m., in seven days.

Conscription.—On the other hand, the Federal Armies now held almost all the great southern through lines of railway, except the Georgia lines and those which supplied Lee from the South. The want of the Southern people was merely growing in degree, not in kind. The conscription, sweeping from the first, had become omnivorous; towards the end of the war every man between 17 and 55 was legally liable to service, and in practice the only limit was physical incapacity. In 1863 the Federal Government also was driven to conscription. The first attempts to carry it out resulted in forcible resistance in several places, the worst being the "draft riots" in New York (July), when the city was in the hands of the mob for several days All the resistance was put down; but exemptions and substitute purchases were so freely permitted that the draft in the North had little effect except as a stimulus to the States in filling their quotas of volunteers by voting bounties.

Election of 1864.—In 1864 Lincoln was re-elected with Andrew Johnson as vice-president. The Democratic convention had declared that, after four years of failure to restore the Union by war, during which the Constitution had been violated in all its parts under the plea of military necessity, a cessation of hostilities ought to be obtained, and had nominated Gen George B. McClellan and G H. Pendleton Farragut's victory in Mobile Bay (Aug 5), by which he sealed up the last port, except Wilmington, of the blockade-runners, and the evidently staggering condition of the Confederate resistance in the East and the West, were the sharpest commentaries on the Democratic platform; its candidates carried only three of the 25 states taking part in the election. The 36th State—Nevada—had been admitted in 1864

Surrender of Lee.—The actual fighting of the war ended with the surrender of Gen. Robert E Lee to Gen U.S. Grant at Appomattox, Va, April 9, 1865. All the terms of surrender named by Grant were generous: no private property was to be surrendered; both officers and men were to be dismissed on parole, not to be disturbed by the United States Government so long as they preserved their parole and did not violate the laws; and he instructed the officers appointed to receive the paroles "to let all the men who claim to own a horse or mule take the animals home with them to work their little farms." Gen. Joseph E. Johnston, with the only other considerable army in the field, surrendered on much the same terms at Durham Station, N.C. (April 26), after an unsuccessful effort at a broader settlement. All organized resistance had now ceased; Union cavalry were ranging the South, picking up Government property or arresting leaders; but it was not until May that the last detached parties

of Confederates gave up the contest.

Death of Lincoln.—Just after Lee's surrender President Lincoln died by assassination (April 15), the crime of a half-crazed enthusiast. Even this event did not impel the American people to any vindictive use of their success for the punishment of individuals. In the heat of the war, in 1862, Congress had so changed the criminal law that the punishment of treason and rebellion should no longer be death alone, but death or fine and imprisonment. Even this modified punishment was not inflicted. There was no hanging; some of the leaders were imprisoned for a time, but never brought to trial.

The Armies.—The Armies of the Confederacy are supposed to have been at their strongest (700,000) at the beginning of 1863; and it is doubtful whether they contained 200,000 men in March 1865. The dissatisfaction of the Southern people at the manner in which Davis had managed the war seems to have been profound, and it was only converted into hero worship by the ill-advised action of the Federal Government in arresting and imprisoning him. Desertion had become so common in 1864, and the attempts of the Confederate Government to force the people into the ranks had become so arbitrary, that the bottom of the Confederacy had dropped out of it before Sherman moved northward from Savannah. On the contrary, the numbers of the Federal Armies increased steadily until March 1865, when they were a few hundreds over 1,000 000. As soon as organized resistance ceased, the disbanding of the men began; they were sent home at the rate of about 300 000 a month, about 50,000 being retained in service as a standing Army.

Cost of the War.—The direct cost of the Civil War has been variously estimated, the best estimate including the first three years of reconstruction being $5,000,000,000 to the North and $3,000 000,000 to the South. But if pensions, interest and other such items up to 1910 are included, the result is a total of between $11,000,000,000 and $12 000,000,000 for the North alone. But the cost to the South also was enormous, $4,000,000 000 cannot be an exaggeration.

Results.—In return for such an expenditure, and the death of between 750 000 and 1,000,000 men, the abiding gain was incalculable. The rich section, which had been kept back in the general development by a single institution, and had been a clog on the advance of the whole, had been dragged up to a level with the rest of the country. Free labour was soon to show itself far superior to slave labour in the South, and the South was to reap the largest material gain from the destruction of the Civil War. The persistent policy of paying the debt immediately resulted in the higher taxation falling on the richer North and West. As a result of the struggle the moral stigma of slavery was removed. The power of the nation, never before asserted openly, had made a place for itself; and yet the continuing power of the States saved the national power from a development into centralized tyranny. And the new power of the nation, by guaranteeing the restriction of government to a single nation in central North America, gave security against any introduction of international relations, international armament, international wars and continual war taxation into the territory occupied by the United States. Finally, democracy in America had certainly shown its ability to maintain the unity of its empire. (A. J., X.)

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FROM 1865 TO 1910

The capitulation of Lee (April 9, 1865), followed by the assassination of Lincoln (April 15) and the surrender of the last important Confederate army, under J. E. Johnston, marked the end of the era of war and the beginning of that of reconstruction, which involved a revolution in the social and political structure of the South, in the relation of State and nation in the American Federal Union, and in the economic life of the whole country.

Condition of the South.—Economically the condition of the

South was desperate The means of transport were destroyed; railways and bridges were ruined, Southern securities were valueless, the Confederate currency system was completely disorganized Emancipated negroes wandered idly from place to place, trusting the Union armies for sustenance, while their former masters toiled in the fields to restore their plantations.

The social organization of the South had been based on negro slavery Speaking generally, the large planters had constituted the dominant class, especially in the cotton States, and in the areas of heaviest negro population these planters had belonged for the most part to the old Whig Party Outside of the larger plantation areas, especially in the hill regions and the pine barrens, there was a population of small planters and poor whites who belonged in general to the Democratic Party In the mountain regions, where slavery had hardly existed, there were Union areas, and from the poor whites of this section had come Andrew Johnson, senator and war governor of Tennessee, who was chosen vice-president on the Union ticket with Lincoln in 1864 as a recognition of the Union men of the South

The North.—The importance of personality in history was clearly illustrated when the wise and sympathetic Lincoln, who had the confidence of the masses of the victorious North, was replaced by Johnson, opinionated and intemperate, whose antecedents as a Tennessean and Democrat, and whose State rights principles and indifference to Northern ideals of the future of the negro made him distrusted by large numbers of the Union Republican Party

The composition of this party was certain to endanger its stability when peace came It had carried on the war by a coalescence of Republicans War Democrats, Whigs, Constitutional Unionists and Native Americans, who had rallied to the cause of national unity At the outset it had asserted that its purpose was not to interfere with the established institutions in slave States but to defend the Constitution, and to preserve the Union But the war had destroyed slavery, as well as preserved the Union, and the civil status of the negro and the position of the revolted States now became burning questions To the extremists of the Radical wing it seemed in accordance with the principles of human liberty that the negro should not only be released from slavery but should also receive full civil rights, including the right to vote This group was also ready to revolutionize Southern society by destroying the old ascendancy of the great planter-class

For many years before the war, parties had differed on such important questions as the tariff, internal improvements and foreign policy, and the South had used its alliance with the Northern Democracy to resist the economic demands of the industrial interests of the North A return of Southern congressmen might mean a revival of the old political situation, with the South and the Northern Democracy once more in the saddle

Attitude of the Two Sections.—Any attempt to restore the South to full rights, therefore, without further provision for securing for the freedmen the reality of their freedom, and without some means of establishing the political control of the victorious party, would create party dissension Even Lincoln had aroused the bitter opposition of the radical leaders by his generous plan of reconstruction Johnson could have secured party support only by important concessions to the powerful leaders in Congress, and these concessions he was temperamentally unable to make The masses of the North, especially in the first rejoicings over the peace, were not ungenerous in their attitude, and the South as a whole, accepted the results of defeat in so far as to acquiesce in the permanence of the Union and the emancipation of the slaves, the original issues of the war

Reconstruction.—In the settlement of the details of reconstruction, however, there were abundant opportunities for the hatred engendered by the war to flame up once more As it became clear that the Northern majority was determined to exclude the leaders of the South from political rights in the reconstruction of the Union, and especially as the radicals disclosed their purpose to ensure Republican ascendancy by subjecting the section to the rule of the loyalist whites and, later to that of the emancipated negroes, good will disappeared, and the South entered upon a fight for its social system The natural leaders of the people, men of intelligence and property, had been the leaders of the section in the war Whatever their views had been at first as to secession, the great majority of the Southern people had followed the fortunes of their States To disfranchise their leaders was to throw the control into the hands of a less able and small minority of whites; to enfranchise the blacks while disfranchising the white leaders was to undertake the task of subordinating the former political people of a section to a different race, just released from slavery, ignorant, untrained and without property.

These underlying forces were in reality more influential than the constitutional theories which engaged so much of the discussion in Congress, theories which, while they afford evidence of the characteristic desire to proceed constitutionally were really urged in support of, or opposition to, the interests just named

The most extreme Northern Democrats, and their Southern sympathizers, starting from the premise that constitutionally the Southern States had never been out of the Union, contended that the termination of hostilities restored them to their former rights in the Federal Union unimpaired and without further action This theory derived support from President Lincoln's view that not States, but assemblages of individuals, had waged war against the Government The theory of the extreme Republican Radicals was formulated by Sumner and Stevens Sumner contended that, while the States could not secede, they had by waging war reduced themselves to mere Territories, entitled only to the rights of Territories. Stevens, appealing to the facts of secession, declared the Southern States conquered provinces, subject to be disposed of at the will of the conqueror. In the end Congress adopted a middle ground, holding that while the States could not leave the Union, they were, in fact, out of normal relations, and that the constitutional right of the Federal Government to guarantee republican Governments to the various States gave to Congress the power to impose conditions precedent to their rehabilitation

It is necessary to recall the initiation of reconstruction measures by President Lincoln rightly to understand the position which was taken by President Johnson. Impatient of theoretical discussion, Lincoln laid down practical conditions of restoration in his proclamation of Dec 8, 1863 In this he offered amnesty to those who would take an oath of loyalty for the future and accept the acts of Congress and the proclamation of the President with reference to slaves From the amnesty he excepted the higher military, civil and diplomatic officers of the Confederacy as well as those who had relinquished judicial stations, seats in Congress, or commissions in the Army or Navy and those who had treated persons in the Federal service otherwise than lawfully as prisoners of war The proclamation provided, further, that when in any of the seceding States (except Virginia, where the President had already recognized the loyal Government under Gov Francis H Pierpont) a number of persons not less than one-tenth of the voters in 1860 should have taken the above described oath, and, being qualified voters under the laws of the State in 1860, should have established a State Government, republican in form, it should be recognized

The First Reconstruction Bill.—Although Lincoln expressly pointed out that the admission of the restored States to representation in Congress rested exclusively with the respective houses, and announced his readiness to consider other plans for reconstruction, heated opposition by the radicals in Congress was called out by this proclamation They feared that it did not sufficiently guarantee the abolition of slavery, which up to this time rested on the war powers of the President, and they asserted that it was the right of Congress, rather than of the President, to determine the conditions and the process of reconstruction. In a bill which passed the House by a vote of 73 to 59 and was concurred in by the Senate, Congress provided that reconstruction was to be begun only when a majority of the white male citizens of any one of the Confederate States should take oath to support the Constitution of the United States The President should then invite them to call a Constitutional Convention The electors of this convention would be required to take an oath of

allegiance which excluded a much larger class than those deprived of the benefit of the amnesty proclamation, for it eliminated all who had voluntarily borne arms against the United States, or encouraged hostility to it, or voluntarily yielded support to any of the Confederate Governments The bill also required that the State Constitution should exclude a large proportion of the civil and military officers of a Confederate Government from the right of voting, and that it should provide that slavery be forever abolished and that State and Confederate debts of the war period should never be paid In July 1864 Lincoln gave a "pocket veto" to the bill and issued a proclamation explaining his reasons for refusing to sign The triumph of Lincoln in the election of 1864 did not clearly signify the will of the people upon the conditions of reconstruction, for the declaration of the Democratic convention that the war was a failure overshadowed the issue, and the Union Party which supported Lincoln was composed of men of all parties

Thirteenth Amendment.—On Jan 31, 1865, the House concurred in the vote of the Senate in favour of the 13th amendment to the Constitution abolishing slavery throughout the Union Four years earlier Congress had submitted to the States another 13th amendment by the terms of which no amendment should ever authorize Congress to interfere with slavery within the States. But owing to the war this amendment had remained unratified, and now Congress proposed to place beyond constitutional doubt, or the power of States to change it, the emancipation of slaves By Dec 18, 1865, the amendment had been ratified and was proclaimed in force.

In the meantime, Louisiana, in accordance with Lincoln's proclamation, had adopted a Constitution and abolished slavery within the State Owing to the obstructive tactics of Sumner, aided by Democrats in the Senate, Congress adjourned on March 4, 1865, without having recognized this new State Government as legitimate "It we are wise and discreet," said Lincoln, "we shall reanimate the states and get their governments in successful operation with order prevailing and the Union re-established before Congress comes together in December"

President Johnson.—Such was the situation when Johnson took up the Presidency upon Lincoln's death After an interval of uncertainty in which he threatened vengeance against various Southern leaders, President Johnson accepted the main features of Lincoln's policy Congress not being in session, he was able to work out an executive reconstruction on the lines of Lincoln's policy during the summer and autumn of 1865 On May 29, he issued a proclamation of amnesty, requiring of those who desired to accept its provisions an oath to support the Constitution and Union, and the laws and proclamations respecting the emancipation of slaves Certain specified classes of persons were excepted, including certain additions to those excluded by Lincoln, especially "all persons who have voluntarily participated in said rebellion and the estimated value of whose taxable property is over twenty thousand dollars" This provision was characteristic of Johnson, who disliked the Southern planting aristocracy, and aimed at placing the preponderant power in the hands of the Democratic small farmers As part of his system he issued another proclamation in which he appointed a governor for North Carolina and laid down a plan for reconstruction. By this proclamation it was made the duty of the governor to call a convention chosen by the loyal people of the State, for the purpose of altering the State Constitution and establishing a State Government The right to vote for delegates to this convention was limited to those who had taken the oath of amnesty and who had been qualified to vote prior to the secession of the State

Already Virginia, Tennessee, Louisiana and Arkansas had Governments which had been recognized by Lincoln. Between June 13 and July 13, 1865, Johnson applied the same process which he had outlined for North Carolina to the remaining States of the Confederacy Before Congress met in December all the Confederate States, except Texas (which delayed until the spring of 1866), had formed Constitutions and elected Governments in accordance with the presidential plan. All of their legislatures, except that of Mississippi, ratified the 13th amendment

Gradually, however, the South turned to its former leaders to shape its policy, and the radical Republicans of the North were alarmed at the rapidity of the process of restoration on these principles. The disorganized and idle condition of the former slaves constituted a serious element in the Southern situation, as Lincoln had foreseen The negroes expected a grant of land from confiscated Southern estates, and it was difficult to preserve order and to secure a proper labour supply.

Under these conditions the efforts of the South to provide security for their communities by bodies of white militia were looked upon with apprehension by the North, and there was sufficient conflict between the two races to give colour to charges that the South was not accepting in good faith the emancipation of the slaves. Especially irritating to Northern sentiment were the so-called "black codes" or "peonage laws," passed by the newly elected Southern legislatures. They rested on the belief that it was necessary that the former slaves should be treated as a separate and dependent class. Some of these imposed special disabilities upon the negro in the matter of carrying weapons and serving as witnesses Vagrancy laws and provisions regarding labour contracts which had precedents in colonial and English legislation, but were specifically framed to restrain the negroes only, were common. Mississippi denied them the right to own land, or even to rent it outside of incorporated towns; South Carolina restricted them to husbandry and to farm or domestic service, unless specially licensed

The Freedmen's Bureau.—The problem of succouring and protecting the negroes had forced itself upon the attention of the North from the beginning of the war, and on March 3, 1865, Congress had created the Freedmen's Bureau with the power to assign abandoned lands, in the States where the war had existed, to the use of the freedmen, to supervise charitable and educational activities among them; to exercise jurisdiction over controversies in which a freedman was a party, and to regulate their labour contracts. The local agents of the bureau were usually Northern men, some of them gave the worst interpretation to Southern conditions and aroused vain hopes in the negroes that the lands of the former masters would be divided among them, and later many became active in the political organization of the negro

Although the National Government itself had thus recognized that special treatment of the freedmen was necessary, Congress, on assembling in Dec. 1865, was disposed to regard the course of the South in this respect with deep suspicion Moreover, as the 13th amendment was now ratified, it was seen that the South, if restored according to the presidential policy, would return to Congress with added representatives for the freed negroes Only three-fifths of the negro slaves had been counted in apportioning representatives in Congress, though now free they were not allowed to vote Under the leadership of the Radicals, Congress refused, therefore, to receive the representatives of the States which had met the conditions of the President's proclamations A joint committee of 15 took the whole subject of reconstruction under advisement, and a bill was passed continuing the Freedmen's Bureau indefinitely When this was vetoed by President Johnson (Feb 19, 1866) Congress retaliated by a concurrent resolution (March 2) against admitting any reconstructed State until Congress declared it entitled to recognition, thus asserting for the legislative body the direction of reconstruction.

While the measure was under consideration the President in an intemperate public address stigmatized the leaders of the Radicals by name as labouring to destroy the principles of the Government and even intimated that the assassination of the President was intended It was hardly possible to close the breach after this, and the schism between the President and the leaders of the Union Republican Party was completed when Congress passed (April 9, 1866) the Civil Rights bill over Johnson's veto. The act declared the freedmen to be citizens of the United States with the same civil rights as white persons and entitled to the protection of the Federal Government.

The Fourteenth Amendment.—To place this measure beyond the danger of overthrow by courts or by a change of party majority, on June 13, 1866, Congress provided for submitting to

the States a 14th amendment to the Constitution. This gave constitutional guarantee of citizenship and equal civil rights to freedmen, and in effect provided that when in any State the right to vote should be denied to any of the male inhabitants 21 years of age and citizens of the United States, except for participation in rebellion or other crime, the basis of representation in the State should be reduced in the proportion which the number of such citizens bore to the whole number of male citizens 21 years of age in the State. This section of the amendment, therefore, left the States the option between granting the suffrage to the negro or suffering a proportionate reduction in the number of representatives in Congress It was a fair compromise which might have saved the South from a long period of misrule and the North from the ultimate breakdown of its policy of revolutionizing Southern political control by enfranchisement of the blacks and disfranchisement of the natural leaders of the whites

In order to ensure the passage of this amendment the radical leaders proposed bills which declared that, after its adoption, any of the seceding States which ratified it should be readmitted to representation But it also provided that the higher classes of officials of the Confederacy should be ineligible to office in the Federal Government These bills were allowed to await the issue of the next election

For further protection of the rights of the negro, Congress succeeded in passing, over President Johnson's veto, an act continuing the Freedmen's Bureau for two years Tennessee, having ratified the 14th amendment, was (July 24, 1866) restored to representation and Congress adjourned, leaving the issue between the President and the legislative body to the people in the Congressional elections

Party Changes.—The campaign brought with it some realignment of party. President Johnson, having broken with the leaders of the Union Republican Party, was more and more forced to rely upon Democratic support, although his executive appointments were still made from the ranks of the Republicans The so-called National Union convention, which met in Philadelphia in midsummer in an effort to abate sectionalism, and to endorse the President's policy, included a large number of war Democrats who had joined the Union party after the secession of the South, many moderate Southerners, a fragment of the Republican Party, and a few Whigs, especially from the border States They claimed that the Southern States had a right to be represented in Congress Other meetings friendly to the Radicals were called, and under the designation of Union-Republican Party they declared for the congressional policy While the campaign for elections to Congress was in progress the President made a journey to Chicago, speaking at various cities *en route* and still further alienating the Republicans by abuse of his opponents. As a result of the autumn elections two-thirds of the members of the House of Representatives were opposed to him. Almost contemporaneously every seceding State except Tennessee rejected the 14th amendment, paving the way for the entire triumph of the Northern extremists

Tenure of Office Act.—In the ensuing winter and spring Congress completed the conquest of the President, awed the Supreme Court, and provided a drastic body of legislation to impose negro suffrage on the South By the Tenure of Office Act (March 2, 1867) Congress forbade the President to remove civil officers without the consent of the Senate, and at the same time by another act required him to issue military orders only through the general of the Army (Grant), whom the President was forbidden to remove from command or to assign to duty at another place than Washington, unless at the request of the officer or by the prior assent of the Senate. These extraordinary invasions of the presidential authority were deemed necessary to prevent Johnson from securing control of the military arm of the Government, and to protect Edwin Stanton, the secretary of war, and Gen Grant. Fearing the President might take advantage of the interim when Congress would not be in session, the 40th Congress was required to meet on March 4, immediately following the expiration of the 39th.

Other Legislative Acts.—The Reconstruction Act of March 2, 1867, provided for the military Government of the Southern States while the drastic policy of Congress was being carried out It was passed over the veto of the President and declared that no legal Governments or adequate protection for life or property existed in the seceding States, except Tennessee. These States it divided into five military districts, each to be placed under the command of a general of the Army, whose duty it was to preserve law and order. But the existing civil Governments were declared provisional only and subject to the paramount authority of the United States to abolish, modify, control, or supersede them. The act further provided that a Constitutional Convention might be elected by the adult male citizens of the State, of whatever race, colour or previous condition, resident in the State for a year, except such as might be disfranchised for rebellion or felony.

When the convention, thus chosen under negro suffrage, and with the exclusion of Confederate leaders, should have framed a State Constitution conforming to the Federal Constitution and allowing the franchise to those entitled to vote for the members of the convention, the Constitution was to be submitted for the approval of Congress If this were obtained and if the State adopted the 14th amendment, and this amendment became a part of the Federal Constitution, then the State should be entitled to representation in Congress, but the senators and representatives sent to Congress were required to take the "iron-clad oath," which excluded those who had fought in the Confederate service, or held office under any Government hostile to the United States, or given support to any such authority.

By the pressure of military control Congress thus aimed at forcing the adoption of the 14th amendment, as well as the acceptance of negro suffrage in the State Constitutions of the South A supplementary act of March 23, 1867, and an act of interpretation passed on July 19 completed this policy of "thorough" In the registration of voters the district commanders were required to administer an oath which excluded those disfranchised for rebellion and those who after holding State or Federal office had given aid and comfort to the enemies of the United States

Supreme Court Decisions.—Against this use of military power to govern States in time of peace the Supreme Court interposed no effective obstacle. Like the executive it was subordinated to Congress. It is true that in the case *ex parte* Milligan, decided in Dec 1866, the court held military commissions unlawful where the ordinary civil tribunals were open. In the case of Cummings v. Missouri (Jan. 14, 1867) it decided also that a State test oath excluding Confederate sympathizers from professions was a violation of the prohibition of *ex post facto* laws; and the court (*ex parte* Garland) applied the same rule to the Federal test oath so far as the right of attorneys to practise in Federal courts was concerned.

But threats were made by the radicals in Congress to take away the appellate jurisdiction of the court, and even to abolish the tribunal by constitutional amendment. The judges had been closely divided in these cases and, when the real test came, the court refused to set itself in opposition to Congress When Mississippi attempted to secure an injunction to prevent the president from carrying out the reconstruction acts, and when Georgia asked the court to enjoin the military officers from enforcing these acts in that State, the Supreme Court refused (April and May 1867), pleading want of jurisdiction. Chief Justice Salmon P. Chase argued that if the President refused to obey, the court could not enforce its decree, while if he complied with the order of the court, and if the House of Representatives impeached him for refusing to enforce the law, the Supreme Court would be forced to the vain attempt to enjoin the Senate from sitting as a court of impeachment

In one instance it seemed inevitable that the court would clash with Congress; the McCardle case involved an editor's arrest by military authority for criticizing that authority and the reconstruction policy. But Congress, apprehending that the majority of the court would declare the reconstruction acts unconstitutional, promptly repealed that portion of the act which gave the court jurisdiction in the case, and thus enabled the judges to dismiss the appeal. Afterwards, when the reconstruction policy had been accomplished, the court, in the case of Texas v White

(1869), held that the Constitution looked to "an indestructible Union composed of indestructible states"; and that although the secession acts were null, and the Federal obligations of the seceding States remained unimpaired, yet their rights were suspended during the war

Impeachment of President Johnson.—The powerful leaders of the Republicans in Congress had been awaiting their opportunity to rid themselves of President Johnson by impeachment For full details of these efforts *see* JOHNSON, ARTHUR His trial in the spring of 1868, however, by the Senate resulted in a verdict of acquittal.

"Carpet-baggers."—Meanwhile the military reconstruction of the South and the organization of the negro vote progressed effectively The party management of the negroes was conducted by "carpet-baggers," as the Northern men who came South to try their fortunes were nicknamed, and by the white loyalists of the South, to whom was given the name "scalawags" In the work of marshalling the freedmen's vote for the Republican Party secret societies like the Loyal League, or Union League played an important part As the newly enfranchised mass of politically untrained negroes passed under Northern influence politically, the Southern whites drew more and more together and although they were unable under the existing conditions to take control, they awaited their opportunity A "Solid South" was forming in which old party divisions gave way to the one dominant antagonism to Republican ascendancy by negro suffrage. Politically the important fact was that the Republicans had rejected the possibility of reviving the old party lines in the South, and had gambled upon the expectation of wielding the united coloured vote with such leadership and support as might be gained from former Northerners and loyal whites In the end negro rule failed, as was inevitable when legal disabilities and military force were removed, but the masses of the Southern whites emerged with a power which they had not possessed under the old rule of the planting aristocracy For the time being, however, negro votes gave control to the Republicans In South Carolina, Florida, Alabama, Mississippi and Louisiana the negroes were in a majority, in Virginia, North Carolina, Arkansas and Texas they were in the minority; while in Georgia the two races were nearly evenly balanced

Ku-Klux Klan.—The white leaders of the South were divided as to the best means of meeting the problem Some advocated that those entitled to vote should register, and then refrain from the polls, in order to defeat the Constitutions made under negro suffrage, for the law required them to be ratified by a majority of the qualified voters Others would have the white race bear no part in the process Societies such as the "Ku-Klux Klan" and the "Knights of the White Camelia" were organized to intimidate or restrain the freedmen But for the present the Republicans carried all before them in the South Some of the new State Constitutions imposed severe disfranchisement upon the former dominant class, and before the end of July 1868 all of the former Confederate States, except Virginia, Mississippi and Texas, had ratified the 14th amendment, which was proclaimed in effect By the beginning of 1870 these three States had also ratified the amendment, as had Georgia a second time, because of her doubtful status at the time of her first ratification

The Southern States Restored to the Union.—By the summer of 1868 Arkansas, South Carolina, North Carolina, Georgia, Alabama, Louisiana and Florida, having satisfied the requirements of the reconstruction acts, were entitled to representation in Congress But Georgia did not choose her senators until after the adjournment of Congress, and, inasmuch as the State excluded the negro members of the legislature in September, Congress on reassembling returned the State to military rule until its submission Alabama was restored in spite of the fact that her white voters had remained away from the polls in sufficient numbers to prevent a majority of all the voters registered from having ratified the constitution. The nominating conventions and the campaign of 1868 gave interesting evidence of the trend of political and economic events. Party lines, which had broken down in the North when all united in saving the Union, were once more reasserting themselves President Johnson, who had been elected by the Union Republican Party, had found his most effective support among the Democrats. The Republicans turned to Gen Grant, a Democrat before the outbreak of the war.

Grant Nominated.—The Republican nominating convention met on May 20, 1868, a few days after the failure of the impeachment proceedings, and it chose Grant as the candidate for the Presidency The platform supported the congressional reconstruction measures Upon the vital question whether universal negro suffrage should be placed beyond the power of States to repeal it by a new constitutional amendment, the platform declared. "The guarantee by Congress of equal suffrage to all loyal men at the South was demanded by every consideration of public safety, of gratitude and of justice, and must be maintained; while the question of suffrage in all the loyal states properly belongs to the people of those states" Nowhere in the North was the negro an important element in the population, but the North had shown an unwillingness to apply to itself the doctrines of negro rights which had been imposed upon the South Between 1865 and 1868 Connecticut, Wisconsin, Minnesota, Kansas, Ohio and Michigan had refused to give the negro the right to vote within their own bounds, and this plank was evidence of the unwillingness of the party to make a direct issue of universal negro suffrage The platform pronounced in favour of payment of the public debt, not only according to the letter but the spirit of the laws under which it was contracted The significance of this lay in its challenge to the Democratic agitation on the currency question

It was this question which gave the tone to the proceedings of the Democracy at their convention in July 1868. The situation can best be presented by a brief review of the financial history just preceding the convention Together with the discussion over political reconstruction in the South, Congress and the Administration had been obliged to deal with the reconstruction of debt, taxation and currency in the nation at the close of four years of expensive war The problems of funding, readjustment of taxation, and resumption of specie payments proved to be so complicated with the industrial growth of the nation that they led to issues destined to exert a long-continued influence

Finance.—The various war tariffs, passed primarily for the sake of increased revenue, had been shaped for protection under the influence of the manufacturing interests, and they had been framed also with reference to the need of compensating the heavy internal taxes which were imposed upon the manufacturers. When the war ended, public sentiment demanded relief from these heavy burdens, especially from the irksome internal taxes The rapidly growing grain-raising districts of the Middle West exhibited a lively discontent with the protective tariff, but this did not prevent the passage in 1867 of the Wool and Woollens Act, which discriminated in favour of the woollen manufacturers and raised the *ad valorem* duty on wool In spite of several large reductions of internal revenue, the national debt was being rapidly extinguished

The currency question, however, furnished the economic issue which was most debated One set of interests aimed at rapidly reducing the volume of the currency by retiring the legal tender notes, or "greenbacks" The secretary of the Treasury, Hugh McCulloch, pressed this policy to the foreground, and desired authority to issue bonds to retire these notes Another set of interests demanded the retention of the greenbacks, supporting their views by arguments varying according to the degree of radicalism of the speakers The more moderate, like Senator John Sherman, of Ohio, who reflected the views of parts of the West, argued that the recuperation of the nation and the rapid increase of business would absorb the existing currency, while gold would cease to go abroad Thus, by the increasing credit of the Government, specie payment would be automatically resumed The most extreme, so far from contracting the currency by retiring the greenbacks, wished to increase this form of money, while diminishing the circulation of the notes of the national banks. The discussion tended to produce a sectional issue with the West against the East, and a social issue with bondholders

and the creditor class in general arrayed against the less well-to-do. Congress agreed with Secretary McCulloch, and in the Funding Act of 1866 not only provided for converting short-time securities into long-term bonds, but also for retiring $10,000,000 of greenbacks in six months and thereafter not more than $4,000,000 monthly. But the agricultural depression of 1866 produced a reaction. Loud demands were made that bonds should be paid in greenbacks instead of coin and the national bank-notes suppressed In 1868, on the eve of the presidential campaign, Congress, alarmed by the extent of these popular demands, suspended the process of contraction after $40,000,000 in greenbacks had been retired. Ohio was the storm centre of the agitation. The "Ohio idea" that greenbacks should become the accepted currency of the country was championed by George H. Pendleton, of that State, and his friends now brought him forward for the Democratic nomination for President on this issue In the national convention of that party they succeeded in incorporating into the platform their demands that there should be one currency for the Government and the people, the bondholder and the producer, and that where the obligations of the Government did not expressly provide for payment in coin, they should be paid in lawful money (*i e*, greenbacks) of the United States

But another wing of the Democratic Party desired to make prominent the issue against the reconstruction measures of the Republicans. This wing added to the platform and declaration that these acts were unconstitutional and void, and the demand that the Southern States should be restored to their former rights and given control over their own elective franchise.

Democrats Nominate Seymour.—Although the followers of Pendleton had shaped the financial plank of the platform, they could not nominate their leader The opposition was at first divided between the various candidates New York, which feared the effect upon the conservative financial interests of the East if Pendleton were nominated, attempted to break the deadlock by proposing an Ohio man, Chief Justice Chase But eager as Chase was for the Presidency he had flatly refused to abandon the views which he held in favour of negro suffrage Ohio was, therefore, able to retaliate by stampeding the convention in favour of Horatio Seymour, of New York As the war governor of his State he had been a consistent critic of the extremes to which the Federal Administration had carried its interpretation of the war power. For vice-president the convention nominated Francis P Blair, jun, of Missouri

Grant Elected.—But the popularity of Grant in the North, together with the Republican strength in the States of the South which had been reconstructed under negro suffrage, gave an easy victory to the Republicans in the election of 1868 Seymour carried only Delaware New Jersey, New York and Oregon, of the North, and Maryland, Kentucky, Georgia and Louisiana of the South Tennessee, and five of the former Confederate States, upon which negro suffrage had been imposed (North Carolina, South Carolina, Florida, Alabama and Arkansas) voted for Grant. Virginia, Mississippi and Texas had not yet been restored

Fifteenth Amendment.—This decisive victory and the knowledge that it had been won by the advantage of the negro vote in the restored States led the Republican leaders to ignore their recent platform declaration in regard to negro suffrage. Shortly after Congress assembled propositions were made to place the freedman's right to vote beyond the power of the States to change To do this by constitutional enactment it was necessary to make the provision universal, and Congress, therefore, submitted for ratification the 15th amendment declaring that "the right of citizens of the United States to vote shall not be denied or abridged by the United States or by any state on account of race, color or previous condition of servitude." Congress was given power to enforce the amendment by appropriate legislation By March 30, 1870, the amendment had been ratified; but it is doubtful whether this could have been accomplished by legislatures chosen on the issue As it was, the States of Virginia, Mississippi, Texas and Georgia were required to ratify it as a condition of their readmittance to representation in Congress, and the three former States, having been permitted to vote separately on the obnoxious provisions of their Constitutions in regard to the disfranchisement of former Confederates, rejected those clauses, adopted the 15th amendment and were restored in 1870. Georgia, after a new experience of military rule, likewise ratified the amendment, and her representatives were likewise admitted to Congress.

As soon as the 15th amendment was proclaimed in effect, and the military Governments of the South were superseded, the dominant party proceeded to enact measures of enforcement These seemed especially necessary in view of the fact that, partly by intimidation of the coloured vote, Louisiana (1868) and Tennessee (1869) broke away from the Republican column; while in the election of 1870 Tennessee, North Carolina, Georgia, Virginia and Alabama went Democratic The enforcement legislation of 1870 provided penalties for violating the 14th and 15th amendments and re-enacted the Civil Rights Act of 1866. In the years 1871 and 1872 acts were passed providing for effective Federal supervision of Congressional elections, and the "Ku-Klux Acts" (1871 and 1872) still further increased the power of the Federal courts to enforce the amendments and authorized the President to suspend the writ of *habeas corpus* and use military force to suppress public disorders But these stern measures were accompanied by some efforts to restore harmony, such as the repeal of the "iron-clad oath" for ex-Confederates, in 1871, and the passage of the General Amnesty Act of 1872. The North was becoming restive under the long-continued use of the Federal military arm within State borders in time of peace

Reconstruction Governments.—In any case the cost of rehabilitating the public works and providing education and the political and judicial institutions which should apply equally to the hitherto non-political class of the blacks, would have been a heavy one But the legislatures, especially of Louisiana, South Carolina, Tennessee, Arkansas and Alabama, plunged into an extravagance made possible by the fact that the legislatures contained but few representatives who paid considerable taxes In 1872 it was estimated that the public debts of the 11 reconstructed States amounted to nearly $132,000,000, two-thirds of which was composed of guarantees to corporations Legislative expenses were grotesquely extravagant, the coloured members in some States engaging in a saturnalia of corrupt expenditure. This alienated from the so-called Radical Party the support of Southern whites, because they resented the concessions of the carpet-bag leaders to the negro vote, because they suffered from the burden of taxation, and above all because race friction increased

By 1872 a coalition had been formed under the name of Conservatives But the control of electoral machinery in the strongly centralized State executives chosen by negro votes, and coercion by the Federal authority, still upheld Republican rule in various Southern States Virginia and North Carolina were practically bankrupt, the capitals of Louisiana, Arkansas and Alabama, where rival State officers claimed possession, were occupied by Federal troops, and many of the Governments were so corrupt that only the contemporaneous rottenness in New York City and in certain branches of the Federal Government afford a parallel

It was a time of lax public morals after war, which was ill suited to the difficult experiment of transferring political power to a race recently enslaved Only the strong arm of the Federal authority sufficed to prevent the whites of the South from overthrowing a condition of things which it was impossible under American political ideas permanently to maintain

Southern Changes.—An important economic reorganization was in progress in the South White districts were recovering from the war and were becoming the productive cotton areas by the use of fertilizers and by the more intelligent white labour. Cities were rising, and the mines and manufactures of the southern Appalachians were developing In the black belt, or region of denser negro settlement the blacks became tenant farmers, or workers on shares The effective and just direction of negro labour was a difficult problem and was aggravated by the political agitation which intensified race friction It became evident that there was a negro problem as well as a slavery question, and that the North was unable to solve it.

Foreign Relations.—In the meantime important foreign relations had been dealt with by Secretary William H Seward, under Johnson, and by Secretary Hamilton Fish, under Grant. Not only were many treaties of commerce and extradition, including one with China, negotiated by Seward, but he also brought about a solution of more important diplomatic problems The relations of the United States with France and England had been strained in the course of the war Not only had Napoleon III. been inclined to recognize the Confederacy, but he had also taken advantage of the war to throw into Mexico a French army in support of the Emperor Maximilian The temptation to use force while American military prestige was high appealed even to Gen. Grant; but Seward by firm and cautious diplomatic pressure induced France to withdraw her troops in 1867, and the power of Maximilian collapsed Russia's friendly attitude throughout the war was signalized by her offer to sell Alaska to the United States in 1867. Seward promptly accepted it and the treaty was ratified by the Senate and the purchase money ($7,200,000) was voted by the reluctant House, which saw little in the acquisition to commend it

"Alabama" Claims.—With England, affairs were even more threatening than with France Confederate cruisers (notably the "Alabama"), built in England and permitted by the negligence of the British Government to go to sea, had nearly swept the American merchant marine from the ocean Unsettled questions of boundary and the fisheries aggravated the ill feeling, and England's refusal in 1865 to arbitrate made a serious situation Prolonged negotiations followed a change of attitude of England with regard to arbitration, and in 1870 President Grant recommended to Congress that the United States should pay the claims for damages of the Confederate cruisers, and thus assume them against England. However, in 1871, the Treaty of Washington was negotiated under Secretary Fish, by the terms of which England expressed regret for the escape of the cruisers and provided for arbitration of the fisheries, the north-western boundary, and the "Alabama" claims The case of the United States was victorious, the tribunal awarding damages against Great Britain to the amount of $15,500,000 Two months later the German emperor gave to the United States the disputed north-west boundary, including the San Juan island in Puget sound

In the West Indies also important questions were presented Seward had negotiated a treaty of purchase of the Danish West Indies, but the Senate refused to ratify it, nor did Grant's attempt to acquire Santo Domingo meet with a different fate at the hands of that body (1870). In Cuba another insurrection was in progress. Secretary Fish "pigeon-holed" a proclamation of President Grant recognizing the Cubans as belligerents, and secured a policy of neutrality which endured even the shock of the "Virginius affair" in 1873, when 50 of the men of the filibustering steamer flying the American flag were shot by the Spanish authorities It was shown that the vessel had no right to the flag. Negotiations for an isthmian canal resulted only in a treaty with Nicaragua in 1868 giving to the United States a right of way across the isthmus and providing for a Government survey of the Panama route.

It was in the field of domestic concerns, in economic and social development, that the most significant tendencies appeared. The old issues were already diminishing in importance before the other aspect of reconstruction which came from the revived expansion of the nation toward the West and the new forms taken by the development of American industrial society.

Finance.—The Republican Party, following the traditions of the Whigs, was especially responsive to the demands of the creditor class, who demanded legislation to conserve their interests Its victory in 1868 was signalized by the passage in the spring of the following year of an act pledging the faith of the United States to pay in coin or its equivalent all the obligations of the United States, except in cases where the law authorizing the issue had expressly provided otherwise. In 1870 and 1871 refunding acts were passed, providing for the issue of bonds to the total amount of $1,800,000,000, one billion of which was to run for 30 years at 4%. This abandonment of the doctrine of early convertibility was made in order to render the bonds acceptable to capitalists, but in fact they soon went to a premium of over 25%.

While the legislature was thus scrupulous of the credit of the nation and responsive to the views of capital, the Supreme Court was engaged in deciding the question of whether the legal tender notes (greenbacks) were constitutional Successive decisions in 1868 determined that they were not legal in certain cases In these decisions the judges had divided, four to three Within a year the court was changed by the appointment of one new judge to fill a vacancy, and the addition of another in accordance with a law enlarging the court In 1871 the former decision was reversed and the constitutionality of the Legal Tender Acts sustained on loose-construction reasoning In 1884 the court went to the extent of affirming the right of Congress to pass legal tender acts in time of peace In 1871 and 1872 Secretary George S Boutwell illustrated the power of the Administration to change the volume of the currency, by issuing in all over $6,000,000 of legal tender notes; and, following the practice of his predecessors, he sold gold from the Treasury to check speculations in that part of the currency

Economic Changes.—Speculation and the rapid growth of great fortunes were characteristic of the period The war itself had furnished means for acquiring sudden riches; the reorganization of taxation, currency and banking increased the opportunities; and the opening of new fields of speculative enterprise in the oil fields of Pennsylvania and Ohio and the gold and silver mines of the mountains of the Far West tended in the same direction An enormous development of manufactures resulted from the diminished commerce and increased demand for manufactured goods, the protection afforded by the tariff, the stimulus due to rising prices, and the consumption of the rapidly growing West It was officially reported in 1869 that "within five years more cotton spindles had been put in motion, more iron furnaces erected, more iron smelted, more bars rolled, more steel made, more coal and copper mined, more lumber sawn and hewn, more houses and shops constructed, more manufactories of different kinds started, and more petroleum collected, refined and exported, than during any equal period in the history of the country"

Pacific Railways.—Between the Civil War and 1872, the extension of the nation's activity to the industrial conquest of the great West, as well as the economic reorganization of the East, had a profound effect upon the development of the United States Between 1862 and 1872 grants were made to the Union Pacific and Central Pacific companies, and to other connecting corporations, for railways from the Missouri to the Pacific, amounting to nearly 33,000,000ac, and in the same period large loans of funds were made by the general Government for this enterprise Construction advanced rapidly after 1866, and by 1869 an all-rail connection had been established on the line of the Union Pacific and Central Pacific railways between the East and San Francisco Various grants were made in these years to other roads, both trans-continental and Middle Western Between 1850 and 1871 Congress granted about 155,000,000ac for railway construction, but not all these grants were perfected It is estimated that some $500,000,000 were invested in the construction of Western railways between 1868 and the panic of 1873, and about 30,000m. of railway had been added.

The effects of this extraordinary extension of railway transportation were immediately apparent In the Far West the railway lines rapidly made possible the extinction of the bison herds This opened the way for the great extension of the cattle country, following the retreat of the Indians Upon the plains Indians the effect was revolutionary Their domain had been penetrated by the railways at the same time that their means of subsistence had been withdrawn During the Civil War most of these Western tribes had engaged in hostilities against the Federal Government By the Peace Commission Act of July 20, 1867, commissioners, including Gen. William T. Sherman, were sent to negotiate treaties As a result the tribes of the Indian Territory were so concentrated as to permit the transfer of other Western tribes to the same region, while the Sioux of the northern plains were given a reservation embracing the western portions of the Dakotas. Discontent with these treaties resulted, however, in hostilities following 1867 Between the close of the war and 1880 some $22,000,000

were expended in Indian wars, although the act of 1871 inaugurated the change of policy whereby the Indians were no longer dealt with by treaty, but were regarded as wards of the nation, to be concentrated on reservations and fed at the expense of the nation under the supervision of Indian agents.

Mining.—Part of these Indian difficulties were due to the opening up of new mining areas in the Rocky Mountains, some of them within the Indians' choicest hunting-grounds At the beginning of the Civil War a preliminary mining boom struck Colorado; the rich Comstock lode was opened in Nevada, Arizona was the scene of mining rushes; the Idaho mines were entered; and the Montana ores were discovered, so that in the period of the Civil War itself the Territories of Nevada, Idaho and Montana had been organized The discovery of gold in the Black Hills in 1874 continued the same movement In 1860 the nation produced $156 000 worth of silver, in 1861 over $2 000,000 and in 1873 nearly $36,000,000 Capital in mines and quarries of the United States was over $65,000,000 in 1860, over $245,000,000 in 1870, and nearly $1,500,000,000 in 1880

The Middle West.—This revolution in the life of the great plains and the Rocky Mountains, opening the way to agriculture and to cattle raising, and preparing for the exploitation of the precious metals of that great area, was contemporaneous with the important development of the farming regions of the Middle West Even during the Civil War the agricultural development of the northern half of the Mississippi valley had continued This was aided by the demand for food products to supply the armies and was made possible by the extension of railways, the taking up of the prairie lands through the operation of the homestead law of 1862, the marketing of the railway land grants, and the increased use of agricultural machinery in those years Between 1860 and 1870 the population of the North Central group of States increased over 42%, and in the next decade by 34%, a total addition to the population in those two decades of 8,000 000 Between 1870 and 1880 about 200,000sq m were added to the farm lands of the United States, an area almost equal in extent to that of France In the same decade the North Central States increased their improved farms from near 78,500,000ac to over 136,800,000 acres The production of Indian corn about doubled between 1860 and 1880, and that of wheat and oats more than doubled. The addition came chiefly from the Middle West

Railway Scandals.—The pressing need of increased transportation facilities had led, as we have seen, to lavish land grants and to subsidies by nation, States and municipalities to the railways The railways themselves tempted by these opportunities, had extended their lines in some cases beyond the immediate needs of the regions Extravagances in construction and operation, aggravated by "construction rings" of railway officials and by rolling stock companies who received extravagant prices by favouritism, brought about a condition where the roads were no longer able to meet the demands of their stockholders for returns on the investment without imposing rates that the Western farmer deemed extortionate In the competitive development of these roads and in the struggle of business corporations and localities with each other, the roads also discriminated between persons and places. This condition chiefly accounted for the political unrest which manifested itself in the West in the so-called "Granger" movements of the '70s

"Granger" Movement.—The farmers felt the pressure of the unsettled currency, taxes were very heavy, the protective tariff seemed to them to bear unduly upon the producers of crops which exceeded the home consumption and had to seek the foreign markets The price of Indian corn, wheat and cotton in the early '70s tended to fall as production rose, so that the gold value of the total crop was not greatly increased during the decade after the war, in spite of increase of production Dissatisfaction with their share in the prosperity of the country, and especially with the charges of middlemen and transportation companies, discontent with the backwardness of rural social conditions, and a desire for larger political influence, all aided in fostering the growth of organizations designed to promote the farmers' interests. The most influential of these organizations was the Patrons of Husbandry, which was founded in 1867 and spread chiefly after 1872 by local clubs or "granges," especially in the West and South

The height of the movement was reached in the autumn of 1874 It threatened the disruption of the old political parties in most of the Middle Western States By holding the balance of power the Grangers secured legislation in many of these States, fixed maximum railway rates, and provided for regulation through commissions In the reaction after the panic of 1873 (when nearly a fifth of the railway mileage of the United States had passed into the hands of receivers) many of the "Granger laws" were repealed, the regulation was rendered nominal and the railways more than regained their political power, yet the agitation had established the important principle, sanctioned by decisions of the Supreme Court, that the railways were common carriers subject fully to public regulation so far as it was not confiscatory The movement for regulation of interstate commerce by congressional legislation was begun at this time under the leadership of congressmen from the Granger States. Later efforts were more wisely considered and more effective; but the rural democracy showed its opposition to the increasing political influence of capital, to special privileges and to the attempts of corporations to avoid public control periodically thereafter

Tweed Ring.—The presidential election of 1872 took place in the midst of this Western upheaval At the same time in the South the reform Republicans and Democrats were uniting under the name of "Conservatives" against the carpet-bag rule, and control was passing into their hands A reform movement was active against the evident corruption in national and municipal administrations, for Grant's trust in his appointees was grossly violated The Tweed ring was systematically looting New York city, and prior to Tweed's indictment in 1871 it was acquiring large power in State legislation. Civil service reformers, men of moderate views with respect to reconstruction many war Democrats who had adhered to the Union Party, and tariff reformers began to break away

Grant Re-elected.—The Liberal-Republican movement started in Missouri, and a national convention was called to meet at Cincinnati on May 1, 1872 Their platform attacked the corruption of civil service by the Administration, supported the results of the war as embodied in the last three amendments and demanded amnesty and local civil government for the South It opposed further land grants to railways, but denounced repudiation and demanded specie payments in terms which excluded from its support the advocates of inflation of the currency This effort to combine the opponents of Grant's Administration was wrecked by the nomination of Horace Greeley, a strong protectionist, who did not command the confidence of the masses of the disaffected Although endorsed by the Democrats, Greeley was defeated by Grant, who ran on the record of the Republican Party, which now dropped the word Union from its name Greeley died before the electoral count, the Democrats won only the States of Maryland, Kentucky, Missouri, Tennessee, Georgia and Texas, the votes of Louisiana and Arkansas being thrown out

Panic of 1873.—The enormous cost of the war, the excessive railway building, over-trading, and inflated credit and fluctuating currency, the sinking of capital in opening new farming lands and in readjusting manufactures to new conditions brought their results in the panic of 1873, precipitated by the failure (Sept. 18) of Jay Cooke, the financier of the Northern Pacific railway For over five years the nation underwent a drastic purgation, railway building almost ceased, and so late as 1877 over 18% of the railway mileage of the nation was in the hands of receivers. The iron industry was prostrated, and mercantile failures for four years amounted to $775,000,000 At the close of the period there was a replacement of partnerships and individual businesses by corporations, but in the interval political unrest was in the foreground

Crédit Mobilier.—The charges that congressmen had been bribed by stock in the Crédit Mobilier, a construction company controlled by Union Pacific stockholders, led to a congressional investigation which damaged the reputations of prominent Republicans, including Vice President Schuyler Colfax, but the same Congress which investigated this scandal voted itself retroactive

increases of salary, and this "back-pay grab" created popular indignation Evidences of fraud and corruption in revenue collection under the "moiety system," and the general demoralization of the civil service continued. The demand for relief from the stringency of the crisis of 1873 expressed itself in the so-called Inflation Bill (passed April 1874) providing a maximum of $400,000,000 for greenback issues This was vetoed by Grant, but he later signed a bill accepting as a maximum the existing greenback circulation of $382,000,000 This compromise was satisfactory neither to contractionists nor greenbackers.

Republicans Lose Congress.—The "tidal wave" in the congressional elections of 1874 was the result of these conditions. It marked a political revolution The House of Representatives, which exhibited a two-thirds Republican majority in 1872, showed an opposition majority of about 70, and the Senate was soon to be close Such Republican strongholds as Pennsylvania, Ohio and Massachusetts went over to the Democrats in the State elections, while in the grain-raising States of the Middle West the Grangers were holding the balance of power, and in the South the Republican Radicals remained in force in few States and only by the use of Federal troops President Grant in his message of Dec 1874 acknowledged that public opinion was opposed to this use of force, but declared that without it negro suffrage would be worse than a mockery Thus by the year 1874 the era of triumphant Republicanism and reconstruction was closing The leaders perceiving power about to pass from them rapidly enacted a series of party measures before the meeting of the newly elected Congress Under the leadership of Senator John Sherman an act was passed (Jan 14, 1875) providing for resumption of specie payments on Jan 1, 1879, gradually contracting greenbacks to $300 000,000 and compensating this by expanding the circulation of the national banks

In the field of the tariff a similar policy was followed. The act of 1870 had somewhat reduced duties on tea, coffee, sugar and iron, but under Western pressure in 1872 the Republican Congress had consented to a 10% reduction on most classes of goods in order to save the general system of protection. On the eve of their relinquishment of full power the Republicans (March 3, 1875) repealed the Tariff Act of 1872, increased the duties on molasses and sugar and increased the revenue tax on tobacco and spirits. Thus the tariff was restored to the war basis, before the incoming Democratic House could block the advance Similarly on March 1 Congress passed a Civil Rights Act, milder than the measure for which Sumner had fought so long, guaranteeing equal rights to the negroes in hotels, public conveyances, and places of amusement and forbidding the exclusion of them from juries An effort to pass a new force bill levelled against the intimidation of negro voters failed By these measures the Republicans placed the important features of their policy where they could be overturned only by a Democratic capture of Presidency and Senate

Supreme Court Decisions.—In the midst of these changes the Supreme Court handed down decisions undoing important portions of the reconstruction system by restraining the tendency of the nation to encroach on the sphere of the State; and restricting the scope of the recent constitutional amendments On April 14, 1873, in the Slaughter House cases, the courts held that the amendments were primarily restrictions upon the States for the protection of the freedom of the coloured man, rather than extensions of the power of the Federal Government under the definition of United States citizenship, and that general fundamental civil rights remained under State protection In the case of the United States v Reese, decided March 27, 1876, the court declared parts of the act of 1870 (which provided for the use of Federal force to protect the negro in his right to vote) unconstitutional, on the ground that they did not specify that the denial of suffrage must be on the sole ground of race or colour A reasonable pre-requisite, such as a poll-tax, for voting was permissible The South later took advantage of this decision to restrain negro suffrage indirectly In United States v Cruikshank (1876) the court held that the amendments to the Constitution left it still the duty of the State, rather than of the United States, to protect its citizens, even when whites had mobbed the negroes In 1883 the court declared the conspiracy clause of the Ku-Klux Act unconstitutional and restricted the application of the law to acts of a State through its officers and not to private citizens. In the same year it declared the Civil Rights Act of 1875 invalid.

In 1875 President Grant refused the appeal of the "carpet-bagger" Gov Adelbert Ames of Mississippi to be supported by troops, whereupon Ames resigned his office into the hands of the Conservatives The Mississippi plan of general intimidation of negroes to keep them from the polls was followed in Louisiana, South Carolina and Florida which alone remained Republican Thus steadily the radical reconstruction policy and Republican control of the South were being reversed It was made clear that negro suffrage could be enforced upon the South only by military rule which could no longer command Northern sympathy or the sanction of the Federal court. Northern interest increasingly turned to other issues, and especially to discontent over administrative corruption

Corruption.—The spoils system had triumphed over the advocates of civil service reform to such an extent that Grant abandoned the competitive system in 1875 on the ground that Congress did not support him in the policy. Enormous frauds in the collection of the internal revenue by the whisky ring with the connivance of Federal officials were revealed in 1875, and at about the same time, secretary of War William W. Belknap resigned to avoid impeachment for corruption in the conduct of Indian affairs The enforced resignation in 1876 of secretary of the Treasury Benjamin H Bristow, after he had successfully exposed the whisky ring, and of postmaster-general Marshall Jewell, who had resisted the spoils system in his department, tended to discredit the Administration. Blaine, the leader of the Republicans in the House of Representatives, fell under suspicion on account of his earlier relations with the Little Rock and Fort Smith and Northern Pacific railways, which left it doubtful, in spite of his aggressive defence, whether he had not used his influence as Speaker in previous Congresses to secure pecuniary advantages from land grant railways

Campaign of 1876.—Thus the campaign of 1876 approached, with the Republicans divided into (1) steadfast supporters of the Grant Administration, (2) a discontented reform wing (which favoured ex-Secretary Bristow), and (3) an intermediate group which followed Blaine. This statesman made a bold stroke to shift the fighting which the Democrats planned to make against the scandals of the Administration, to the old-time war issues. By proposing to exclude Jefferson Davis from amnesty, he goaded Southern congressmen into indiscreet utterances which fanned anew the fires of sectional animosity. A compromise candidate was selected in the person of Gov Rutherford B. Hayes, of Ohio, who had vigorously opposed the greenback movement in his State, and whose life and character, though little known to the general public, made him acceptable to the reform leaders of the party. The Democrats, demanding reform, economy, a revenue tariff and the repeal of the resumption clause of the act of 1875, chose the reform governor of New York, Samuel J. Tilden, as their candidate. The Independent National, or Greenback, Party, which was to develop rapidly in the next two years, nominated Peter Cooper, a New York philanthropist, and demanded the repeal of the Resumption Act, and the enactment of a law providing a paper currency

Hayes Elected.—The election proved to be a very close contest. Tilden, according to the count of both parties, had a plurality of over 250,000 votes, and at first the leading Republican journals conceded his election He had carried New York, Indiana, New Jersey and Connecticut and, by the Democratic count, the solid South. But the Republican headquarters claimed the election of Hayes by one electoral vote, based on the belief that the States of South Carolina, Florida and Louisiana had gone Republican Since these States were in the midst of the transition from negro to white Government, and elections were notorious for fraudulent practices, a serious question was raised, first as to the proper authority to count the electoral vote, and second, how far it was permissible to go behind the returns of the State authorities to ascertain the validity of the canvass of the votes in the

State. The political capacity and moderation of the nation were severely tested; but in the end a characteristic American solution was found by the creation of an electoral commission in which five associate justices of the Supreme Court were joined with an equal number of representatives from each of the two houses of Congress The result was that this commission refused to "go behind the returns," and Hayes was declared elected by one vote To prevent the threatened danger of a filibuster by Democrats of the House of Representatives against the completion of the count until after legal date for the inauguration of the President, Hayes's friends agreed with leading Democrats that he would withdraw the Federal troops from Louisiana.

Thus a new era began under a moderate and reforming Republican President, a close Republican Senate and a Democratic House of Representatives The Southern question was not settled, but other issues of an economic and social nature increasingly forced themselves to the front. During the dozen years that followed Hayes's inauguration neither party held complete possession of both the executive and the two houses of Congress. His own moderate character, the conditions of his election and the check imposed during the first two years by a Democratic House of Representatives (and during the second two years by an opposition in both houses) made the period of Hayes's Administration a transition from the era of reconstruction to the era of dominant economic and reform agitation

When he withdrew the troops which sustained the Republican Governments in Louisiana and South Carolina, those States returned to the rule of the white Democrats. In the Congress elected in 1878 the former slave States chose 101 Democrats to the House of Representatives and only four Republicans. Leading Republicans like Blaine protested vigorously against the policy, declaring that the men who saved the Union should govern it; and on the other hand the Democrats in Congress added "riders" to appropriation bills designed to starve the Administration into complete cessation of the use of troops and Federal deputy marshals at Southern elections Due to this policy extra sessions had to be summoned in 1877 and 1879 to provide supplies for the Government Hayes assisted his party by vetoing these coercive attempts of the Democrats and it was not until later that Federal attempts to supervise Southern elections entirely ceased

Civil Service Reform.—As his early policy toward the South had dissatisfied many of the leaders of his party, his opposition to the spoils system alienated others In 1877 a Civil Service Reform Association was formed in New York and extended to other States In June 1877 President Hayes issued an executive order against the participation of Federal officers in political management, and he furnished evidence of his sincerity by removing Alonzo B Cornell, the naval officer of New York, who was also chairman of both State and national Republican committees, and Chester A Arthur, collector of the port of New York As both were friends of Senator Roscoe Conkling of that State, the leader of the Grant men, this was a bold challenge The "Stalwarts" answered it by securing the nomination of Cornell as governor of New York and Arthur as vice-president of the United States.

Finances.—The monetary question rose to primary importance at this time Hayes himself had campaigned in Ohio successfully against the greenback movement, and he chose as his secretary of the Treasury, John Sherman, whose long service as chairman of the finance committee had made him familiar with conditions and influential with moderate men. The *per capita* circulation of the nation had fallen from $20 57 in 1865 to $15 58 in 1877 and was still declining. The remarkable increase in the production of silver, as the new mining regions were opened, was accompanied by a fall in its ratio to gold from 15 to one in 1860 to 17 to one in 1877. Congress had, in 1873, passed an act dropping the standard silver dollar from the list of coins; but though the significance of this omission of a coin not widely circulated passed almost unnoticed at the moment, the demonetization of silver was afterward stigmatized as a conspiracy, "the crime of 1873" As the date (Jan. 1, 1879) for the redemption of the greenbacks in specie approached, demands were renewed for the replacement of national bank-notes by greenbacks, for the postponement, or abandonment of resumption, for the free coinage of silver, and for the use of silver as well as gold in payment of bonds redeemable in "coin." Sectional grouping of debtor against creditor regions, rather than party alignment, showed itself in the votes, for each party had its "soft money" as well as "hard money" followers.

A monetary commission, appointed in 1876, reported in 1877, but without agreement or real influence upon the country The president took strong ground against free coinage and against the payment of bonds in silver; but the House of Representatives passed the measure, known as the Bland bill, for the free coinage of silver, by a vote of 163 to 34. In the Senate this was amended and as it finally passed both houses it was known as the Bland-Allison Act after the two leaders, the Democratic representative from Missouri and the Republican senator from Iowa. This compromise was carried over the veto of President Hayes and became a law Feb 28, 1878. In the vote of Feb. 15, all but one of the senators from New England, New York and New Jersey opposed it, while the States west of the Alleghenies furnished only four opposing votes. The law restored the legal tender character of the silver dollar and authorized the secretary of the Treasury to buy silver bullion at the market price, to an amount of not less than $2,000,000 nor more than $4,000,000 per month, and to coin the bullion into silver dollars.

Hardly had the Bland-Allison compromise been effected on the silver issue when an act was passed (May 31, 1878) forbidding the further retirement of greenbacks, which remained at $346,681,000 Substantially the same sectional alignment was followed in the vote on this bill as in the silver votes Not satisfied with this legislation, nearly 1,000,000 voters cast their ballots for Greenback Party candidates at the congressional elections in the autumn of 1878 The preparations of Secretary Sherman had been so carefully made, and the turning tide of trade brought coin so freely to the United States, that before the date of resumption of specie payments a gold reserve had been accumulated to the amount of $133,000,000 in excess of matured liabilities and the greenbacks rose to par before the date of redemption.

Election of 1880.—In the campaign of 1880, Hayes and Tilden both declined to stand for renomination Thus the issue of the "fraud of 1876," which the Democratic platform called the paramount issue, was subordinated Nor was it possible for the Republicans to force the tariff question into a commanding position, for although the Democratic platform declared for a tariff for revenue only, a considerable wing of that party led by Samuel J. Randall, of Pennsylvania, favoured protection. Gen. Winfield S. Hancock, a distinguished soldier in the Civil War, whose nomination for the Presidency by the Democrats was designed to allay Northern distrust, refused to make the tariff a national issue. The recent adjustment of the monetary question and return of prosperity relegated the discussion of the currency also to a subordinate place.

The Republicans, after a heated convention in which the followers of Grant, Blaine and Sherman, fought each other to a deadlock, selected Gen. James A Garfield of Ohio, who was political manager for Sherman in the convention This was a blow to the Grant, or "Stalwart" wing, which was, however, partly placated by the nomination of Arthur for the vice-presidency. Garfield's popular plurality was only a little over 7,000 out of a total vote of over 9,000,000; but his electoral vote was 214 to Hancock's 155. The area of the former slave States marked the boundaries between the Republican and the Democratic States, except that Hancock also carried New Jersey, Nevada and California The Republicans won the elections for the House of Representatives which would meet in 1881, and the Senate was at first nearly evenly divided, two independents holding the balance. In the ensuing four years party lines were badly broken, factions made bitter war upon each other, and the independent reformers or "Mugwumps" grew in numbers The selection of Blaine as secretary of State committed Garfield to the anti-Grant wing, and the breach was widened by his appointment of the collector of the port of New York against the protests of Roscoe Conkling and Thomas C. Platt, the "Stalwart" senators from New York They resigned, then sought re-election in order to vindicate the right of senatorial recommendation; but were defeated.

Garfield Assassinated.—In the midst of this excitement the President was assassinated by a disappointed office-seeker of unsound mind Vice-President Arthur, who succeeded Garfield in Sept. 1881, by his tact and moderation won the admiration of former opponents; but the bad crops in 1881 and the dissatisfaction with boss rule among independent voters caused a Democratic victory in the congressional campaign of 1882.

Legislative Acts.—Garfield's assassination had given new impetus to the movement against the spoils system, a National Civil Service Reform League had been organized in 1881, President Arthur presented the question in his message of December of that year, and in 1882 George H. Pendleton, a Democratic senator from Ohio, urged the subject upon the attention of Congress. Stimulated by the elections of 1882 Congress passed an act (Jan 16, 1883) authorizing the President to appoint a commission to classify certain of the Federal employees, and providing for appointment and promotion within this classified list by competitive examination. Congressional recommendations for these offices were not to be received, and political assessments for campaign purposes were forbidden This was an effective beginning in the purification of the civil service; but the evil of assessment of employees was succeeded by the evil of soliciting campaign contributions from corporations interested in legislation. The extension of the competitive list proceeded gradually through succeeding Administrations The Edmunds Anti-Polygamy Act (1882) was levelled at the Mormons and the Chinese Exclusion Act was passed at the demand of labour, after a long agitation in 1882, the way having been prepared by the Treaty of Peking in 1880 Bills to this effect had been vetoed by Hayes and Arthur as violative of international agreement, but the desire of the politicians to win the California vote, and the compromise by which the exclusion was limited to ten years finally carried the measure, and the Supreme Court (1889) held it constitutional.

Surplus Revenues.—From 1879 to 1890 the Treasury showed a surplus of revenue over expenditure This furnishes the explanation of much of the legislation of that period It led to extravagant appropriations, such as the Arrears of Pensions Act of 1879, and the River and Harbor Act of 1882 providing for the expenditure of more than $18,000,000 which was passed over the veto of Arthur Appropriation bills were merely constructed in various committees of Congress under a system of bargaining between interests and sections with primary reference to the political fortunes of the congressmen

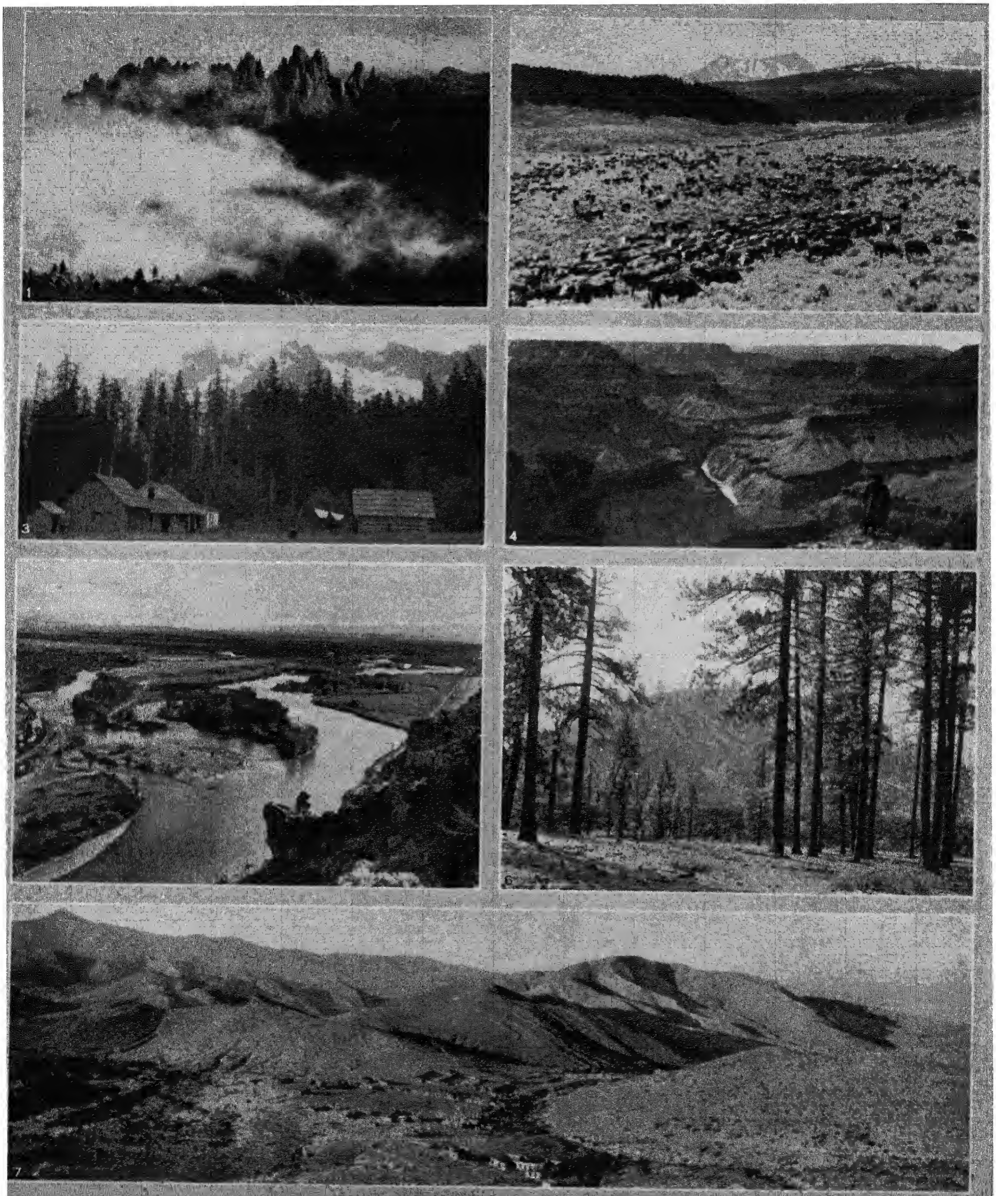
The surplus also strengthened the demand for a reduction of the tariff A tariff commission, composed of men friendly to protection, appointed in 1882, proposed an average reduction of 20 to 25% Nevertheless, in the act as passed in 1883 duties were increased in general on those protected articles which continued to be imported in large volume, especially on certain woollen goods and about two-thirds of the imported cotton goods, and on iron ore and some steel products, while they were lowered on finer grades of wool and cheaper grades of woollen and cotton fabrics, etc It was unsatisfactory to large portions of both parties and did not materially lower the revenue; but the act of 1883 made extensive reductions in internal taxes As the Senate had just fallen into the hands of the Republicans, and the House would not become Democratic until the new Congress met, this protective law gave the Republicans the advantage of position Moreover, the Democrats were themselves divided, 19 Representatives voting with the Republicans on the act of 1883. In the next Congress (1884), when the leaders made an attempt to rally the Democrats to show their position by passing a bill for a horizontal reduction of 20% in general, 41 Democrats voted against the bill and prevented its passage through the House.

Election of 1884.—Thus the campaign of 1884 found both parties still lacking unity of policy although it seemed possible that the tariff might become the touchstone of the contest. The Republicans challenged the independents by nominating Blaine, whose record was objectionable to many reformers, and who had been chiefly identified with the reconstruction politics. The Democrats, taking advantage of the situation, nominated Grover Cleveland of New York. He had won approval by his reform administration as mayor of Buffalo and as governor of New York during the past two years, when he had shown an independence of party "bosses" and had convinced the public of his sincerity and strength of character He represented conceptions and interests which had grown up since the war, and which appealed to a new generation of voters. The platform emphasized the idea that "new issues are born of time and progress," and made the leading question that of reform and change in Administration, lest the continued rule of one party should corrupt the government. On the question of tariff the Democrats took a conservative attitude, emphasizing their desire to promote healthy growth, rather than to injure any domestic industries, and recognizing that capital had been invested and manufactures developed in reliance upon the protective system. Subject to these limitations, they demanded correction of abuses. The Greenbackers nominated Gen Benjamin F Butler of Massachusetts, recently chosen governor of that State on the Democratic ticket, but he polled only 175,000 votes John P St. John, the candidate of those who would prohibit the liquor traffic, secured 150,000 votes, an unprecedented gain

Cleveland President.—The campaign abounded in bitter personalities, and the popular vote was close, Cleveland's plurality being only 23,000. The great State of New York, with electoral votes enough to have turned the scale, was carried by the Democrats by only a few more than 1,000 votes out of a total of over 1,000,000 Cleveland's electoral majority was 37. The election was nevertheless recognized as making an epoch For the first time since victory came to Lincoln and the Republicans on the eve of the Civil War, nearly a quarter of a century earlier, the country had entrusted power to the Democrats, although over two-thirds of their electoral vote came from the former slave States. New York, Connecticut, New Jersey and Indiana constituted their Northern territory Perhaps the most significant thing about the result was the evidence that in the North political and sectional habits and prejudices were giving way among a sufficient number of independent voters, responsive to strong personal leadership on reform issues, to turn the political scale. The transition from war issues which began in 1872, and became marked in 1876, was completed by the election of Cleveland in 1884

During the first half of his term President Cleveland had the opposition of a strongly Republican Senate In the second half the Senate remained Republican by a majority of two, and the House continued Democratic. His civil service policy naturally met severe criticism not only from his party foes, but also from the spoils men among his Democratic followers, who desired a clean sweep of Republican office-holders, and from those of his independent supporters who looked to him to establish the service on a strictly non-partisan basis The outcome of the first two years of his Administration was that, of the entire body of Federal office-holders, two-thirds were changed and the obnoxious Tenure of Office Act was repealed, thus leaving the President the right of removal without presenting his reasons. Nevertheless there was a gain, for the criticism by the Republicans placed them on record against the former spoils system; Cleveland somewhat checked the political activity of officeholders; and before leaving the Presidency he transferred the railway mail service to the classified list requiring competitive examination

The transition of executive power for the time to the Democratic Party, however much it impressed the imaginations of the public, as the end of an era, was not so significant as the national growth and expansion in the decade between 1880 and 1890 whereby forces were set loose which determined the characteristics of the succeeding period Between these years the nation grew from about 50,000,000 to over 62,000,000. The Middle West, or North Central group of States, gained nearly 5,000,000 and the Western division over 1,250,000. West of the Alleghenies altogether more than 8,000,000 souls had been added, while the old Eastern States gained but 4,000,000. In 1890 the North Central division alone had achieved a population nearly 5,000,000 greater than that of the North Atlantic, while the trans-Allegheny region surpassed the whole East by about 10,000,000, and the numbers of its representatives in House and Senate placed the political destiny of the nation in its hands.



VARIED SCENERY IN WESTERN UNITED STATES

1. View of the Cathedral rocks in the Black Hills of South Dakota
2. Cattle ranch near Bozeman, Mont., showing peaks of the Rockies
3. View of the Cascade mountains, Washington. Forest ranch in foreground
4. Grand Canyon of the Colorado river, Arizona
5. Where the Jefferson, Madison and Gallatin rivers form the Missouri river, near Three Forks, Montana
6. Volcanic cone and lava wall near Bend, Oregon
7. View of the desert country around Ft. Bowie, Arizona

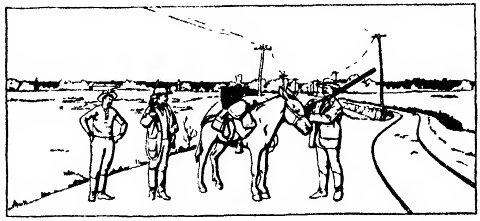
The West.—One of the most important reasons for the wholesale taking up of Western resources in these and the following years was the burst of railway building subsequent to the interruption of the panic of 1873 The eager pioneers pushed into western Kansas and Nebraska as they had into the northern Ohio valley a half-century before Nebraska grew from a population of 123,000 in 1870 to nearly 500,000 in 1880 and to over 1,000,000 in 1890 From about 333,300 in 1870, Kansas' rose to almost 1,000,000 in 1880, and to nearly 1,500,000 in 1890 The railway had "boomed" the Golden West and a cycle of abundant rains seemed to justify the belief that the "Great American Desert" was a myth Thus settlers borrowed money to secure farms beyond the region of safe annual rainfall under the agricultural methods of traditional pioneering Swift disappointment overtook them after 1886, when droughts and grasshoppers ruined the crops and turned back the tide of Middle Western colonists until the western parts of these States were almost depopulated, Kansas alone losing one-seventh of its population, nor did prosperity return for a decade

As the column of settlement along the Ohio valley had extended its flanks into the old North-west between the Ohio and the Great Lakes, and into the old South-west of the lower Mississippi after the war of 1812, so the later pioneers by railway trains began to take possession of the remoter and vaster North-west and South-west The "granger roads," centring in Chicago, thrust their lines out to develop wheat farms in interior Iowa, Minnesota and the Dakotas, where the virgin soil of the prairie farms brought returns that transferred the wheat belt to this new land of promise, and by competition forced the older wheat areas to develop varied agriculture The introduction into the Minneapolis mills of the recently invented steel-roller system of making flour not only built up a great flour industry there but created a demand for the hard wheat suited to the North-western prairies The pine forests of Michigan, Wisconsin and Minnesota were exploited in the same era

A more impressive movement was in progress as additional trans-continental railways were extended from the frontier to the Pacific In 1870 for 1,000m west of Duluth, at the head of Lake Superior, along the line of the projected Northern Pacific railway there were no cities or little towns Relying upon its land grant and upon the undeveloped resources of the vast tributary region, the railway, after halting for a few years subsequent to the panic of 1873 at Bismarck on the Missouri rushed its construction to Seattle and was opened in 1883 The Great Northern, a product of the vision and sound judgment of James J Hill, started from St Paul without a land grant and reached Puget sound in 1893 Thus a new industrial zone had been brought into existence Colorado had become a State in 1876, in 1889 North Dakota South Dakota, Washington and Montana were admitted as States and the next year Idaho and Wyoming were added The Western political forces, especially the friends of silver, were thus given the balance of power in the Senate

As a new North-west was opened by the completion of the Canadian Pacific (1883), the Northern Pacific (1883) and the Great Northern (1893), so the new South-west was entered by the completion of the Southern Pacific from New Orleans across Texas, New Mexico, Arizona and southern California to San Francisco by 1883. In 1883 also the lines which became the Atchison, Topeka and Santa Fe, extending from the lower Missouri valley, with St Louis and Kansas City as important terminals, through south-eastern Colorado, northern Arizona and New Mexico, reached the same goal The Denver and Rio Grande opened new mining areas between Denver and Ogden

Not only additional mines were reached by these lines, but a great cattle country, recently the habitat of the bison and the Indian, was opened. All the large cities commanding the approaches to this country developed packing industries, but Chicago especially profited. South-eastern Texas was the original home of these cattle ranches, but the driving of herds to supply the miners of the Rocky Mountains revealed the fact that the whole bison country was capable of supporting range cattle, and the practice grew of driving the stock to the feeding ground of the north and returning The height of the movement along the cattle trail, which in its largest extent ran through the public lands of the great plains from Texas to the Dakotas and Montana, was reached in 1884 In that period cattlemen fought over the possession of the range, controlled vast tracts by seizing the approaches to the water supplies under perversion of the land



BY COURTESY OF AMERICAN EXPRESS

"ON THE NORTH LINE." THE LAND RUSH TO OKLAHOMA IN 1889
Since 1834 the land comprising the present state of Oklahoma had been in the possession of Indian tribes. In 1889 the Federal government purchased a title to a large tract and a proclamation was issued that at noon on April 22nd, this land would be opened to homestead settlement. More than 20,000 people were on the border at the appointed hour

laws, fenced in the public domain, either defiantly or by leases from land grant roads, and called out proclamations of Presidents from Hayes to Cleveland The steady advance of the farmer, and protective measures against the spread of the cattle disease known as Texas fever, gradually prevented the continuance of the trail, and ultimately broke down the system of great ranches About 1870 shipment of live-stock from Chicago had become significant, and within a decade the refrigerator car revolutionized the packing industry by making possible the shipment of dressed beef not only to the markets of the Eastern United States but even to Europe The value of slaughtering and packing industries in the United States increased from less than \$30,000,000 in 1870, to \$564,000,000 in 1890

Another important revolution in American economic life was effected by the opening of new iron mines, the growth of the steel and coal industry and the rise of an extraordinary internal commerce along the whole length of the Great Lakes By 1890 the output of pig-iron in the United States surpassed that of Great Britain, having doubled since 1880 The full meaning of the revolution is seen in the fact that by 1907 the United States produced more pig-iron and steel than Great Britain, Germany and France combined As a result of the growth of the wheat, lumber and iron-ore production of the North-west, the traffic along the 1,000m of the Great Lakes grew (chiefly after 1890) by leaps, and changed from wooden sailing-vessels to steel ships driven by steam The traffic through the Sault Ste Marie canal came greatly to exceed that through the Suez canal

The New South.—The South shared in these industrial transformations Not only did white labour produce an increasing proportion of the cotton crop, but cheap white labour came from the uplands to cotton mills situated at the water-powers. This, with the abundant supply of raw material, enabled the South to develop cotton manufacture between 1880 and 1890 on a scale that threatened New England's dominance The southern Appalachians began to yield their treasures of coal and iron, northern Alabama became one of the great centres of the iron industry and the South produced nearly 400,000 tons of pig-iron in 1880 and 2,500,000 20 years later By 1890 the production of coal, iron-ore and pig-iron in this section was as great as that of the United States in 1870 The value of the products of manufacture in the South rose from \$338,000,000 in 1880 to \$1,184,000,000 in 1900 The exploitation of the long leaf pine forests also attracted Northern capital Fruit and truck gardening grew rapidly, and the South began to exhibit traits of industrial development familiar in the North and West. The negro problem continued to hold the South as a whole to the Democratic party

Industrial Changes.—The opportunities opened to capital by these forces of growth in the West and South, as well as the

general influence of an age of machine production, led to transformations in the East which brought new difficulties for political solution The East began to exhibit characteristics of other long-settled countries where increasing density of population and highly developed industry are accompanied by labour troubles To capital the opening resources of the West, and the general national prosperity after 1879, offered such inducements that large scale production by corporations became the order of the day The forces which had exhibited themselves in increased manufacture and railway development between the Civil War and the panic of 1873 now found expression in a general concentration of industries into fewer plants with vastly greater capital and output, in the combination of partnerships into corporations, and of corporations into agreements and trusts to avoid competition and to secure the needed capital and economies for dealing with the new problems of industrial magnitude. Western farming competition led to the actual abandonment of much inferior land in New England and to agricultural disadvantages in the Middle States As agriculture became less attractive and as industrial demands grew, the urban population of the East increased at the expense of the rural The numbers of cities of the United States with more than 8,000 people nearly doubled between 1880 and 1890; by 1900, the urban population constituted a third of the total, this phenomenon was especially marked in the North Atlantic division, where, by 1900, over half the population was in cities of more than 8,000 inhabitants

In similar fashion concentration of industry in large establishments was in progress In 1880 nearly 2,000 mills were engaged in the woollen industry; in 1890 not many more than 1,300. Even more marked was the change in iron and steel, where large-scale production and concentration of mills began to revolutionize this fundamental industry, and other lines of production showed the same tendency The anthracite mines of Pennsylvania fell into the possession of seven coal-carrying railways which became closely allied in interest. In most of the important industries the tendency of large organizations to subject or drive out the small undertakings became significant Already the railways to avoid "cut-throat competition" had begun to consolidate, to form rate agreements and to "pool" their earnings

Interstate Commerce Act.—The Cullom bill as enacted into the interstate commerce law of Feb. 4, 1887, was framed to prevent unjust discriminations by the railroads between persons, places and commodities, the tendency of which was to foster monopoly. The law forbade discriminations and pooling, made a higher charge for a short haul than for a long haul over the same road illegal, required publicity of rates, and provided for a commission to investigate and fine offenders But the decisions of the commission were reviewable by the Federal courts and the offender could be coerced, if he refused to obey the commission, only by judicial proceedings The commission was empowered to provide uniform accounting and to exact annual reports The principle settled by the law was an important one, and marked the growing reliance of the former individualistic nation upon Federal regulation But the difficulties by no means disappeared; the Federal judiciary refusing to accept the findings of the commission on questions of fact, retried the cases, and the Supreme Court overruled the commission on fundamental questions, and narrowed the scope of the act by interpretation.

Social Unrest.—Labour exhibited the tendency to combination shown by capital. The Knights of Labor, founded in 1869, on the basis of "the individual masses" instead of the trades unions, and professing the principle that "the injury of one is the concern of all," grew from a membership of about 100,000 in 1885 to 730,000 in 1886. The number of strikes in 1886 was over twice as many as in any previous year. In one of the strikes on the Gould railway system 6,000m of railway were held up. In New York, Henry George, author of books proposing the single tax on land, ran for mayor of the city and received 68,000 out of 219,000 votes At the same time socialistic doctrines spread, even among Western farmers. But sympathetic strikes, anarchistic outbreaks, and drastic plans for social change did not appeal to the people as a whole The Knights of Labor began to split, and the unions, organized as the American Federation of Labor, began to take their place with a less radical membership. President Cleveland broke with precedents in 1886 by sending in the first message on labour, in which he advocated, without success, a labour commission to settle controversies A national bureau of labour to collect statistics had been established in 1884; State legislation increasingly provided for arbitration of labour disputes, and regulation of factories and child labour.

Early in 1885 a law had been enacted forbidding the importation of labour under contract, and in 1888 the Chinese Exclusion Act was continued. Immigration was exceptionally large in the decade from 1880 to 1890, amounting to about 5,250,000 as compared with 2,800,000 for the previous decade But a large number of these new-comers settled on the newly opened lands of the Middle West By 1890 the persons of German parentage in the Middle West numbered over 4,000,000 Minnesota held 373,000 persons of Scandinavian parentage The Irish constituted the largest element among the English-speaking immigrants The population of foreign parentage amounted to one-third of the whole population of the United States in 1890.

In the midst of this national development and turmoil President Cleveland struggled to unite his party on a definite issue The silver question continued to divide each party, the continued fall of silver leading to renewed agitation for free coinage The surplus led to extravagant appropriation bills, such as special pension bills, which Cleveland vetoed altogether, thereby incurring criticism by veterans of the Civil War, and river and harbour improvement measures, particularly the act of 1886, to which the President gave reluctant assent, and the bill of 1887, to which he gave a "pocket veto" by refusing his signature. But the retention of the surplus in the Treasury would create a monetary stringency, its deposit in banks aroused opposition, and its use to buy bonds was unpopular with the Democrats

The Tariff.—Cleveland boldly met the issue and gave purpose to his party by his annual message of Dec 1887, which he entirely devoted to an exposition of the situation arising from the surplus, and to a demand for a revision of the tariff in order to reduce revenue He did not profess free trade doctrines "It is a condition which confronts us, not a theory," he declared The election of 1886 had reduced the Democratic majority in the House, but the President was able to induce his party to pass the Mills bill (1888) through that body as a concrete presentation of policy The bill put many important raw materials (including wool) on the free list, substituted *ad valorem* for specific duties to a large extent, and generally reduced the protective duties It was believed that the measure would remit over $50,500,000 of duties, nearly $20,000,000 of which would result from additions to the free list. The Republican Senate also found party unity on the tariff issue and its committee on finance, under the leadership of Senator Nelson W Aldrich of Rhode Island, drafted a counter proposal. They would reduce revenue by repealing the taxes on tobacco, and the taxes on spirits used in the arts and for mechanical purposes, and by revising the tariff so as to check imports of articles produced at home

Harrison Elected.—On the tariff issue the two parties contested the election of 1888, the Republicans denouncing the Mills bill and the Democrats supporting it Blaine having withdrawn from the contest, and John Sherman having secured but little more than half the votes necessary to nominate, the Republicans picked from a multitude of candidates Gen Benjamin Harrison of Indiana, grandson of President William Henry Harrison, to run against Mr Cleveland The popular vote was exceedingly close, but Harrison had an electoral majority of 65, having carried all of the States except the solid South, Connecticut and New Jersey The increasing use of money to influence the election, and particularly the association of great business interests with such political "bosses" as Matthew S Quay of Pennsylvania and Thomas C Platt of New York, were features of the campaign. The congressional elections ensured to the Republicans the undisputed control of all branches of the Government when the 51st Congress should convene, and it was generally agreed that the party had a mandate to sustain the protective tariff.

Lacking a large majority in either house the Republicans were exposed not only to the danger of free silver defections in the Senate, but also to "filibustering" by the Democratic minority in the House as the means of blocking the victorious party's programme. These obstructive tactics were made possible chiefly by the use of privileged motions and roll calls to delay business, and the refusal to respond on the roll call for a vote, thus preventing a quorum. Speaker Thomas B Reed of Maine, a virile and keen-witted leader, greatly strengthened the power of the Speaker, as well as expediting the business of the House, by ruling that the Constitution required a present, not a voting, quorum; and in spite of disorderly protests he "counted a quorum" of those actually present By securing rules sanctioning this action and empowering the Speaker to refuse to entertain dilatory motions, that officer became the effective agent for carrying on the business of the party majority As his power through the committee on rules, which he appointed, grew, he came, in the course of time, also to dominate the action of the House, refusing to recognize members except for motions which he approved This efficiency of action was secured at a loss to the House as a representative and debating body, responsive to minority proposals

Sherman Anti-Trust Act.—But the discipline of party caucus and House rules enabled the Republican leaders to put through with rapidity a number of important laws One of these was the measure known as the Sherman Anti-Trust Act of July 2, 1890, which declared combinations affecting commerce between the several States, or with foreign nations, illegal and punishable by fine or imprisonment or both This act, the full power of which was not exhibited until later, was a response to the growing unrest of the nation as other corporations emulated the success of the Standard Oil Trust (formed in 1882) The members of a trust combined in an organization managed by boards of trustees whose certificates the former owners accepted instead of their shares of stock in the component companies Competition was thus eliminated within the combination and the greatly increased capital and economies enabled it not only to deal with the increasing magnitude of business operation, but also to master the smaller concerns which opposed it State legislation had proved unable to check the process, partly because the trust was an interstate affair By putting into operation its power to regulate interstate commerce, Congress responded to the popular demand for Federal restraint of these great combinations which threatened the old American ideals of individualism and freedom of competition The trusts, although embarrassed, soon showed their ability to find other devices to maintain their unified control Nor was the act used, in this period, to prevent the railways from agreements and combinations which in large measure neutralized the anti-pooling clause of the Interstate Commerce Act of 1887

Silver Purchases.—Another important law was the so-called Sherman Silver Purchase Act of July 14, 1890 By 1889 the ratio of silver to gold had fallen to one to 22 In the 12 years of the Bland-Allison Act of 1878 over 378,000,000 silver dollars had been coined from bullion purchased at the market price This bullion value was falling: it was $.89 in 1877 and $.72 in 1889 The production of gold in the United States in 1878 was about 2,500,000 fine ounces, and of silver about 35,000,000; in 1890 the gold production was 1,588,000 and the silver 54,500,000. The Silver Purchase Act authorized the secretary of the Treasury to purchase each month 4,500,000 oz of silver at its market price and to pay for it in treasury notes redeemable at his discretion, in silver or gold

McKinley Tariff.—The customs duties upon which the fighting of the campaign of 1888 had turned was promptly taken up, and in the McKinley Tariff Act of Oct 1, 1890 the Republicans embodied their conceptions of protection to American industry Some of the main features of this law were the addition of agricultural products to the protected articles; the extension of the free list, particularly the inclusion therein of raw sugar, which had been bringing in a revenue of $50,000,000 annually; the granting of compensating bounties to sugar planters to an amount of about $10,000,000 a year; and the raising of duties to the prohibitory point on many articles of general consumption which could be produced at home Blaine, then secretary of State, had just been active in promoting closer relations with South America wherein he hoped for an extension of American trade and he severely criticized the bill as it passed the House, because the free list opened wide the doors of American trade, particularly to sugar-producing countries, without first exacting compensating advantages for our products in those markets To meet this criticism a provision was finally added authorizing the President to impose discriminating duties where it was necessary to obtain the advantages of reciprocity.

This tariff, which passed on the eve of the congressional elections of 1890, was immediately followed by such increases in prices and the cost of living that it was potent in bringing about the political revolution, or "land slide," which swept the Republicans from power in the House of Representatives. The Republicans returned but 88 members as compared with nearly twice that number in the Congress which passed the McKinley bill. Looked at broadly, the movement was a rural uprising, strongest in the South and Middle West, the old Granger areas, against forces which seemed to them to threaten their ideals of American democracy. But the movement was recruited by the silver-mining states and discontented labour interests

Farm products had not proportionately shared the general increase in prosperity. This convinced large portions of the agricultural West that the currency system had too narrow a basis in gold, which was appreciating in value. Much of the Middle Western agricultural development had been made on borrowed Eastern capital, and it seemed to the farmer that the principal of his mortgage was in effect increasing with the rise in the price of gold, at the same time that his crops brought a smaller net profit He did not give due attention to the effect of greatly increased production, as the new wheat lands were opened on such a grand scale; but he was keenly sensitive to increased freight rates and to the influence of Eastern capitalists, banks, bondholders, trusts and railways upon Federal and State legislatures and judiciary. After the evidence of the power of this tide of Western discontent in the elections of 1890, those portions of it which were ripest for revolt combined in 1892 as the People's Party or Populists, soon to prove an important political factor

The Republicans meanwhile had been actively reducing the surplus In 1892 the excess of revenue over expenditures was $10,000,000; in 1893 only $2,000,000 This was effected not only by the Tariff Act but by such measures as the Dependent Pension Act of 1890 (resulting in a list of pensioners of the Civil War which cost the nation $68,000,000 by 1893, over half of these pensioners having been added during Harrison's Administration), the rapid construction of the new Navy, raising the United States from 12th to fifth in the list of naval powers; the repayment of the direct war tax to the States (1891) to the amount of $51,000,000, and other appropriations such as those provided by river and harbour bills. The Democrats stigmatized this Congress as a "billion dollar Congress" from its expenditures, to which Speaker Reed replied that the United States was a billion dollar nation In fact the Democrats when they regained power were not able greatly to diminish the cost of government

Homestead Strike.—The Democratic House in the 52nd Congress repressed obstructive Republican tactics by methods like those adopted by Speaker Reed, and contented itself with passing a series of bills through that body proposing reductions of the tariff in special schedules, including free wool and a reduction of the duty on woollens, free raw material for the cotton planters of the South, free binding twine for the farmers of the North and a reduced duty on tin plate for the fruit raisers Of course these bills failed in the Republican Senate A bloody strike on the eve of the election of 1892 in the great steel works at Homestead, Pa., where armed guards engaged by the company fired upon the mob which sought higher wages, was not without its adverse effect upon public sentiment in regard to the Republican tariff for the protection of labour

During the campaign of 1892 the Democrats rejected a conservative tariff plank, denounced the McKinley tariff in violent language, and denied the constitutional power to impose tariff

duties except for the purpose of revenue only. But Cleveland, who was renominated in spite of vigorous opposition from leading politicians of his own State, toned down the platform utterances on the tariff in his letter of acceptance In their declarations upon the currency the Democrats furnished a common standing ground for the different factions by attacking the Silver Purchase Act of 1890 as a cowardly makeshift.

Cleveland Re-elected.—The People's Party, in its national convention at Omaha (July 1892), drew a gloomy picture of Government corrupted in all of its branches, business prostrated, farms covered with mortgages, labour oppressed, lands concentrating in the hands of capitalists Demanding the restoration of government to the "plain people," they proposed an expansion of its powers, to afford an adequate volume of currency and to check the tendency to "breed tramps and millionaires" Among their positive proposals were the free and unlimited coinage of silver at the legal ratio of 16 to one, the expansion of a national currency issued directly to the people; the establishment of postal savings banks, Government ownership of the railways, telegraph and telephone, restoration to the Government of the lands held by railways and other corporations in excess of their needs, and a graduated income tax Combining with the Democratic Party in various States beyond the Mississippi, and with Republicans in some of the Southern States, they won large masses of voters in the West, and exerted an influence upon public opinion in that section beyond what was indicated in the returns, although Gen James B Weaver of Iowa, their candidate for the Presidency, received over 1,000,000 popular votes and 22 votes in the electoral college The Republicans renominated President Harrison, though he lacked an enthusiastic personal following. They supported the McKinley Tariff Act in spite of the wave of opposition shown in the elections of 1890 But, fearing party divisions, they, like the Democrats, made an ambiguous declaration on the currency The result of the election of 1892 was to return the Democrats under Cleveland to power by a plurality of over 380,000 and an electoral plurality of 132 Congress in both branches was to be Democratic in 1893, and the way was open for the first time in a generation for that party to carry out a policy unchecked by any legislative or executive branch of Government

Panic of 1893.—But before Cleveland was fairly started in his second Administration the disastrous panic of 1893 swept the nation, nor did prosperity return during the four years that followed The panic is not, directly at least, to be traced to the silver purchases, but was the result of various causes, including the agricultural depression, farm mortgages, reckless railway financing and unsound banking in the United States. The panic began in the spring with the failure of the Reading railway and the collapse of the National Cordage Company, one of the numerous examples of reckless trust financiering into which large banks had also been drawn Clearing-house certificates were resorted to by the New York banks in June, followed in August by partial suspension of specie payments Currency remained at a premium for a month; deposits in national banks shrank enormously; national bank loans contracted more than 14·7%; failures were common, 22,000m of railways were under receiverships, and construction almost ceased

The panic of 1893 was in many ways a turning-point in American history It focused attention upon monetary questions, prostrated the silver-mining States, embittered the already discontented farming regions of the West, produced an industrial chaos out of which the stronger economic interests emerged with increased power by the absorption of embarrassed companies, and was accompanied by renewed labour troubles Most noteworthy of these was the Pullman Car Company strike near Chicago in 1894, which led to sympathetic strikes by the American Railway Union, extending over 27 States and Territories from Cincinnati to San Francisco. Mobs of the worst classes of Chicago burned and looted cars The refusal of Gov John P Altgeld of Illinois to call out the militia, and interference with the United States mails, led President Cleveland to order Federal troops to the scene, on the constitutional ground that they were necessary to prevent interference with interstate commerce and the postal service and to enforce the processes of the Federal courts. The courts issued a sweeping injunction requiring that the members of the American Railway Union or other persons desist from interference with the business of the railways concerned. The president of the striking organization, Eugene V. Debs, was imprisoned for contempt of court and conspiracy

Silver Issue.—The most immediate political effect of the panic was upon the silver issue Soon after the outbreak of the financial crisis, the gold reserve, which protected the greenbacks and the Treasury notes issued under the Silver Purchase Act, shrank ominously, while foreigners returned their American securities instead of sending gold To sell bonds in order to replenish the gold reserve, and to repeal the Silver Purchase Act without substituting free coinage, would aggravate Western discontent and turn away the promise of recruits to the Democratic Party from the Populists of the prairie and silver-mining States; to carry out the Democratic platform by a tariff for revenue only while mills were shutting down would be hazardous in the East. The fruits of victory were turning to ashes; but Cleveland summoned a special session of Congress for August, while the panic was acute, and asked his party to repeal the Silver Purchase Act without accompanying the repeal with provisions for silver Not until the last of Oct 1893 was repeal carried, by a vote in which the friends of repeal in the House were about equally divided between Democrats and Republicans, and nearly two-thirds of its opponents Democrats.

By this time the surplus had disappeared and the gold reserve was drawn upon for ordinary expenses Early in 1894 the Administration, failing to secure legislation from Congress to authorize the sale of gold bonds on favourable terms to protect the reserve, sold under the Resumption Act of 1875 $50,000,000 5% bonds, redeemable in ten years Part of this very gold, however, was withdrawn from the reserve by the presentation of legal tender notes for redemption, and the "endless chain" continued this operation to the verge of extinguishing the reserve, so that another loan of $50,000,000 in 1894 was followed in 1895 by a dramatic meeting between Cleveland and some of his cabinet with the Wall street banker, J Pierpont Morgan, who agreed on behalf of his syndicate to sell the Government $65,166,000 of gold for $62,315,000 of bonds, equivalent to 4% bonds for 30 years at a price of 104 In return the syndicate agreed to use its influence to protect the withdrawals of gold from the Treasury These securities were over-subscribed when offered to the public at 112½. President Cleveland had protected the Treasury and sustained the parity of gold and silver, but at the cost of disrupting his party Again, in the beginning of 1896, the Treasury was forced to sell bonds, but this time it dealt directly with the public and easily placed $100,000,000 in bonds at about 111, affording a rate of interest about equal to 3·4%

Tariff Reform.—Before the political harvest of the monetary issue was reaped, the Democrats had also found party ties too weak to bear the strain of an effective redemption of the party pledges on the tariff The Wilson bill prepared as the administrative measure was reported late in 1893, while the panic was still exerting a baneful influence Its leading features were the substitution of *ad valorem* for specific duties in general, the extension of the free list to include such materials of manufacture as iron ore, wool, coal, sugar and lumber, and the reduction of many prohibitory rates The loss in revenue was partly provided for by an income tax, significant of the new forces affecting American society, and an increase in the duty on distilled liquors. Although the bill passed the House by an overwhelming majority, it met the opposition in the Senate of the representatives, Democratic as well as Republican, of those States whose interests were adversely affected Led by Senators Arthur P. Gorman, of Maryland; Calvin S Brice, of Ohio; and David B. Hill, of New York, the bill was transformed by an alliance between Democratic and Republican senators, on the plea that it would otherwise result in a deficit of $100,000,000 Coal, iron ore and sugar were withdrawn from the free raw materials and specific duties replaced *ad valorem* in many cases, while many other individual schedules

were amended in the direction of protection The House, given the alternative of allowing the McKinley Act to remain or to accept the Senate's bill, yielded, and the Wilson-Gorman Tariff Act became a law without the President's signature, Aug 27, 1894. Even the income tax was soon (1895) held by the Supreme Court to be unconstitutional

Venezuela Message.—Toward the close of his administration Cleveland's brusque message on the Venezuelan boundary question aroused such excitement and so rallied the general public (though not the more conservative) that the war spirit, shown soon afterwards against Spain, might have been a potent factor in the election of 1896 had not England exhibited exceptional moderation and self-restraint in her attitude The silver question, therefore, became the important issue The Republicans nominated McKinley and declared for the gold standard in opposition to free coinage, losing thereby an influential following in the silver-mining and prairie states, but gaining the support of multitudes of business men among the Democrats in the East and Middle West

William J. Bryan.—The Democratic convention marked a revolution in the party The old school leaders were deposed by decisive majorities, and a radical platform was constructed which made "the free and unlimited coinage of both silver and gold at the present legal ratio of 16 to one, without waiting for the aid or consent of any other nation," the paramount issue Objecting also to the decision against the income tax, and to "government by injunction as a new and highly dangerous form of oppression," they incurred the charge of hostility to the Federal judiciary. William J Bryan made a brilliant speech in behalf of free coinage, and so voiced the passion and thought of the captivated convention that he was nominated by it for the Presidency over the veteran free-silver leader, Richard P Bland of Missouri The Cleveland men, or "gold Democrats," broke with their party after it became committed to free silver, and holding a convention of their own, nominated Gen John McA Palmer, of Illinois, for the Presidency on a platform which extolled Cleveland, attacked free coinage and favoured the gold standard Its main influence was to permit many Cleveland men to vote against Bryan without renouncing the name of Democrats On the other hand the Populist convention also nominated Bryan on a platform more radical than that of the Democrats

The contest was marked by great excitement as Bryan travelled across the country addressing great audiences The endangered business interests found an efficient manager in Marcus A Hanna of Ohio, McKinley's adviser, and expended large sums in a campaign of education In the event, the older States of the Middle West, holding the balance between the manufacturing and capitalistic East and the prairie and mining States of the West, gave their decision against free silver But class appeals and class voting were a marked feature of the campaign, the regions of agricultural depression and farm mortgages favouring Bryan, and those of urban life favouring McKinley Labour was not convinced that its interests lay in expanding the currency, and Mr. Hanna had conducted McKinley's campaign successfully on the plea that he was the advance agent of prosperity under the gold standard and a restoration of confidence McKinley carried all the Northern States east of the Missouri, and North Dakota, Oregon and California of the Farther West, as well as Maryland, Delaware, West Virginia and Kentucky His plurality over Bryan in the popular vote was more than 600,000, and his electoral majority 95 All the departments of Government were transferred by the election to the Republicans

Dingley Tariff.—Having secured power, the Administration called a special session of Congress, and enacted the Dingley protective tariff (July 24, 1897), under which the deficit in the Treasury was turned into a surplus. The act raised duties to their highest point, and as the protective schedules included some important articles produced by trusts which had a practical monopoly, such as sugar and petroleum, this was seized upon by the Democrats to stigmatize the tariff as the "mother of trusts" Many articles which had been placed on the free list in the Tariff Act of 1894, including lumber and wool were made dutiable

Gold Standard.—The Republicans also wrote their triumph into the Gold Standard Act of March 4, 1900, which ensured the maintenance of this standard by reserving $150,000,000 of gold coin and bullion to redeem the United States notes and the Treasury notes of 1890, and by authorizing the sale of bonds when necessary to maintain the reserve National banks were authorized in the smaller towns (3,000 or less) with a capital of $25,000, half of that formerly required, and increased circulation was further provided for by permitting the national banks to issue notes on United States bonds up to their par value

Economic Changes.—The economic policy of the Republicans was facilitated by the prosperity which set in about 1898 The downfall of silver-mining turned the prospectors to seek new gold-fields, and they found them, especially in Alaska, and contemporaneously the chemists discovered cheaper and more efficient methods of extracting the gold from low-grade ores Within five years after the crisis of 1893 the gold production of the United States nearly doubled The United States coined $437,500,000 in gold in the five-year period 1897–1902, while the average for five-year periods since 1873 had been only $224 000,000 Thus gold instead of silver began to inundate the market and to diminish the demand for expansion of the currency Agriculture, prostrated in the years immediately preceding and following the panic of 1893, turned to the scientific study of its problems, developed dry farming, rotation and variety of crops, introduced forage crops like alfalfa, fed its Indian corn to cattle and hogs, and thus converted it into a profitable and condensed form for shipment Range cattle were brought to the corn belt and fattened, while packing industries moved closer to these western centres of supply Dairy-farming replaced the unprofitable attempts of older sections of the Middle West and the East to compete with the wheat-fields of the Farther West Truck and fruit farming increased in the South, and the canning industry added utility to the fruits and vegetables of the West Following the trend of combination the farmers formed growers' associations and studied the demand of the market to guide their sales The mortgaged farms were gradually freed from debt. The wheat crop increased from less than 400,-000,000bu valued at $213,000,000 in 1893 to 675,000,000bu valued at $392 000,000 in 1898 Prosperity and contentment replaced agitation in the West, and the Republican Party gained the advantage of these changed conditions

In the South also there was greater contentment as the new industries of iron, textiles and forestry grew, and as the cotton crops increased Unrest was diminished by the new State Constitutions, which after 1890 disqualified negro voters by educational and tax requirements so contrived as not to disfranchise the poor whites

In the decade which followed the crisis of 1893 a new industrial structure was made out of the chaos of the panic. "High financing" was undertaken on a scale hitherto unknown Combinations absorbed their weaker rivals; Standard Oil especially gained large interests in New York banks and in the iron mines and transportation lines about the Great Lakes, while it extended its power over new fields of oil in the South-west. In general, a small group of powerful financial interests acquired holdings in other lines of business, and by absorptions and "community of interest" exerted great influence upon the whole business world The group of financiers, headed by J Pierpont Morgan, came to dominate various Southern transportation lines and the anthracite coal roads and mines, and extended their influence to the Northern Pacific railway, while a new genius in railway financing, Edward H Harriman, began an avowed plan of controlling the entire railway system of the nation Backed by an important banking syndicate he rescued the Union Pacific from bankruptcy, and with its profits as a working basis he started in to acquire connecting and competing lines Labour also shared in the general prosperity after 1898 Relative real wages increased, even allowing for the higher cost of living, and the length of the working day in general decreased except in special industries

General Prosperity.—By 1900 the continental United States had a population of 76,000,000; an aggregate real and personal wealth of $88,500,000,000; a per capita public debt of $14 52, and per capita money circulation of $26 94 against $21 41 in 1896 In 1901 bank clearings amounted to nearly $115,000,000,000 against

$45,000,000,000 in 1894. Imports of merchandise had fallen in this period, while exports rose from about $847,000,000 in 1893 to $1,394,000,000 in 1900. Of these exports foodstuffs and food animals, crude and partly manufactured, aggregated nearly 40% of the total. The production of pig-iron, which was about 7,000,000 long tons in 1893, was nearly twice that in 1900. This economic prosperity and these far-reaching processes of social change by which the remaining natural resources of the nation were rapidly appropriated, went on contemporaneously with the extension of the activity of the nation overseas The first rough conquest of the wilderness accomplished, the long period of internal colonization drawing to a close, the United States turned to consider its position as a world power

To understand this position it is necessary to return to an earlier period and briefly survey the foreign relations since the close of the reconstruction era. The most significant and persistent influence came from the growing interest of the United States in the Pacific, as its population and economic power extended to that ocean. The problem of an overflow of Chinese migration to the Pacific coast, and the jeopardizing of the American standard of labour by this flood, had been settled by various treaties and laws since 1880 The question of the relation of the United States to an interoceanic canal was not so easily settled. In 1878 Colombia granted a concession to a French company, promoted by Ferdinand de Lesseps, the engineer of the Suez canal, to dig a tide-level canal through the Isthmus of Panama President Hayes voiced the antagonism of the United States to this project of European capital in his message of 1880 in which he declared that such a canal should be under the control of this nation, and that it would be "virtually a part of the coast-line of the United States" Although an American company was organized to construct a canal under a concession from Nicaragua in 1884, no real progress was made, and the French company, defeated by engineering and sanitary difficulties, failed at the close of 1888.

Pan-American Congress.—Meantime, for a few months, Blaine, as secretary of State under President Garfield, began a vigorous foreign policy with especial reference to the Pacific He attempted to get the consent of England to abrogate the Clayton-Bulwer Treaty of 1850, which contemplated the construction of an isthmian canal by private enterprise under joint control and neutralization of the United States and Great Britain, together with such other Powers as should join them In South America he actively pressed the influence of the United States to settle the war between Chile and Peru. Again, in the years from 1889 to 1892, Blaine held the portfolio of State, and attempted to increase the influence of his country in Spanish America by the Pan-American congress of 1890, which proposed a great international railway system and bank, commercial reciprocity and arbitration, without immediate results Indeed, the bad feeling aroused by his earlier policy toward Chile found expression in 1891 in a mob at Valparaiso, when some of the men from the United States ship "Baltimore" on shore leave were killed and wounded. An apology averted the war which President Harrison threatened. Blaine also asserted, against Canada particularly, the right of the United States to the seals of the Bering Sea, but in 1893 arbitrators decided against the claim

Foreign Affairs.—As the Navy grew and American policy increasingly turned to the Pacific, the need of coaling stations and positions advantageous to its sea power was appreciated By a tripartite treaty in 1889 the Samoan islands were placed under the joint control of the United States, England and Germany, and, a decade later, they were divided among these powers, Tutuila and the harbour of Pago-Pago falling to the United States. The Hawaiian islands, which had been brought under the influence of civilization by American missionaries, were connected by commercial ties with the United States. Upon the attempt of the ruler to overturn the constitution, the American party, aided by the moral support of the United States, which landed marines, revolted, set up a republic, and asked annexation to the Union. A treaty, negotiated under President Harrison to this end, was withdrawn by President Cleveland, after investigation, on the ground that the part of the United States in the revolution was improper. He attempted, without success, to restore the original state of affairs, and on July 7, 1898, the islands were annexed.

President Cleveland's conservatism in this and other matters of foreign policy had not prepared the people for the sudden exhibition of firmness in foreign policy with which he startled the nation in his message of Dec. 1895 upon the question of the boundary of Venezuela. That nation and England had a long-standing dispute over the line which separated British Guiana from Venezuela Great Britain declined to arbitrate, at the suggestion of the United States, and gave an interpretation to the Monroe Doctrine which the Administration declined to accept. President Cleveland thereupon brusquely announced to Congress his belief that Great Britain's attitude was in effect an attempt to control Venezuela, and proposed that a commission on the part of the United States should report upon the disputed boundary, and support Venezuela in the possession of what should be ascertained to be her rightful territory Secretary of State Richard Olney declared: "To-day the United States is practically sovereign on this continent, and its fiat is law upon the subjects to which it confines its interposition" Great Britain tactfully accepted arbitration, however, and in the end (1899) was awarded most of the territory regarding which she had been unwilling to arbitrate.

Spanish-American War.—The growing activity of the United States in foreign relations next manifested itself against Spain. Cuba in its commanding position with reference to the Gulf of Mexico and the approaches to the proposed isthmian canal, as well as in its commercial relations, and its menace as a breeding spot for yellow fever, had long been regarded by the United States as an important factor in her foreign policy. Between 1868 and 1878 a harsh war had been in progress between the island and the mother country, and American intervention was imminent But Spain promised reforms and peace followed; again in 1895 revolt broke out, accompanied by severe repressive measures, involving grave commercial injury to the United States

By the Treaty of Paris, signed Dec 10. 1898, Spain lost the remaining fragments of her ancient American empire She relinquished Cuba, which the United States continued temporarily to occupy without holding the sovereignty pending the orderly establishment of an independent Government for the island. Porto Rico, Guam and the Philippines were ceded outright to the United States, which agreed to pay $20,000,000 to Spain, and to satisfy the claims of its citizens against that power By the treaty Congress was to determine the civil rights and political status of the native inhabitants of the ceded territory.

As a result of the Spanish-American War, the United States found itself in a position of increased importance and prestige among the nations of the world Especially in the Pacific, it was immediately involved in the diplomatic situation created by the efforts of European States to divide China into spheres of influence or of actual possession. The interests of the United States in the trade with China, as well as her new position in the Philippines, inclined her to oppose this policy, and secretary of State John Hay showed himself one of the great American diplomats in his treatment of this difficult problem In order to preserve Chinese entity and the "open door" for trade, he drew replies from the nations concerned, the result of which was to compel them to avow and moderate their intentions

The acquisition of Porto Rico and the acceptance of responsibilities in Cuba gave new importance to the isthmian canal and increased the relative weight of the United States in regard to its control The popular excitement with which the voyage of the "Oregon" was followed, as it took its way 14,000m. around South America to participate in the destruction of the Spanish fleet in the battle of Santiago, showed the American people the need of such communication between the Atlantic and Pacific coasts.

The Philippines.—But the immediate political issues were concerned with problems of the relation of the newly won lands to the United States Government. Bryan had persuaded his party to join in ratifying the Treaty of Paris, expecting to determine the status of the islands later. But attention soon turned to the insurrection which broke out (Feb. 4, 1899) in the Philippines under Aguinaldo, after it became probable that the Administra-

tion intended to retain these islands, not under a weak protectorate, but as a possession to be ruled and "assimilated" It was not until the spring of 1902 that this insurrection was completely put down, and in the interval the question of the destiny of the islands and the harshness of the measures of repression aroused political debate. The Democrats and many Republicans charged the Administration with a policy of imperialism.

Porto Rico.—The same issue was involved, in its constitutional and economic aspects, in the treatment of Porto Rico and Cuba. While the insurrection continued in the Philippines the government there was legally a military one, although exercised in part through civil officers and commissions. But in the case of Porto Rico the question was whether the "Constitution follows the flag," that is, whether it extended of its own force without an act of Congress to acquired territory, and covered the inhabitants with all the rights of citizens of the United States, as an integral part of the American people.

The Foraker Act of 1900 imposed a special tariff for two years upon Porto Rico, the proceeds to go to that island's own Treasury. The act further asserted the principle that the inhabitants of the new possessions were not incorporated into the United States or entitled to all the privileges of citizens of the United States under the Constitution, by declaring that statutory acts of the United States locally inapplicable should not be in force in Porto Rico The Supreme Court sustained this act in 1901, holding that Porto Rico was not so strictly a part of the United States that separate customs tariffs could not be imposed upon the territory. The Foraker Act also provided a government for the island In Cuba the United States remained in authority until May 20, 1902 Details of the arrangements whereby the United States secured the substantial advantages of a protectorate without destroying the independence of Cuba, will be found by the reader in the article on CUBA

Re-election of McKinley.—Meantime, in the election of 1900, the Democrats renominated Bryan on a platform which opposed the Republican Administration's acts in relation to the newly acquired territory and declared that "imperialism" was the paramount issue The platform reaffirmed its silver doctrine of the previous campaign and denounced the tariff as a breeder of trusts The Republicans renominated McKinley and endorsed his Administration. McKinley received an electoral majority of 137 and a popular plurality of 849,790. Before his second term was fairly begun he was shot by an anarchist while attending the Pan-American exposition at Buffalo, and died on Sept 14, 1901. His wisdom in choosing able cabinet officers, his sympathetic tact in dealing with men and with sections, as well as the victories of the Spanish-American War, had brought him popularity even among his political opponents. But McKinley, like Cleveland, lacked the imagination to perceive and the desire to voice the aspirations and demands that had been gathering force for many years for legislation and executive action that should deal with the problem of effective regulation of the economic forces that were transforming American society. This gave his opportunity to Theodore Roosevelt, who as vice president now succeeded to office.

Roosevelt President.—It was in foreign relations, which Secretary Hay continued to conduct, that continuity with McKinley's Administration was most evident. But even here a bolder spirit, a readiness to break new paths and to take short cuts was shown by the new President. Venezuela had long delayed the payment of claims of citizens of various nations. In 1901, the President, having been informed by Germany of its intention to collect the claims of its citizens by force, but without acquisition of territory, announced that the United States would not guarantee any State against punishment if it misconducted itself, provided that the punishment did not take the form of acquisition of territory. As a result, a blockade of Venezuela was undertaken by the joint action of Germany, England and Italy at the close of 1902. The diplomatic intervention of the United States early the next year resulted in Venezuela's agreement to pay the claims in part and to set aside a portion of her customs receipts to this end But since the blockading powers demanded preferential treatment, the United States secured a reference of the question to The Hague court, which decided that this demand was justified. Santo Domingo offered a similar problem, having a debt incurred by revolutionary governments, beyond its power to pay, and being threatened with forcible intervention by European States President Roosevelt, in 1904, declared that in case of wrongdoing or impotency requiring intervention in the western hemisphere the United States might be forced "to the exercise of an international police power." In 1905 Santo Domingo and the United States signed a protocol under which the United States Government was empowered to take possession of the custom-house, conduct the finances and settle the domestic and foreign debts of Santo Domingo In spite of the refusal of the Senate to assent to this protocol, President Roosevelt put the arrangement unofficially into effect, until, in 1907, the Senate consented to a treaty authorizing it with some modifications.

In the Far East the Boxer insurrection in China had been followed by the combined military expedition of the powers to the relief of Peking (in which the United States shared), and the exaction of a huge indemnity, of which the United States relinquished nearly half of its share, as in excess of the actual losses. The United States protested against Russian demands upon China, and actively participated in the negotiations which resulted in Russia's agreement to evacuate Manchuria The delays of that power and her policy toward China having led Japan to declare war, Secretary Hay's diplomacy was influential in limiting the zone of hostilities, and the good offices of President Roosevelt brought about the conference between the two powers at Portsmouth, N H, which terminated hostilities in 1905 The dispute over the boundary between Alaska and Canada was narrowed by diplomatic discussion, and the remaining questions, involving the control of important ports at the head of the great inlets which offered access to the gold-fields, were settled by arbitration in 1903 favourably to the American contentions

The isthmian canal also received a settlement in this Administration by a process which was thoroughly characteristic of the resolution of President Roosevelt. *See* PANAMA CANAL.

The Philippines.—In the Philippines early in 1901 municipal and provincial governments were provided for, and the President had been for a brief time granted full power to govern the archipelago He appointed Judge Taft civil governor, and limited the power of the military governor to regions where insurrection continued. On July 1, 1902, congressional authority was substituted for that of the President, but Taft remained governor The provisions of the Constitution guaranteeing life, liberty and property were in general extended specifically to the dependency, and a legislative assembly was promised, the lower house elective, and the upper house to consist of the Philippine commission By negotiations with Rome Gov Taft secured for the Philippines the "friars' lands" which had been a source of friction. On Oct. 16, 1907, the first Philippine assembly was convened in the presence of Taft, then secretary of war.

The tariff question complicated American relations with both the Philippines and Cuba Beet sugar and tobacco interests feared the competition of these products, and opposed freedom of trade between the United States and the new territories The Philippine tariff of 1902 made a reduction of only 25% from the Dingley tariff in the case of the products of those islands, instead of the 75% urged by Taft; but the duties were to go to the Philippines In the case of Cuba a more heated controversy arose over the tariff—Roosevelt strongly urged a substantial reduction in justice to Cuba at several regular and special sessions of Congress, but not until the close of 1903 was a treaty in operation which, under the principle of reciprocity, admitted some products of the United States to Cuba at reduced rates, and allowed Cuban products a reduction of 20% from the Dingley tariff

The Trusts.—The dominant historical tendencies of the beginning of the 20th century in the United States, however, were characterized by huge combinations of capital and labour, the rapid passing of natural resources into private possession, and the exploitation of these resources on the principle of individualism by aggregations of capital which prevented effective competition by ordinary individuals. Pioneer conceptions of individual in-

dustrial achievement free from governmental restraint were adopted by huge monopolies, and the result was a demand for social control of these dangerous forces.

After the Sherman Anti-Trust Act of 1890 the combinations found in the favourable laws of States like New Jersey opportunity to incorporate under the device of the "holding company," which was supposed to be within the law A "promotion mania" set in in 1901 The steel industry, after a threatened war between the Standard Oil and Carnegie groups, was united by Pierpont Morgan into the United States Steel Corporation with stocks and bonds aggregating $1,400,000,000 This was only one of the many combinations embracing public utilities of all kinds. Where open consolidation was not effected, secret agreements, as in the case of the meat packers, effectively regulated the market In the field of railway transportation, Harriman used the bonds of the Union Pacific to acquire the Southern Pacific with the Central Pacific, and by 1906 he was dictator of one-third of the total mileage of the United States Meanwhile the Great Northern and the Northern Pacific had been brought into friendly working arrangements under James J. Hill, and tried to secure the Burlington railway A fierce contest followed between the Hill, Morgan and Harriman forces, resulting in a compromise by which the Northern Securities Company, a holding company for the joint interests of the contestants, was created It was admitted by the counsel for this company that the machinery provided in this organization would permit the consolidation of all the railways of the country in the hands of three or four individuals By using notes of one railway company, based on its treasury securities, one could acquire a controlling interest in others, and by watering the capital stock, recover the cost of the undertaking, while the public paid the added rates to supply dividends on the watered stock

Following a similar tendency the great Wall street banking-houses were dominated by the large financial groups in the interest of speculative undertakings, the directors of banks loaning to themselves, as directors of industrial combinations, the funds which flowed into New York from all the banks of the interior By a similar process the great insurance and trust companies of New York became feeders to the same operations Thus a community of control over the fundamental economic interests of the nation was lodged in a few hands

Such was the situation in domestic affairs which confronted Roosevelt when he became President In his first message he foreshadowed his determination to grapple with these problems In 1903 he instructed the attorney-general to bring suit to dissolve the Northern Securities Company as a combination in restraint of trade, and in 1904 the Supreme Court held the merger illegal But the effect was to increase the tendency to change from incomplete combination of financial interests to consolidated corporations owning the property, and to lead the Government, on the other hand, to seek to regulate these vast business interests by legislation The Elkins law, passed in 1903, increased the power of the interstate commerce commission to prosecute offenders, especially those who violated the anti-rebating clauses In the same year the creation of the Federal bureau of corporations provided for increased publicity in the affairs of these organizations

Combinations of Labour.—Labour was combining in its turn Not only did local unions in most of the trades increase in number and power, but workers in separate industries over large areas were combined for collective bargaining and a national organization, the American Federation of Labor, had a membership by 1905 of approximately 2,000,000. Labour legislation by the States increased under these influences, and political leaders became increasingly aware of the power of the labour vote, while employers began to form counter organizations to check the growth of the movement In 1902 Pennsylvania members of the United Mine Workers of America struck. Inasmuch as their employers were the owners of the anthracite coal monopoly under the control of an allied group of coal-carrying railways, the contest was one of far-reaching importance, and soon brought about a coal famine felt throughout the nation So threatening was the situation that President Roosevelt called a conference of the contestants, and induced them to submit their difficulties to an arbitration commission which, by its report, in the spring of 1903, awarded to the miners shorter hours and an increase of wages.

Steadily the United States enlarged its economic functions In 1903 Congress created a department of Commerce and Labor and made the secretary a member of the cabinet. The reports of this department gave publicity to investigations of the perplexing industrial conditions. The department of Agriculture enlarged its staff and its activity, investigating different plants and animals, ascertaining means of checking insect pests, advising upon the suitability of soils to crops, seeking new and better seeds, and circulating general information. The contemporaneous development of agricultural education in the various Western and Southern States whose agricultural colleges had been subsidized by land grants and appropriations by the Federal Government, and the experimental farms conducted by railways, all worked to the same end. The nation began also to awake to the need of protecting its remaining forests, which were rapidly falling into the hands of corporations by perversion of homestead and other land laws President Cleveland had withdrawn large forest tracts, and in 1898 Gifford Pinchot was made head of a division of forestry in the department of Agriculture In 1901 the work was organized under a separate bureau, and four years later the national forests were placed under his management

Reclamation.—The increasing demand for lands for agriculture led also, under Roosevelt, to the real beginning of national irrigation actively in the vast arid area of the Far West The reclamation service was created by the act of June 17, 1902, which set aside the proceeds of the sale of public lands in 13 States and three Territories as a fund for irrigation works The Government itself reserved timber and coal tracts, water powers and other requisites for construction, and sold the irrigated lands to actual settlers in small farms, while retaining title to the reservoirs and the works. The income from the reclamation fund between 1901 and 1910 aggregated over $60,000,000. By the use of suitable crops and dry farming agricultural occupation was extended into formerly desert lands

Election of 1904.—In the election of 1904 the popularity of President Roosevelt, after his strenuous activity in challenging some of the strongest tendencies in American life, was put to the test His political management exhibited the fact that he was trained in the school of the New York politician as well as in the reformer's camp, and he was easily nominated by the Republicans on a platform which endorsed his Administration, and made no promise of tariff changes The Democrats turned to the Conservative wing, omitted any reference to silver or the income tax, and nominated Judge Alton B Parker, of New York The issue of imperialism had been largely eliminated by the current of events and the anti-trust issue was professed by both parties. In the outcome Roosevelt won by the unprecedented popular plurality of over 2,500,000, and an electoral majority of 196

The State elections of the same period showed that a wave of reform and of revolt against former political forces was rising In five States which Roosevelt carried by his popularity the machine Republican candidates for governor were defeated by reforming Democratic candidates, and in cities like Chicago and Philadelphia the issues of reform and radicalism won unexpected though temporary success. Roosevelt had "stolen the thunder" of the parties of social unrest, including the old populistic areas of the Middle West and the labour element of the cities, and also retained control of the Republican party machinery.

Roosevelt's Second Administration.—In his second Administration President Roosevelt pressed his policies so hard and with such increasing radicalism that he lost control of the regular organization in Congress before the end of his term. In the House Speaker Joseph G. Cannon, of Illinois, exhibited the full power of his office in concentrating party policies in the hands of the few regular leaders, while in the Senate a directing group of New England men who had served for a long time, chiefly senators Nelson W Aldrich and Eugene Hale, showed a similar mastery. Against this control a significant revolt, illustrative of revived discontent in the Middle West, was made by the Republican senator Robert M. La Follette, of Wisconsin, who had won his fight in that State

against the faction friendly to the railways, and had secured primary elections, railway rate regulation on the basis of expert valuation of the physical property of the railways, and a system of taxation which rested more heavily upon public utilities In pressing similar policies upon Congress he became isolated from the party leaders, but forced them to go on record by roll calls

In New York a legislative investigation of the insurance companies disclosed such connections with the high financing of Wall street as to create widespread distrust and to lead to reform legislation The attorney who conducted the investigation, Charles Evans Hughes, had shown such ability that he was chosen governor of New York in 1906 His administration was marked by independence of the party machine and a progressive policy Foreign relations were conducted during the second administration of Roosevelt by Secretary Elihu Root from 1905 He fostered friendly relations with the other American nations, allaying their concern lest ambitious designs of their larger neighbour might endanger their independence In Cuba a signal illustration of the good faith of the United States was exhibited when an insurrection in the summer of 1906 left the republic substantially without a government Taft, then secretary of War, was sent, under the treaty provisions for intervention, to organize a provisional Government. During his few days' service as governor-general he set in motion the machinery for restoring order But Roosevelt had plainly stated that if the insurrectionary habit became confirmed in Cuba she could not expect to retain continued independence

Japanese Immigration.—Attention was again fixed upon the Pacific coast, not only by the earthquake and conflagration which in 1906 destroyed the business parts and much of the residence section of San Francisco, but also by municipal regulations there against the presence of Japanese in the public schools The incident seemed to threaten grave consequences, which were averted by the popularity of Roosevelt both in California and in Japan In the Immigration Act of Feb 20, 1907, the problem of exclusion of Japanese labour, which underlay the difficulty, was partly solved by preventing the entrance to the continental United States by way of neighbouring countries of persons holding passports issued by a foreign Government for going to other countries or dependencies of the United States

As a demonstration of the naval power of the United States in Pacific waters, the President sent the American fleet on a cruise around the world, in the course of which they were received in a friendly spirit by Japan The Navy was increased to keep pace with the growth of that of other nations, both in numbers and size of vessels, in this period, but not to the extent demanded by the Administration Already a more efficient organization of both Army and Navy had been effected While the nation prepared for war, it also engaged prominently in the successive international peace congresses between 1899 and 1907, aiming consistently to increase the use of arbitration

Railway Regulation.—The tendencies of the Government to deal with social improvement were exemplified by the laws of 1906 providing for pure food and meat inspection The Railway Rate Regulation Act of 1906 strengthened previous interstate acts by including pipe lines (except for gas and water) under the jurisdiction of the interstate commerce commission, and extending the meaning of "common carrier" to include express and sleeping-car companies. Published rate schedules were required, not to be changed without 30 days' notice, and more stringent provisions were made to prevent rebating The act provided for review by the Federal courts, and did not permit the commission to investigate an increase of rates until the rates went into operation, nor did it provide for a valuation of the railways as a basis of rate-making which the commission had desired. Later acts partly met the demands of railway employees by increasing the liability of common carriers and by providing for shorter hours.

Panic of 1907.—Although Roosevelt had made concessions to the railways in the formation of the act of 1906, his utterances showed a tendency alarming to the large business interests and the holders of corporation securities generally. The unsettled business conditions were reflected in the stock market, and began to produce a reaction against the activity of Government in this direction. The panic of 1907 started with the downfall of an attempted combination of a chain of banks, copper interests and other enterprises, and was followed by the collapse of the Knickerbocker Trust Company in New York (Oct. 21, 1907). The country was generally prosperous, though much of the banking funds was tied up in New York city at this juncture Clearing-house certificates were resorted to; by Nov 1 partial suspension was general throughout the nation; and banking facilities were more completely interrupted than at any time since the Civil War The Government greatly increased its deposits, and offered Panama 2% bonds to the amount of $50,000,000, and 3% certificates for $100,000,000, with the object of providing the national banks a basis for additional note issues But these were taken only to a small amount, as they proved useful for their moral effect chiefly An enormous addition to the money supply was made in the course of the panic, both by governmental activity, gold imports and national bank-notes The crisis was brought to a close before the end of 1907 by the vigour of the Government and the activity of the large financial interests under the lead of J P Morgan, who finally entered the field to stop the decline, at the same time that his associates in the Steel Trust acquired possession of their last remaining rival of importance, the Tennessee Coal and Iron Co

The reaction after the panic, and the loss of influence resulting from his announcement that he would not permit his renomination for the campaign of 1908, left Roosevelt unable to exercise the compelling power which he had displayed in previous years Congress under the control of the Conservatives refused him legislation which he asked, but before he left the Presidency he raised a new issue to national importance in his calling of a congress of State governors and experts to consider the need of the conservation of natural resources. This congress met in May 1908 and endorsed the proposal for vigorous attention by State and nation to the question

Election of 1908.—In the campaign of 1908 he succeeded, against the opposition of both the extreme Conservative and the Radical wings, in procuring the nomination of Secretary Taft by the Republicans on a platform endorsing the Roosevelt policies, promising a revision of the tariff at a special session, on the basis of such protection as would equal the difference between the cost of production at home and abroad, together with a reasonable profit to American industries, and providing for maximum and minimum rates to be used in furthering American commerce and preventing discriminations by other nations A postal bank was promised, a more effective regulation of the railways, and a modification of the Sherman Anti-Trust Act The Democrats again selected William J Bryan as their candidate; demanded the enforcement of criminal law against "trust magnates" and such additional legislation as would prevent private monopoly; opposed the use of injunctions in cases where they would issue if no industrial dispute was involved, impugned the Republicans' good faith in tariff revision, promising for themselves a substantial reduction of duties; favoured an income tax and a guarantee fund by national banks to pay depositors of insolvent banks, or a postal savings bank, if the guaranteed bank could not be secured, demanded election of United States senators by direct vote of the people, legislation to prevent contributions by corporations to campaign funds, and a more efficient regulation of railways

Taft President.—The Republicans won a sweeping victory, Taft's popular plurality reaching about 1,270,000 and his electoral majority 159 But it had been won by some ambiguity of utterance with respect to tariff and railway regulation. The result was made manifest early in the new Administration, when party contentions over the direction of revision of the tariff, the thoroughness of the regulation of railways and corporations, and the question of where the postal bank fund should be placed, resulted in a movement of "insurgency" among the Republicans of the Middle West The insurgents termed themselves "Progressive Republicans," and did not hesitate to join forces with the Democrats in order to shape legislation to their wishes Progressives and Democrats united in overturning the control of Speaker J G. Cannon in the House of Representatives by modifying the rules,

and a group of senators, chiefly from the Middle-western States, destroyed the control of the regular leaders in the Upper House. President Taft's influence over the revolting wing was further weakened by the charges made against his secretary of the Interior, Richard A. Ballinger, on behalf of Gifford Pinchot, the chief forester, who accused the Administration of obstructing Mr. Roosevelt's "conservation" policy

Pinchot was indeed removed from office, but the "conservation" issue was raised to primary importance by the return of Roosevelt from his African trip His influence was revealed even while he was enjoying the hospitality of European countries. On his return, there was a widely extended desire to know his judgment of the Administration's policy, but he maintained silence until the close of the summer of 1910, when in a series of public utterances in the West he ranged himself, on the whole, with the progressive wing and announced a "new nationalism" which should enlarge the power of the Federal Government and drive the "special interests" out of politics. The "insurgents" achieved remarkable victories in the Middle West, California, New Hampshire and New York in the fall conventions and primary elections, retiring various leaders of the regular wing of the Republicans. Senators Aldrich and Hale, former regular leaders in the Senate, had already announced their purpose to resign The result of the autumn elections was a pronounced victory for the Democratic Party

Social Questions.—At the close of the first decade of the 20th century the United States was actively engaged in settling its social and economic questions, with a tendency toward radicalism in its dealings with the great industrial forces of the nation The "sweat shops" and slums of the great cities were filled with new material for American society to assimilate To the sisterhood of States had been added Oklahoma (1907), and in 1910 Congress empowered New Mexico and Arizona to form Constitutions preparatory to statehood, thus extinguishing the last Territories, except the insular dependencies and Alaska Already the food supply showed signs of not keeping pace with the growth of population, while the supply of gold flowed in with undiminished volume High prices became a factor in the political situation Between 1890 and 1900, in the continental United States, farms were added in area equal to that of France and Italy combined Even the addition of improved farm land in that decade surpassed the whole area of France or of the German Empire in Europe But intensive cultivation and agricultural returns hardly kept pace with the growth in population or the extension of farms (F J.T.)

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FROM 1910 TO 1926

The American Nation.—In 1910 the total population of the continental United States was 92,000,000 Of these, only 50,000,000 were native whites of native parentage; 13,000,000 were foreign-born, and 19,000,000 others were of foreign-born or mixed parentage. The negroes and Indians together numbered about 10,000,000. Everybody in the United States except the American Indian is an immigrant from some other country or a descendant of an immigrant. The main race groups are: (1) the descendants of the colonists, who were mainly Anglo-Saxons, with some Germans and Scotch-Irish and small elements of other races; (2), descendants of the Europeans who came over in great numbers from 1820 to 1870, (3), the large number of recent immigrants and their children

In the opening years of the present century the country was not yet aroused to the dangers arising from this mixture of unassimilated races. Few voices were raised against admitting not only western Europeans, whose languages and customs were much like those of the United States, but men and women from east and south-east Europe and from western Asia. The only bar to immigration based on race was the prohibition, since 1888, of Chinese immigration and the practical exclusion of Japanese labourers by a "gentlemen's agreement" with the Japanese Government (1907). The undigested load was becoming heavy.

Defects in Government.—The units of American society were held together by a strong, if complicated, democratic government, well fitted to rule a diverse population. The political forms were familiar to every schoolboy: (*a*) A group (in 1910)

of 46 States, each with its own government rigidly confined by the traditional principle of "checks and balances" into three departments, legislative, executive, judicial; (*b*) a widely distributed franchise almost equivalent to universal suffrage for adult males; (*c*) a belief that the courts were the highest authority, not only as to questions of personal rights and duties, but as to the validity of the laws and acts of the other two departments; (*d*) local government of city and town, township and county. This combination of governments was expensive and not highly skilled, but was supported by the conviction of a large part of the population that it was the "best government on earth."

In the organization and conditions of business there could be traced some startling contradictions between the word liberty and the fact. Nominally all kinds of business not prohibited by law were open to all comers in free and honourable competition In reality, by 1908, a considerable number of both employers and employees were engaged in a combat outside the laws, constant and conscienceless. It was hard for individuals and firms to compete with corporations, and hard for small corporations to compete with large ones The railways were among the most conspicuous of the large corporations, and they, too, tended to combine into larger and more powerful units. The States could not deal adequately with these powerful bodies because most of the railways and many of the other corporations operated from State to State, and could not be controlled at either end by anything short of federal power

Political organizations were on nearly the same basis as business companies they also grew bigger and more powerful and gathered into fewer groups Nominally, parties are simply associations of voters for common ends. Actually, they are armies acting under commanding leaders who in many cases hold no offices. The evils of this "invisible government," as Elihu Root called it, were apparent The political philosophy of Americans was based on the belief that mankind was steadily growing better. Hence a tendency to rely upon laws and political devices for correcting the ills of popular government What was most needed was the leadership of bold and far-seeing men.

Finances and the Tariff (1908–13).—Every growing unit in the country was harassed by questions of taxation and expenditure The U.S. Government also sought new resources, and found them in the income-tax. This was made possible on July 13, 1909, by the 16th amendment to the Constitution, which came into effect on Feb. 25, 1913. Another new resource of the Federal Government was a tax upon corporations levied on net income (Aug. 5, 1909). The important question of reorganizing the national banking system, so as to furnish a strong national institution, was debated from 1908 to 1912, and was the subject of an elaborate report by a national monetary commission; but no action was taken at that time The net Federal debt was $1,000,000,000, or only about $11 per head of the population.

A financial resource over which Congress had sole authority was the tariff Under strong pressure from members of the party to carry out the promises of the Republican convention of 1908, President Taft, a few days after his inauguration, summoned Congress to meet in special session, for a "revision" of the tariff. As usual there was a long controversy, which resulted (Aug. 5, 1909) in the Payne-Aldrich Tariff The act created a permanent court of customs appeals, with power to determine finally all questions as to the value of imports, together with a tariff board, expected to make investigations and recommend specific measures which Congress might adopt. As to rates, the Act was not very different from its predecessor, except for a decided increase of duties on cotton and silk manufactures There was a loud outcry that the "revision" intended by the party platform was a revision downward and not upward. Nevertheless President Taft signed the bill, and in a speech at Winona, Sept. 17, 1909, surprised the country by declaring that it was the "best tariff bill that the Republican Party has ever passed"

Political Reform (1908–13).—When Roosevelt left the presidency in 1909 the position of President was at the highest point of authority that it had ever known. Most presidents have found their principal legislative influence in the veto; Roosevelt had followed the McKinley method of emphasising his wishes in personal discussion with members of Congress He did more. he revived the Jacksonian method of announcing a legislative plan, and if congressmen hung back, of appealing over their heads to the country at large A similar policy was adopted by President Taft, who had many of the qualities of leadership He was large, happy, genial, fond of his many friends, a cheerful, balanced man He had served as first civil governor of the Philippines and as secretary of War in the cabinet of Roosevelt, who practically designated him as his successor. Nevertheless, as an avowed inheritor of Roosevelt's policies, he drew upon himself the opposition of Roosevelt's enemies while it soon became apparent that he was not relying upon Roosevelt's friends

At this time "the primary" method of selecting candidates was spreading rapidly through the Union Candidates for each party were selected by the ballots of the people, thus undermining the convention system From nominations for local officers the new method had spread, by 1911, to State officers in numerous States; and after 1910 it began to be applied to the choice of delegates to the national party conventions An unforeseen effect was that the official ballots were made upon the basis of party nominations, with an opportunity for independent voting. The primary thus became a part of the system of public elections, and therefore the party system was engrafted on public law, as a part of the Government

The distrust of conventions and controlled elections extended to the numerous and powerful bosses in city and State Legislatures. Three new devices were set at work to curb them and to interest the electors in public measures. The first of these, the "referendum" (*q v*), was by 1909 spreading rapidly through the Western States, as a means of checking legislative action contrary to public sentiment The referendum system furnished a mechanism, usually imbedded in State constitutions, by which on the demand of a sufficient number of voters, a statute could be held back from effect until submitted to a vote of the electors What was to be done if the Legislature refused to enact a statute demanded by the people? The "initiative" (*q v*) was invoked, by which a designated number of voters could unite on a measure, which must then be submitted to the electors for their suffrages

A third branch of this system of appeal to the people was the "recall" (*q v.*), under which a public officer already chosen by popular vote (and in a few cases those who were appointed in some other way) could be subjected to an election; and, should the majority decide against him, be thereby removed from office. In 1911–12 the question came up in connection with the proposed constitution of the new State of Arizona, which included a provision for the recall of judges Because of this provision President Taft vetoed the Act of Admission The State withdrew the clause, was duly admitted in 1912, and thereupon proceeded to reinsert the recall In practice, recalls have proved to be few, and recalls of judges very few A still wider application of the principle of the responsibility of functionaries to the voters was the "recall of judicial decisions," which was advocated by Roosevelt in 1912, but proved to be more than the country desired

United States Senators, till then chosen by State Legislatures, were next made subject to popular choice Urged by public sentiment, Congress submitted (June 12, 1912) the 17th Amendment, which was duly ratified and added to the Constitution (May 31, 1913) Under this, all elections to the Senate were to be made by direct popular vote Another evidence of a rising feeling of responsibility in Congress was a statute (Aug 7, 1911) requiring candidates for the House and Senate to submit statements of the money raised and expended in their behalf and limiting the amount which they themselves might spend One purpose of both these measures was to make it difficult for men to purchase their way into the Senate On July 13, 1912, Senator Lorimer, of Illinois, was practically expelled from the U S. Senate for buying votes in the Legislature

Another slow reform was in the ballot system Most cities, towns and States were loaded down with long lists of the officers

to be chosen The result was an agitation for the reform commonly known as the "short ballot," by reducing the number of elective officers and increasing the officers to be appointed by the few elective officials. Working difficulties were found in many of these reforms. It was hard to keep the public keyed up to the necessary pitch of thought and attention at every election; but it was evident that the American people intended to free themselves from the shackles of "invisible government."

Social Questions (1908–12).—The spirit of discontent extended to many questions outside of politics. Throughout the Taft administration there was an increasing pressure for "equal suffrage" —that is, woman suffrage—which, introduced in the Territory of Wyoming in 1869, had gradually spread among the Far-western States, and then begun working its way eastward. Again, both state and national governments were compelled to deal with the question of alcoholic beverages. From the earliest times there had been restriction on liquor selling and liquor sellers By 1909 in almost all States there was some form of general legal restriction—prohibition, local option, high licence or a State dispensary system. The question became national, because the liquor trade transported its wares from one State to another; and that brought it within the Interstate Commerce clause of the Constitution and the Interstate Commerce Act Eventually by the original Package Act of 1890, Congress adopted the policy of prohibiting shipments of liquor into prohibition States. Pure food laws in force before 1909 were supplemented by the Drug Label Act of 1912, which greatly aided in preventing the adulteration of drugs.

Many questions arose out of immigration The laws in 1909 forbade the entry of labourers under a contract to work in the United States, of convicts, diseased persons and the insane; but the execution of the laws was slack. The first statute looking toward decided control of immigration was that of Feb 1907, which increased the grounds of exclusion, and at the same time provided a plan to help the immigrants in finding work It also created an immigration commission, which in 1910 made a report in 41 volumes, strongly recommending the sifting of immigrants by testing their ability to read and write some language Meanwhile, in the decade 1901–10 the number of immigrants rose to an average of 1,000,000 a year. Since, however, the record showed that from 300,000 to 500,000 annually returned to their old homes, the actual rate of increase of population by immigration was no more than about ½% annually.

Labour Questions.—No legal obstacle stood in the way of the right to organize, first, by local trade unions, then by nation-wide unions for single trades, and finally by national unions combining many trades. To this was slowly added by the unions the principle of the "right to labour," which means both that it is the duty of the community to see that the worker has a job and that at least the skilled workers have a kind of title in their employment, so that it is contrary to good morals for a "scab" to take the place of a striker.

The legal position of labour unions in these controversies was brought out by suits of national importance against unions. In the test case of Gompers v Buck's Stove and Range Co, the charge was that the federation, by posting the company in its publications as "unfair to labour," was boycotting, and thus infringing legal rights Gompers, president of the American Federation of Labor, was convicted for contempt of court on the ground that he had refused to obey a court order to abandon the boycott In 1908 a suit was decided against a union of the hatters of Danbury (Conn), who had attempted to boycott the products of a local hat manufacturer with a verdict of $74,000 damages.

Another phase of the labour situation was the spread of employers' liability laws through various States, and the passing of an Act of Congress (April 22, 1908) for the protection of the employees of interstate railways. In June 1912 Congress added to its previous enactment of an eight-hour maximum regular day for public employees, by providing that all contract work for the Federal Government must also be on the eight-hour basis As most labourers were voters they brought powerful influences to bear on State Legislatures and on Congress in favour of labour On the other hand, the courts, particularly those of the States, were slow to recognize the changes in industrial conditions.

In addition, the courts began to use a system of labour injunctions: workmen, labour unions and their members were ordered to abstain from committing acts which if committed would presumably violate a law and would thus lead to a prosecution, in which the question of guilt could be settled by a jury Instead, the courts by injunction would decide on the responsibility and affix a penalty not specifically laid down in any statute.

Trusts and Transportation 1887–1912.—During the 20 years ending with 1910 it became clear that the most difficult question before the United States Government was the regulation of the vast aggregates of capital, commonly called trusts (*q.v*), which combined into corporations, aimed at the control of particular lines of business, and also of the railways. The efforts of Congress to adjust the question were registered in two lines of restrictive statutes, headed by the Interstate Commerce Act of 1887 and the Sherman Anti-Trust Act of 1890 Upon these was built a structure of decisions by the United States Supreme Court To carry out and partly to avoid these decisions, the Mann-Elkins Act of June 18, 1910, widely extended the Interstate Commerce Acts by including telephones, telegraphs, express and sleeping-car companies, and setting up a Commerce court which was to render decisions on transportation questions. Federal control of railways on the whole worked well. The commission was a striking example of disregard of the principle of separation of powers, inasmuch as it was a rule-making body, an executive body, and a court which interpreted its own rules, subject as to some questions of appeal to the Federal courts

The great problem of the trusts was much farther from a solution than that of the railways, because the large corporations were linked together through the holding and manipulation of stocks by capitalists and banks, and through the so-called "interlocking of interests" The only effective way of dealing with large corporations whose activities extended from State to State was to bring suit against them for monopolizing or conspiring to monopolize in their lines of trade It was considered a triumph when (May 9, 1911) the United States Supreme Court rendered decisions against two of the most powerful trusts—the Standard Oil Company and the American Tobacco Company The court held that the anti-trust legislation must be interpreted by the "standard of reason"—namely, that a combination was not unlawful or against the public interest unless it actually caused a restraint of trade and commerce among the Federal States or with foreign nations Having thus set up a "rule of reason" which Congress had refused to enact, and having created an example of judicial legislation, the court proceeded in both the pending cases to hold that the companies were guilty of attempts to monopolize their lines of trade. As to penalties, the court contented itself with ordering the offenders to disintegrate. The general danger of vast aggregations of capital was ignored.

Foreign Affairs.—The fields of the diplomacy of the United States for the last 100 years have been American, Pacific, and in a much smaller degree European In the Second Hague Conference of 1907 the United States delegates urged international arbitration; and in accordance with the general principles put forth at that conference, Elihu Root as secretary of State secured 25 arbitration treaties with as many countries (1908). The United States and Great Britain arranged (Jan 27, 1909) to refer to The Hague tribunal their long-standing dispute on the Newfoundland fisheries. The result was a decision acceptable to both sides (Sept. 7, 1910). In 1911 the Republican majority under President Taft's leadership initiated a policy of commercial reciprocity with Canada. An agreement was made with the Canadian Government by which each side should by legislation reduce or abolish duties on certain raw products and manufactures. With great difficulty the necessary bill was pushed through Congress (July 1911); but two months later the Canadian electors refused to support the reciprocity agreement, and the plan broke down

Latin America.—Notwithstanding the position of the United States as the responsible holder of the Philippine Islands, and hence an Asiatic Power, the tradition of isolation continued to

be a strong force in the public mind Nevertheless no formidable public protest was made to a policy of special American intervention in Mexico, the Caribbean and the Isthmus region. The arrangements of 1902 made Cuba practically a dependency, subject in the last resort to decisions from the White House President Taft continued the occupation of the Dominican Republic; consent of the Senate under a treaty to that effect having been obtained by Roosevelt in 1907. In 1911 Mr Taft secured a convention by which Nicaragua gave exclusive canal privileges to the United States

The Panama canal was now approaching completion and the little Republic of Panama, which it bisected, though nominally an independent State, was in fact under American control. An Act of Congress (Aug. 24, 1912) laid tolls on shipping, from which American ships engaged in coastwise trade were to be relieved The British Government lodged a protest on the ground that by its treaty with the United States the canal was to be opened on equal terms to the ships of "all nations", President Taft, however, stood by the act, and the question was passed on to the next administration.

Still more serious were the relations with Mexico, where, in 1910, a revolution headed by Madero, assailed the long established government of Porfirio Diaz and drove him after a few months out of the country. Mexico was thrown into confusion, and President Taft found it necessary to place troops on the border In 1912 he proclaimed an embargo on the export of arms or military supplies to Mexico Meanwhile the concessions and property of Americans in Mexico were threatened or destroyed The Americans who had interests in Mexico began a steady pressure for intervention by the United States.

Pacific Relations 1908–12.—Across the Pacific, clouds rose on the diplomatic horizon. The commercial treaties with Japan allowed a reciprocal freedom of residence and trade to the nationals of the two countries The immigration of Japanese was very distasteful to the people of California, who undertook to restrict Japanese children to separate schools Behind this difficulty was the rising power of the Japanese and their national spirit, greatly enhanced by their victory over the Russians in 1905. In 1908 Roosevelt sent round the world a powerful naval fleet, which visited Japan and was received with elaborate courtesy by a welcoming Japanese squadron exactly equal in number, ship for ship In the Root-Takahira reciprocal note of Dec. 1, 1908 (which was never submitted to the Senate), the United States practically admitted Japan's special interest in Asiatic affairs The question of Japanese immigration was settled for the time being by a renewal of the commercial treaty (July 24, 1911). It continued the previous "gentlemen's agreement," according to which, though claiming a right of immigration into the United States, the Japanese Government pledged itself not to issue passports to labourers

Politics 1909–12.—In the action of Congress on many of the important issues above discussed no party lines were drawn, though such measures as the tariff and new taxes were distinctly Republican On the tariff, some members from Middle-western States, particularly Minnesota, voted against the Payne-Aldrich measure of 1909 Another disturbance was due to resentment against the Speaker of the House, Joseph Cannon of Illinois, who through the union of various powers virtually had a veto on any measure or proceeding which he did not like Cannon kept too tight a hand; hence (March 19, 1910) a group of Republican "insurgents" joined hands with the Democrats to reduce his prerogatives till Cannon became simply a partisan moderator.

A new issue upon which both parties were divided was covered by the general term "conservation" Although most of the arable land had passed out of its possession, the Federal Government was still the possessor of great tracts of forest, of mineral lands and of water power. Congress in 1902 provided for a system of irrigation, the cost to be advanced by the Government and repaid in instalments by the users of the water President Roosevelt became interested in stopping the waste of timber and minerals, in preserving part of the gifts of nature for future generations, and in retaining public ownership of the utilities of the country, particularly the forests and streams In 1910 new statutes provided for a fresh classification of land and for the reservation of coal by the Government

Roosevelt and Wilson.—By 1910 it became clear that the Republican Party was weakening, and that President Taft's popularity and influence were lessening The State and congressional elections of 1910 were unfavourable to the Republicans The insurgents, who soon came to be called Progressives, gained most of the Republican districts in the west, and the Democrats gained about 50 seats in Congress. This result transferred to the Democrats the control of the House, while in the Senate they secured 41 of the 92 members.

A group of dissatisfied Republicans gathered about Senator La Follette of Wisconsin as a leader and presumptive candidate for President Meanwhile State Legislatures were passing primary laws which included the election of delegates to national nominating conventions This made it easier to break through the old line organizations, as La Follette had done in his own State Taft's friends and supporters naturally expected that the President would be renominated

All these calculations were disturbed by the greatest personality in the country, Theodore Roosevelt. A few weeks after leaving the White House (1909) he started on an expedition to Central Africa, and was, on his way back, received in Europe as the ex-President of the most important of republics and as a commanding personage He returned to the United States (June 18, 1910) to find political conditions little to his liking Most of his friends had disappeared from the Administration; his policies seemed to him to have been slighted Taft did not satisfy the ex-President, and the two drifted apart On Aug 31, 1910, at Osawatomie, Kan, Roosevelt set forth a programme which he called "the New Nationalism," favouring publicity of the accounts and proceedings of trusts, a tariff commission, a graduated income-tax, an adequate Army and Navy, conservation, protection of labour, and the direct primary with the recall of elective officers For the time being Roosevelt made no direct movement toward standing for the Presidency Meanwhile several of the Western States, particularly California under the guidance of Governor Hiram Johnson, accepted a radical programme of political and social reform. A formal breach with Taft and the open candidature of Roosevelt seemed inevitable The crisis came when (Feb 12, 1912) President Taft in a speech alluded to the Progressives (evidently having Roosevelt in mind) as "Extremists—not Progressives; they are political emotionaries, or neurotics" This was taken as a challenge, and a few days later Roosevelt openly declared himself a candidate

The Election of 1912.—As the convention held in Chicago approached, the lines of battle were developed. Behind Taft were Barnes of New York, Penrose of Pennsylvania, Crane of Massachusetts, and other "stand-pat" leaders Among those in favour of Roosevelt were James R Garfield of Ohio, Pinchot of Pennsylvania and a strong body of Republican governors Roosevelt himself went to Chicago, and threw his immense energy and enthusiasm into the campaign The convention was a scene of unusual excitement

The critical decision was made in the preliminary meetings of the national committee, which was strongly "stand-pat"; for that committee had to decide upon the right of claimants to be inscribed in the preliminary roll of delegates Every contest except one was settled in favour of the Taft claimants The shifting of 30 delegates from one side to the other would have brought about a "stampede" to Roosevelt, but they were not to be had Roosevelt advised his delegates to take no further part in the proceedings. At the final roll-call, June 22, there were 561 votes for Taft, 58 scattering and 107 for Roosevelt, besides 344 Roosevelt men not voting In the last issue, therefore, Taft had a majority of 50 votes out of 1,070 In the minds of Roosevelt and most of his followers the nomination was a violation of the principles of popular government Roosevelt openly advised a bolt This was duly accomplished by a formal Progressive Convention It met in Chicago in August and nominated Roosevelt for president and Hiram Johnson for vice-president

Meanwhile the Democratic Convention met at Baltimore with William J. Bryan in a position to dictate the choice. The apparently sure candidate was Champ Clark of Missouri, Speaker of the House of Representatives But under the rules of the Democratic Convention requiring a two-thirds majority, he was finally defeated by Woodrow Wilson, Governor of New Jersey. The platforms of the two old parties were of the usual type The Republicans declared for protective duties The Democrats stood by their platform of a tariff for revenue only, additional regulation of the railways and presidential preference primaries The Progressive platform was a general programme of political reform and "an enlarged measure of social and industrial justice"

Woodrow Wilson's Victory.—Not platforms, however, but men, appealed to the voters All three candidates took the field From the first it was clear that the real fight was between Roosevelt and Wilson. The Progressives were well organized, and their convention and campaign included many women The final question was whether Roosevelt could draw to himself a sufficient number of Democrats to reduce the Democratic vote below the winning point The result in Nov showed that the Democrats in the main stood by their party candidates. The total popular Democratic vote, 6,286,214, was only about 120,000 less than in 1908. The total Taft and Roosevelt vote combined was almost exactly the same as that of the Republicans in 1900 Roosevelt polled 4,126,020 popular votes to 3,483,922 for Taft; but he carried only six States, with 88 electoral votes, against 2 States with 8 votes for Taft, and 40 States with 435 votes for Wilson

Woodrow Wilson.—On March 4, 1913, Wilson was inaugurated as President. Born in Staunton, Va, in 1856, of Scotch Presbyterian ancestry, he graduated from Princeton in 1879, essayed the practice of law, then was a professor in several colleges. From 1902 to 1910 he was president of Princeton university. He was an easy and attractive speaker, and had a remarkable literary style (*See* WILSON, WOODROW) As Governor of New Jersey during 1911 and 1912 he had opportunity to show his skill as a party leader and his interest in reform In 1912 he was taken up by Bryan, who saw in him an exponent of the political principles for which Bryan had stood and a President who could meet the Progressives on their own ground.

In making up his cabinet it was only reasonable that Bryan should enter it. He was made secretary of State, an office for which he had little adaptation. To a new cabinet office recently created by Congress, the secretaryship of the Department of Labor, Wilson appointed W B Wilson, a strict labour organization man. Lindley M Garrison, secretary of War, and Franklin K Lane, secretary of the Interior, were strong men. Albert S Burleson, postmaster-general, and Josephus Daniels, secretary of the Navy, had insufficient training for their duties David F. Houston, of Missouri, was made secretary of Agriculture, William G McAdoo, secretary of the Treasury and James C McReynolds, Attorney-General. Most of the members of the cabinet were men who could be trusted to follow the President's lead One remarkable statesman not included in this list was Col E. M House of Texas, who for six years was the President's most trusted counsellor and political friend without holding any political office. In the minor civil service Wilson carried out his principles by enlarging the classified list of posts which could be entered only by competitive examinations.

A genial man, who could be a delightful companion, full of experience and of Scotch Presbyterian humour, President Wilson had a powerful mind, an amazing skill of expression and an intense belief in the power of ideals to arouse and inspire a people. He thought he had no need of conferences, of feeling the public pulse, of mixing with members of Congress and party leaders, of personally greeting the average voter.

Finance and Tariff, 1913.—The election of 1912 carried with it a safe Democratic majority in the Senate and a two-to-one majority in the House. On April 8, 1913, the President created a surprise by appearing in person to address the two Houses of Congress jointly at the opening of a special session, instead of sending a written message. This practice he followed throughout his administration, with great effect He felt himself not only chief magistrate of the nation, but head of the Democratic Party, and practically the premier of the Government from which ought to proceed plans for important legislation.

A special session was called particularly to frame a tariff act. Representative Underwood, chairman of the Committee of Ways and Means, gave to the new measure his name and experience The purpose of the statute was to enlarge the free list of raw materials, foodstuffs and some manufactures, to make a moderate reduction of the protective duties, and to correct some of the things which made the Payne-Aldrich Act unpopular. Included in the statute was an income-tax, at last made possible by the adoption of the 16th amendment (Feb. 25, 1913), which was expected to supply any revenue which might be lost by the reduction of duties. A tariff commission was created to make researches into the workings of the Act and to find out what was the actual difference between the cost of labour in the United States and in foreign countries (Oct. 3, 1913).

The powerful influence of the President was again exerted to secure a systematic banking system, with the result that (Dec 23, 1913) the Owen-Glass Federal Reserve Bank Act was added to the statutes. The principle was to create a national institution, which was to be divided into 12 regional banks, in each of which was a body of directors, besides the central organisation in Washington. In these 12 subdivisions clustered such banks, whether national or State-chartered, as chose to accept. The new institution was also to issue a new form of paper money. The system from the start was recognized as a large national asset At the same time a Rural Credits Act was passed (July 17, 1916), which created a special group of banks to lend money to farmers on the security of their farms Both systems worked efficiently.

Transportation, 1914–16.—Under a statute of March 1, 1913, the Interstate commerce commission was authorized to enter on an elaborate valuation of the railway property throughout the country as the basis of a judgment as to what was a reasonable profit The Panama canal was now approaching completion This was the first great agency of transportation owned and managed by the United States Government President Wilson used to the utmost his personal influence for a bill to repeal discrimination in favour of American-owned vessels, of which the British Government had complained; it became an act, June 15, 1914. On Aug 15 the first steamer passed through the canal from sea to sea and in a few months the canal was paying its own way A new question of transportation was arising through the rapid development of motor vehicles At first a plaything, then a luxury, by 1908 they were spreading throughout the land The attention of the whole country was called to the absolute necessity of good roads In 1916 Congress passed an act appropriating approximately $85,000,000 to be paid in about five years to such States as would contribute equal sums for good roads From this beginning the movement spread rapidly throughout the whole country.

The Trusts, 1914.—A few hours before the end of President Taft's term a congressional committee reported against the "great and rapidly growing concentration of the money control and credit in the hands of a few men" In June 1914, in a suit involving the International Harvester Company, the United States Supreme Court upheld state anti-trust laws. The ring of law and justice seemed to be drawing closer round the great offenders. Yet these offenders still flourished, and huge corporations, such as the U S Steel Corp, paid dividends on thousands of millions in stocks and bonds. President Wilson urged successfully a radical amendment of the Sherman Act (Oct. 15, 1914) against discriminating freight agreements, interlocking directorates, and holding corporations.

Another branch of the same attack on the money power was the Federal Trade Commission, created Sept. 26, 1914, which was an attempt to find means of dealing with corporations engaged in interstate commerce other than banks and common carriers In the same direction went the "blue sky laws" passed in this period by many States, to break up the practice of floating the stock of companies which had no property more substantial than the atmosphere.

Labour, 1913–17.—The example of capital, in rolling itself into

masses too great to be controlled by ordinary means, was followed by labour. The American Federation of Labor was a loosely woven council of representatives from the great trade organizations. It did not undertake to call strikes, though it was likely to support them, and it had great effect in bringing about combined and simultaneous demands for the various items in the labour programme. The leaders fixed upon an eight-hour day as the basic working time The next item was the minimum wage, which made its way slowly and was not altogether acceptable to labour. Another demand was that American citizens should have preference over aliens in employment. Labour in general was unfriendly to child labour and was, therefore, interested in a Federal statute of Sept 1, 1916, to prevent the transport of products made by child labour under specified conditions

As the labour unions gained in numbers and strength they used their energies in favour of the "closed shop," a system under which union men refused to work in any establishment where men not members of the union were also employed. From this idea rapidly developed the system of sympathetic strikes, in which members of one union back up another union by refusing to handle, use or transport products of non-union labour Hence boycotts, and perhaps ruin for employers who had no difficulty or quarrel with their own workmen Never in the history of the United States were there so many and so violent strikes as from 1913 to 1917. The I.W W organized long and tumultuous strikes among the silk weavers of Paterson, N J, and the textile workers of Lawrence, Mass In the trying years of 1916–17 violent strikes were directed not only against non-striking workmen, but against the public peace. In July 1917, at Bisbee, Ariz., the tables were turned A kind of vigilance committee seized and carried out of town, with orders not to return, about 1,200 striking miners and their friends. No jury would convict those responsible for this illegal action The most serious of all these labour struggles was the threatened strike in 1916 of the large and very powerful unions of railway employees President Wilson intervened and practically compelled Congress to pass (Sept. 3, 1916) the Adamson Act by which a basic eight-hour day was secured with *pro rata* for overtime. The Supreme Court upheld this statute, which went to the farthest verge of the Federal Government's authority over labour matters.

Social Movements, 1913–17.—These struggles between the railways and the courts, between the trusts and Congress, between labour and State governments, between strikers and the President of the United States, are part of American history because they were vital to the welfare of the country. The farmers everywhere were aroused, for they looked on railways as hostile to their interests, by overcharging for carrying their products; and they resented the trusts, which they believed raised prices. The anti-liquor forces steadily developed strength. They urged out-and-out prohibition and secured it in more than half the States. At the end of 1917 war prohibition was enacted by the Federal Government and also prohibition in the District of Columbia On Dec. 19, 1917, a two-thirds majority was secured in Congress for a prohibition constitutional amendment—the 18th amendment—which was at once submitted to the States. Woman suffrage also advanced steadily Congress submitted a woman suffrage amendment in 1919. Thus changes that had been 50 years on the way finally were brought about by the force of public opinion. A change was also visible in the attitude of the country toward immigration which Congress was determined to reduce by an intelligence qualification. A new bill (Feb. 5, 1917) was passed over Wilson's veto. Besides a literacy test it raised the head-tax to $8 and excluded oriental labourers coming from certain geographical areas, which did not include Japan but did apply to Hindus and Malays

Educational Progress, 1909–21.—The decade following 1909 was marked by a new sense of the possibility of general education, and the need for a more direct, searching and practical type of education The country was accustomed to a system of graded public school, offering the "common school education," and leading up to a few endowed and private schools, and to thousands of public high schools, which were expected to prepare the small proportion of young men and women who went on to institutions of higher education Secondary education was subdivided into literary, commercial and industrial schools The institutions of higher learning set up new professional departments, including the intensive study of education and separate schools of science, engineering, agriculture and other specialties. Private enterprise created a great number of so-called business colleges, and a few very efficient trade schools

Nevertheless there was general complaint that the schools did not relate themselves to the life of the community A National Society for the Promotion of Industrial Education became the focus of a movement to organize what now became generally known throughout the country as vocational education. A national commission was appointed by President Wilson, in 1914, to consider the whole subject. The resulting Smith-Hughes Act (Feb 22, 1917) created a Federal Board for Vocational Education which framed an elaborate plan for instruction in the four vocational fields of agriculture, commerce, industry and home-making. The Act promised to appropriate Federal funds rising to about $7,000,000 in 1925, to be paid to such States as would match these funds dollar for dollar.

Private enterprise accompanied this movement by building up advanced engineering and trade schools of a high type, such as the Carnegie Institute at Pittsburgh, by improving the private commercial schools and by establishing advanced schools of business training in colleges Some of the great manufacturers, especially of the automobiles, set up schools within their own works

When the United States plunged into the World War in 1917, the Government established a variety of vocational schools to train men for the numerous specialties of military service It made use of the shops and other vocational facilities of the existing schools and colleges Great sums were raised by special "drives" among the alumni and friends of the endowed institutions, and the State universities were allotted hitherto unheard-of grants. The strictly vocational schools were admitted into fellowship with the other institutions.

Wilson's Foreign Policy.—Woodrow Wilson was naturally a man of peace, and so emphatically was Secretary Bryan. They set themselves to aid the cause of general peace by arbitration treaties. Secretary Bryan prepared a definite project for treaties by which the nations concerned should, in case of difficulties, pledge themselves to submit their grievances and claims to a special examining commission and to abstain from war or preparations for war until the commission should have had time to report The presumption was that a sensible nation would submit to the judgment of an impartial tribunal There was little difficulty in concluding more than 30 treaties upon this basis in the course of a year, but none was put into effect. The truth is that the American people, as a whole little accustomed to international questions, had no definite foreign policy.

Philippines and Caribbeans.—The Government of the Philippine Islands was altered by setting up the first Filipino Assembly in 1907 In response to the pleading of President Taft, Congress in 1909 grudgingly included them within the customs boundary of the United States Under President Wilson, Gov.-Gen Cameron Forbes was withdrawn and Burton Harrison was appointed his successor, to carry out a policy of liberalization and preparation for independence. The Filipinos were allowed to hold a majority of the seats in the commission, which became a kind of administrative Upper House Filipinos were substituted for Americans in many of the civil offices. The people were thus given a definite opportunity to govern themselves. The Jones bill, enacted Aug. 29, 1916, greatly enlarged the power of the popular part of the Government, and the commission ceased to exist. The act promised that the Filipinos should be given their independence when their ability to govern themselves should be demonstrated.

At the other end of the American sphere of influence, Cuba, while nominally independent, remained a protectorate of the United States On March 2, 1917, the Porto Ricans were for the first time made American citizens and received a popular government of two elected Houses. President Wilson continued the

administration of the Dominican republic which dated back to Roosevelt. He also took military control of Haiti in 1914, and followed it by a controlling treaty which was ratified by the Senate (Feb 28, 1916) He carried even farther Taft's policy in Nicaragua by a treaty (ratified Feb. 18, 1916) which converted that country into a virtual protectorate. Another area came under control of the United States by a treaty for the annexation of the Danish West Indies proclaimed in 1917. These islands were duly organized under the title Virgin Islands of the United States. Little opposition was made to this creation of a virtual empire, including dependent provinces

Latin America and the Orient, 1913–17.—The peaceful policy of the United States towards its neighbours was severely tested by disturbances in Mexico In 1913, Madero, president of that turbulent republic, was murdered, presumably by order of Huerta, an insurgent officer, who thereupon declared himself the head of the State. The almost invariable policy of the United States had been to recognize any *de facto* head of a Latin-American Government without inquiring into the source of his title But on this occasion President Wilson adopted what he called a policy of "watchful waiting" He steadily refused to recognize Huerta, against rival revolutionists In April 1914 a trifling dispute arose at Tampico as to a salute of the American flag, and Wilson, apparently yielding to strong public sentiment, ordered the navy to attack and capture Vera Cruz, of which the United States remained in possession for some months. The real object was to discredit Huerta, who was compelled to flee the country When in 1915 the brigand Villa raided the town of Columbus, N M, the President ordered a military expedition under General Pershing to advance into the interior of Mexico. It remained about eight months, without capturing Villa or accomplishing any other definite result The three friendly nations of South America—Argentina, Brazil and Chile, commonly known as the "A B C Powers"—offered a kind of mediation At their suggestion Carranza was recognized as president by the United States Disorder continued, and in May 1920 Carranza was overthrown and killed by the troops of Obregon For a time thereafter Mexico emerged from the state of revolution

This long controversy was highly disturbing to the desired close relations with Latin America in general In spite of four Pan-American congresses and several scientific congresses, in spite of visits of Roosevelt and of Root and Knox as secretaries of State to South America, there could be no harmony if the United States were to continue "administering" small and defenceless Latin American nations and waging undeclared wars with Mexico. Nevertheless, President Wilson in a speech at Mobile (Oct. 27, 1913) declared that the United States had no designs on the territory or independence of its Latin-American neighbours. Colombia, too, had a grievance arising out of the loss of the isthmus when the Panama canal zone was annexed in 1904. A treaty negotiated by Bryan to pay to Colombia $25,000,000 as a kind of reparation was ratified by the Republican administration in 1921

In regard to the Far East, Wilson had little opportunity to develop a policy. He began by disavowing the plans made under the advice of President Taft for a loan by American bankers to China He argued with the people of California because they insisted on passing a statute restricting alien ownership of lands by Japanese residents. The World War soon united the United States and Japan in a common cause, and on Nov. 2, 1917, the Lansing-Ishii note, on the same plan as the Root-Takahira note of 1908, set forth that the United States recognized Japan's "special interests in China."

Neutrality.—The United States in 1914 expected to remain indefinitely at peace, as was shown by lack of anything that could be considered national military preparation in the terms of modern warfare When on Aug 4, 1914, President Wilson issued a proclamation of neutrality as between the two groups of European nations just engaging in a gigantic struggle, the authorized military establishment was about 107,000 men, of whom some 87,000 were enrolled The United States had not one military aeroplane of approved type; had only four modern heavy field guns and no transport for them; had not a trench bomb or a mine-thrower; nor considerable supplies of any weapons or equipment except 800,000 excellent rifles; nor any officers experienced in the kind of warfare used in recent wars; nor any instruction camps for officers or men. The navy included a fleet of battleships recently built, but weak in small and swift vessels and particularly in submarines. The militia proved to be of little service, though Secretary Bryan publicly declared that the nation needed no preparation, for it "could raise a million men between sunrise and sunset."

Neither the foreign policy nor the diplomatic organization of the United States was fitted for such a crisis. The traditional Monroe Doctrine was expected to keep the nation out of dangerous controversies with the other American States. The counterpart principle of isolation forbade the United States to take any part in European crises or wars As a neutral it stood by the principle of "freedom of the seas," by which was meant in particular the right to carry on commerce with all belligerents in case of war, subject to the limitations of the then acknowledged international law as to contraband and blockade. Soon after the beginning of the World War relief was organized on a large scale for the Belgian people, most of whose country was overrun and held by the Germans This system soon included French refugees, the unhappy peoples of Serbia and Asia Minor and other combatant or non-combatant sufferers, besides the sick and wounded of the contending armies

Difficulties with the Belligerents, 1914–17.—The United States was compelled at once to take into account the relation between the War and American industries, commerce and finance Heavy loans were placed in the United States by Great Britain, France and Russia As fast as the money was borrowed it was spent in the United States for the purchase of food, clothing, animals and especially munitions President Wilson issued a proclamation (Aug. 18, 1914) advising that the people remain neutral "not only in act but in word and in thought" Such neutrality was impossible In the first weeks of the War, German commerce was driven from the seas The command of the sea by the Allies very nearly cut off trade of any kind between the United States and Germany and Austria, while commerce continued in ever-increasing volume with England and France. This disparity led to protests on the part of the German Government, and also to lawless acts perpetrated or directed by agents despatched by the German Government for the purpose of paralysing the munition factories Violent antipathies were caused by the German methods of carrying on war, and particularly the treatment of the occupied areas of Belgium and France. The American population included hundreds of thousands of citizens of the belligerent countries, many of whom attempted to return to their homes in order to serve in the army The road for such recruits was blocked for the Germans and their allies, but open to the Allies. For the first time in half a century the United States found within its own borders a sharp division on questions of foreign policy.

On the other hand, the war trade brought immense profits The favourable balance of trade rose from $690,000,000 in 1913 to $1,770,000,000 in 1915 and $3,000,000,000 in 1916. This prodigious debit was balanced by about $3,000,000,000 sent to the United States in securities and gold, besides $2,000,000,000 in foreign War bonds. Under these circumstances genuine neutrality was out of the question. A decided preponderance of sympathy developed toward the western Allies, who were profitable customers, were in close and almost undisturbed intercourse with the United States and were considered to be fighting against a ruthless, arrogant and dangerous autocracy.

International Controversies, 1914–17.—The internal tension of the United States was tightened by the insistence of Germany on the right to use new weapons, tactics and practices of war, without the traditional limitations of international law, without mercy to non-combatants, on the basis of "a law of necessity." No able-bodied German man or woman was really a non-combatant; the Germans insisted that they must regard all civilian enemies as combatants. There was no way to stop them without using similar new methods of warfare

Great Britain, which in the London Maritime Conference of 1908–09 had shown some disposition to enlarge the privileges of neutral commerce, now seized American ships and shipments, and arbitrarily extended the list of contraband, until (Dec. 26, 1914) a despatch signed by Secretary Bryan, but expressing the conclusions of President Wilson, made a protest. In the course of 1915 the British Government began to apply the American principle of "continuous voyage" as applied by the United States during the Civil War to cover shipments to neutral ports in cases where those shipments were likely ultimately to reach Germany; and also where they might replace products of the neutral countries that could thus be spared for Germany, or if the neutral countries declined to make a hard and fast agreement not to reship

In 1916 the British were practically blockading neutral European ports and capturing vessels, American and other, wherever they liked. The Central Powers set up a new war practice of using submarines as commerce destroyers The American Government protested. A crisis came through the sinking by a submarine of the British passenger liner "Lusitania" (May 7, 1915), with the loss of 113 American lives That sinking was a deliberate act of the Germans to test the temper of the United States. Apparently they were greatly surprised when the people of the United States rose in resentment. President Wilson, who had earlier insisted on "strict accountability," insisted on a sharp protest Mr Bryan thought milder measures sufficient, and on that issue resigned the secretaryship of State (June 8, 1915), being succeeded by Robert M Lansing. The correspondence went on until October when Germany at last informed the American Government that merchant ships would not be sunk without warning and an opportunity to save non-combatant lives Meanwhile, throughout 1915 and 1916, systematic violations of the neutrality laws of the United States by Germans and Austrians caused the dismissal of the Austrian ambassador to the United States and of the two most obnoxious members of the German ambassador's staff

"Preparedness."—By the end of 1915 it became clear that with or without their own desire, the people of the United States might find themselves involved in the War. President Wilson desired peace A day or two after the sinking of the "Lusitania" he spoke of there being such a thing as "a nation that was too proud to fight" In his message of Dec 1915 he urged national defence and the protection of American shipping Long before this time the World War had brought about a violent change in the economic conditions of the country The great demand for foodstuffs raised the price of grain and other farm products The high cost of living became a political issue. The munition factories offered unheard-of wages and drew hundreds of thousands into improvised towns. The World War caused a great change in immigration Hundreds of thousands of men left the United States for Europe, while the net immigration fell from 1,200,000 in 1914 to 300,000 in 1916.

The Election of 1916.—In the midst of this turmoil and confusion of business came the preliminaries of the presidential election of 1916 President Wilson carefully abstained from taking sides between the Allies and the Central Powers, but the aggressive submarine policy of Germany provoked a much sharper tone than did the aggressions by the English. He felt the need of caution, particularly because a growing group of men, among them Roosevelt, were coming to the conclusion that eventually the United States would have to join in the World War

The Republican nominating convention met in Chicago, June 7. A strong effort was made by friends of Roosevelt to capture the Republican Convention, but the "stand-pat" Republicans had control of the party machinery The Progressives—who in Nov. 1914 had cast 1,800,000 votes for congressional and State candidates—also met in convention in Chicago Their purpose was to compel the Republicans to nominate Roosevelt as the only means of healing the breach. That effort failed: the Republicans nominated Justice Hughes of the Supreme Court, who had been a reform governor of New York State. The days of the Progressive Party were numbered.

In the Democratic Convention (June 14) there was practically no opposition to Wilson and his running-mate T. R Marshall. The platfrom in many respects was similar to that of the Republicans Both favoured woman suffrage, the conservation of national resources and national enforcement of child-labour laws; both reaffirmed the Monroe Doctrine. But the Democrats upheld tariff for revenue only, they endorsed the promise of ultimate independence to the Filipinos; they commended the establishment of a Federal trade commission, and they approved a merchant marine owned and operated by the Federal Government In the campaign Roosevelt publicly supported Hughes, though it was well known that he felt no enthusiasm for him. The only "slogan" that caught the public ear was favourable to Wilson. "He kept us out of war" Wilson received about 9,000,000 popular votes against 8,500,000 for Hughes, and was chosen by a very close vote in the electoral college.

President Wilson stood in a very strong position in the United States and in the world He had been re-elected His policy was approved He felt that he had the nation politically united behind him He soon began to take a firmer tone against the Allied system of neutral blockade. He hoped that the one great neutral nation might bring about peace On Dec. 18, 1916, he sent a communication to the warring Powers suggesting that they come to an understanding of each other's demands. On Jan 22, 1917, in an address to the Senate on foreign affairs the President described the replies he had received to the identic note of Dec 18.

> The Central Powers united in a reply which stated merely that they were ready to meet their antagonists in conference to discuss terms of peace The Entente Powers have replied much more definitely, and have stated, in general terms indeed, but with sufficient definiteness to imply details, the arrangements, guarantees and acts of reparation which they deem to be indispensable conditions of a satisfactory settlement

He went on to speak of an "organized common peace," and of a "peace without victory"; he outlined the principle of self-determination, declaring that "Governments derive all their just powers from the consent of the governed," and that "no right anywhere exists to hand people about from potentate to potentate as if they were property" The practical German answer was a brief note communicated by Ambassador Bernstorff to Secretary Lansing (Jan 31, 1917), withdrawing the pledge given in Oct. 1915 and renewed in May 1916 that merchant ships would not be sunk without preliminary warning and announcing that the Germans would shortly resume unrestricted submarine warfare High military authority in Germany believed that Americans would never sacrifice the large profits of export trade and incur the huge expenses of war merely for the sake of a question of neutral maritime rights.

Immediate steps were taken to make the American Navy ready for war For a time the President dallied with a plan of arming merchant ships One result of the controversy was the adoption by the Senate (March 8) of a mild and cumbrous method of cutting short debate by closure. During Feb. and March 1917 a few American vessels were torpedoed by German submarines. On Feb 8 the Government published an intercepted German despatch to the Mexican Government asking it to join in the World War, promising it the "former Mexican provinces," long incorporated in the United States The participation of the United States in the War was now inevitable A formal declaration of a state of war was signed by the President (April 6) after a House vote of 373 to 50 and a Senate vote of 82 to 6, which stated that war had already been begun by Germany Relations with Austria and Turkey were at once broken off, but the declaration of war with Austria was delayed until Dec. 7 and no declaration was ever made against Turkey or Bulgaria

The breach with Germany was a spontaneous national action representing a national belief that the United States could no longer live in peace with such a nation as Germany had become. As President Wilson put it the War was to make the world "safe for democracy" Moreover, there was widespread sympathy with the three western Powers, France, Belgium and Great Britain, which were closest to the United States in their political principles and system of government Wrath was aroused by the German treatment of the people of Belgium and other conquered

countries In some minds there existed a genuine and well grounded fear of a future attack upon the United States by Germany if the resistance of the Allies should be destroyed. Amid all the motives for the War, the one thing was that the American people recognized Germany as an enemy, and the enemies of Germany as natural friends and partners in the great enterprise of subduing "the Hun."

War Measures.—Passionate national spirit, patriotism and urgent reasons for war were all useless unless the United States could enrol, train, equip, convey and continuously supply an immense army The American Navy, though the vessels were good and the crews skilled and well commanded, was in no position to give direct aid in the process of destroying the German army. What was most needed was to raise and convey to the fighting front a large force of American troops.

Soon after the declaration of war by the United States, missions from the various Allied countries were sent to America. The British Mission, headed by Arthur (now Lord) Balfour, British Foreign Secretary, reached Halifax April 20 and proceeded to Washington. The French Mission, headed by René Viviani, the former Premier, and including Marshal Joffre, landed April 24. Other missions came from Italy, Belgium, Russia, Rumania and Japan The United States was able at once to help the western Allies in their pressing financial difficulties Taxes were low and little felt, money abounded Under Acts of Congress beginning Oct. 17, 1917, the Allies received essential credits, which amounted eventually to $9,500,000,000

These enormous payments were made possible by the Liberty Loans In June 1917, 4,000 000 people joined in offering $3,000,000,000 to the Government, and at the end of the World War the interest-bearing debt had increased from $972,469,290 on Dec 31, 1916, to $25,234,496,274, on June 30, 1919 These loans were supplemented by the War Revenue Act (Oct 17, 1917) and later statutes, which laid a variety of new taxes, increased the income-tax heavily, and combined with it an excess-profits tax to bring into the Treasury unreasonable profits likely to be made in the war industries

All traditional limitations on raising an army were discarded On May 18 the Selective Service Act was passed which provided for the enlistment of 1,000,000 men by "selective draft" When called up, the men had to be clothed, housed, fed and drilled Thousands of officers were necessary, and training camps, both for men and officers, were established on a vast scale In May 1917 a few American destroyers reached England On June 9, Gen J J Pershing, who had been selected as commander-in-chief, arrived in England On June 26 a small detachment of United States troops reached Europe. New branches of military service were established, among them the Chemical Warfare Service which provided materials for lethal gases and for gas-masks and other means of resisting the enemy attacks. Congress, on July 24, appropriated $640,000,000 for aviation By August about 700,000 men were enrolled in the army and 230,000 in the navy

Control of Industry and Transportation.—The establishment of huge war industries put a great strain on the industry and transportation of the United States On Aug 10, 1917, a Food Control Act gave the President powers never before conferred with regard to food and fuel. Herbert C. Hoover, of California, who had distinguished himself in the management of the Red Cross in Europe, was made Food Administrator with large powers Before the World War ended he had established "meatless" and "wheatless" days; the price of grain was fixed; eventually the farmers were assured $2 20 a bushel for their wheat crops H. A. Garfield, Fuel Administrator, carried through drastic measures for stimulating the production of fuel, regulating shipments and distributing supplies. On March 21, 1918, the Federal Control Act placed the management of all the railways in the country in the hands of the Government during the World War, and for a period after its close. W. G McAdoo, Secretary of the Treasury, was made director-general of the railways; later Walker D. Hines, an experienced railway man, succeeded him One of the most serious needs of the times was a merchant fleet adequate to carry across the Atlantic the army and its supplies The Government undertook the great task of improvising such a fleet, and vast construction was authorized in both steel and wood.

War Activities at Home.—At once after the declaration of War the American people through official and unofficial channels gave support by civilian service and money contribution. Among the multifarious public agencies was a Committee on Public Information, of which George Creel, journalist, was chairman, which kept up a lively system of publicity aided by the National Board for Historical Service A Censorship Board censored all communications—mail, cable, radio—passing between the United States and foreign countries. As early as Aug. 29, 1916, a Council of National Defence was created by Act of Congress Under it were created numerous special organizations. The Council of National Defence appointed a women's committee to co-ordinate the patriotic work of the women throughout the country. The Advisory Commission of the Council of National Defence created a committee on transportation and communication. A Railroad War Board undertook to secure unity of operation among all the railways, to subordinate private interests and to eliminate competition Important coastwise steamship lines were added to this system In 1918 the Government assumed control of telegraph, telephone, marine cable systems and radios. Many scientists were engaged in research throughout the country under the National Research Council Commerce also was regulated.

By the Espionage Act of June 15, 1917, the President was empowered to control exports, and he created a Bureau of Export Licenses and a Trade Board A list was prepared of firms throughout the world with whom Americans should not trade The Government formally took charge of all foreign trade Feb. 15, 1918, and seized all German ships interned in United States ports.

Samuel Gompers, president of the American Federation of Labor, co-operated in organizing a Committee on Labor, and a Mediation commission was appointed A National War Labor Board (April 9, 1918) acted throughout the country as a kind of "supreme court" to settle labour disputes For the recruiting of essential labour and directing it into necessary industries a U S. Employment Service was created

Several private war agencies were established Chief among these were the American National Red Cross, which was to be found wherever there was fighting, sickness, suffering or starvation, the Y M C A ; Y W C A.; Knights of Columbus (Catholic); Salvation Army; Jewish Welfare Board, American Library Association and War Camp Community Service.

Enemies in the United States.—While the people of the United States were practically a unit in favour of a vigorous prosecution of the World War, a few, chiefly foreign-born or sons of foreign-born, were opposed to the World War or more often to the nations in concert with which the United States was fighting Ever since 1914 the country had been irritated and aroused by a series of illegal, violent and often murderous acts which were traced to German and Austrian agents Such were determined efforts to blow up the international bridge at Vanceboro, Me., and the locks of the Welland Canal, Ont Bopp, German consul-general at San Francisco, was convicted and imprisoned for aiding German vessels in the Pacific in defiance of neutrality laws. Rintelen (after the war specially rewarded by the German Government) was sent to the Federal Prison at Atlanta for aiding in placing bombs on outgoing vessels with intent to destroy them.

The Navy.—Beginning with patrol work on the American coast as soon as war was declared, the activities of the United States Navy extended to co-operation with the British and French in the hunting down of submarines and the protection of convoys and in the laying of the North Sea mine barrage, extending from the Orkneys to Norway. The American Navy had some part in blockading the Austrian coast of the Adriatic, and it participated in maintaining that Allied command of the sea which in the end was fatal to Germany. By a remarkable convoy system over 2,000,000 troops were carried safely 3,000m overseas to France In this work the utmost secrecy was necessary. In June 1917 a few cruisers and transports were provided and the first troops sent across. At intervals vessels assembled and sailed on definite routes under the protection of destroyers According to the report

of the secretary of the Navy (1920), 911,047, or nearly half of the American troops, were carried on United States Navy transports; the rest chiefly by the British. Not one east-bound American transport was torpedoed by the German submarines; and only three ships were sunk on their return voyage. Three small fighting ships were destroyed by the enemy.

During the campaign of 1918 efforts were made to extend the possible field of enlistment by the passage of the Man Power Act of Aug. 27. All men between 18 and 45 were required to register with a view to service if needed, and 11,000,000 were registered By a statute of Oct. 6, 1917, provision was made for a system of military and naval insurance available for all men in the service. (A. B. H.)

The American Expeditionary Force.—When Gen. John J. Pershing, commander-in-chief of the American Expeditionary Force, departed for Europe on May 28, 1917, America's military defensive forces comprised a regular army of approximately 80,000 and a National Guard of less than 150,000. While the regular army was well officered and trained as regimental units, the National Guard was not adequately organized nor sufficiently trained. Industry was not prepared for its part and no authority for raising national armies had been enacted. Consequently, the nation found itself faced with the problems involved in providing man power and organizing, financing, equipping and transporting overseas an enormous army and organizing a theatre of operations—all before Germany could strike decisively on the western front. With her small unprepared forces as a nucleus, the United States called into army service 4,000,000 men, sent overseas 2,086,000 in 19 months, averaging in the summer of 1918 about 10,000 men per day. The first contingent comprised the regular army 1st Division and some special troops which landed in France at the end of June 1917. The peak of the troop shipment was reached in the summer of 1918, when over 300,000 men landed in one month. Over 50% of the American forces were carried in Allied ships. In addition some 7,500,000 tons of supplies were shipped from America to France, practically all in American ships. The tasks involved in these problems were both intricate and gigantic.

Upon America's entry into the World War, German hopes of final victory cannot be said to have been extravagant. The Allies were embarrassed financially and through lack of supplies Losses had been tremendous and resources in man power were so low that there was little prospect of materially increasing their armed strength even in the face of the probable concentration on the western front of practically the whole German military strength in the spring of 1918. A review of the conditions then existing made so apparent the early necessity for a supreme effort that Gen. Pershing cabled Washington on July 6, 1917: "Plans should contemplate sending over at least 1,000,000 men by next May." Upon completion of his study on July 11, 1917, he reported. "Plans for the future should be based . . . on at least 3,000,000 men." By the middle of Oct 1917, Gen. Pershing had completed his basic plans for the operation of the U S. army in Europe These included the training of the combat army, the organization of supply in Europe, a priority for shipment from America of troops and supplies, and a project for the army's strategical and tactical employment.

The American mission was offensive. The plans were based on striking where a definite military decision could be gained. While the Allied armies had endeavoured to maintain the offensive, the British, in order to guard the Channel ports, were committed to operations in Flanders and the French to the front protecting Paris. Both lacked troops to operate elsewhere on a large scale. A deep advance east of Metz, or the capture of the Briey region, by threatening the invasion of rich German territory in the Moselle valley and the Saar basin, and curtailing her supply of coal or iron, would have a decisive effect in forcing a withdrawal of German troops from northern France. The military and economic situation of the enemy and the Allies indicated Lorraine as the field promising most fruitful results and in Sept. 1917 it was selected by Gen. Pershing as the area for the decisive operations of the American army. These plans contemplated a reduction of the St. Mihiel salient followed by a decisive blow based either on Verdun or on Nancy. The organization of the immense American supply service accorded with this strategical conception. The complexity of trench life had enormously increased the tonnage of supplies required by troops. Not only was it a question of providing food but enormous quantities of munitions and material. Upon the railroads of France fell the burden of meeting the heavy demands of the 3,500,000 Allied combatants. If the American army was to have an independent and flexible system it could not use the lines behind the British-Belgium front nor those in the rear of the French front covering Paris, for these were needed for the British and French forces respectively. The problem confronting the American Expeditionary Forces was then to superimpose its rail communications on those of France where there would be the least possible disturbance to the existing arteries of supply. These controlling factors lead to the organization of base ports along the south-west coast of France and the utilization of French railways passing mainly south of Paris

For all practical purposes the American Expeditionary Forces were based on the American continent. Three thousand miles of ocean to cross with a growing submarine menace, an uncertain quantity of ship tonnage available and a land line of communications in France 400 m long, presented almost insurmountable difficulties. The system developed in France included American construction of 83 new ship berths, about 1,500 m. of new railway with shops and round houses, 4,000 km of telegraph and telephone lines with the operation of a 215,500 km system; 1,500 locomotives and 20,000 freight-cars were brought over and American engineers repaired 2 000 French locomotives and 58,000 French freight-cars Daily tonnage at ports increased from 17 000 in July to 45,000 in Nov. 1918 Commanded by Maj -gen. James G Harbord, this great supply system engaged over 650,000 personnel by Nov. 11, 1918.

The problems indicated were complicated by those necessarily involved in the association of the American commander with Allied Governments and commanders. The outstanding problems related to the persistent Allied proposals for the amalgamation of the Americans in the British and French ranks This Gen. Pershing consistently and successfully opposed; he favoured unity of American command, adherence to the American doctrine of open warfare training and the primary value of the rifle and bayonet.

In meeting the crises caused by the German offensives in the spring and summer of 1918, American troops (combat and service) were frequently employed with decisive results under Allied command The 1st Division's successful Cantigny operation near Montdidier, in May, demonstrated American fighting qualities The 2nd and 3rd Divisions in June, blocked the German advance on Paris by holding the line about Château Thierry. The 3rd and 42nd Divisions held a vital part of the line against the German attack of July 15. The successful Allied counter-offensive of July 18 was based on the decisive blow delivered south of Soissons by the 1st and 2nd American Divisions with the 1st French Moroccan Division between them. Thus the American arms were in time to assist in crushing the last offensive of the enemy and to commit him entirely to the defensive.

After these divisions cut the main German communications in the Marne salient, the 3rd, 4th, 26th, 28th, 32nd, 42nd and 77th American Divisions joined the French in driving the enemy out of the salient and across the Vesle river. At the same time some divisions were holding sectors in the Vosges and others were training as reserves behind the British and even participating in British operations Some 20,000 aviation specialists were working in England and over 11,000 motor mechanics were helping the French in addition to several thousand engineers, medical, hospital and other specialists.

The successful counter-offensive of July 18 against the Marne salient showed that the emergency which justified the dispersion of American divisions had passed. By July 24 Marshal Foch accepted Gen. Pershing's proposal for the organization and operation of an independent American combat army and the execution of the American plan of the previous September. Accordingly,

early in the morning of Sept. 12 the American I Army, 550,000 strong, supported by 110,000 French troops, attacked the St. Mihiel salient and within a few hours had attained its objectives. Following out a pre-arranged plan the Americans were immediately transferred to the Meuse-Argonne zone where they began operations on Sept. 26. In the fighting which followed the Americans (24 American and 7 French Divisions) drove the Germans from their strongly fortified positions and captured the heights commanding Sedan; only the Armistice saved the German V. Army from complete destruction. The Germans had employed one-fourth of their divisional strength (62 divisions) to meet the attack. (For full particulars of these two battles *see* ST MIHIEL, BATTLE OF; MEUSE-ARGONNE OPERATION.)

During these purely American battles, other American troops and services continued to operate under Allied command, such as the troops of two divisions who assisted the British to break the Hindenburg line at Le Cateau in Sept 30–Oct 1, the two divisions with the IV. French Army capturing Mont Blanc and advancing towards the Aisne in early October; two divisions with the VI. French Army in Flanders in late October and early November driving the enemy across the Escaut and the Scheldt rivers. In addition, a regiment of infantry with auxiliaries assisted the Italians on the Piave in the fall of 1918 and another regiment and auxiliaries joined the Allies in the Russian Archangel Expedition of 1918–19

Thirteen major operations in which Americans participated —

Operations	Approximate number of Americans engaged
West front—campaign of 1917	
Cambrai, Nov 20 Dec 4	Detachments
West front—campaign of 1918	
German offensives, Mar 21-July 18	
Somme, Mar 21–Apr 6	2,200
Lys, Apr 9–27	500
Aisne, May 27-June 5	27,500
Noyon-Montdidier, June 9-15	27,000
Champagne-Marne, July 15 18	85,000
Allied offensives, July 18 Nov 11	
Aisne-Marne, July 18–Aug 6	270,000
Somme, Aug 8-Nov. 11	54,000
Oise-Aisne, Aug 18–Nov 11	85,000
Ypres-Lys, Aug 19–Nov 11	108,000
St. Mihiel, Sept. 12–16	550,000
Meuse-Argonne—Sept 26–Nov 11	1,200,000
Italian front—campaign of 1918	
Vittorio-Veneto, Oct 24–Nov 4	1,200

The Armistice.—The campaign of 1918 was the final effort of the Germans No one can say that the American Army in the field was the chief element that insured victory, but there is not a doubt that the triumphant success in raising and transporting incessantly troops, provisions and supplies was to the German mind convincing and disheartening evidence that the Government and the people of the United States, with all their power and potentiality, would stand by the Allies indefinitely On Nov. 11, 1918, by the Armistice in which the American armies shared, the Germans admitted their defeat and at once began to evacuate the occupied regions and also portions of their own national territory.

In accordance with the terms of the Armistice, the Allies were to occupy all German territory west of the Rhine The zone assigned the American command was the bridge-head of Coblenz and the district of Trèves This territory was occupied by the American army with its reserves held between the Moselle-Meuse rivers and the Luxembourg frontier. The advance toward German territory began on Nov. 17, 1918, and passing through Luxembourg crossed the German line on Dec. 1.

Shortly after the signing of the Armistice, the American commander formulated plans for the early return of the American forces to America. Re-arrangement of base port and rail facilities, securing additional ships and the demands of the Allies for considerable American forces to remain in France, necessarily presented important considerations Beginning, however, in December, a continuous flow of returning troops was maintained and by May 19, 1919, all combat divisions, except five still in the Army of Occupation, were scheduled to sail by July. The remaining troops, less a permanent force of one regiment of infantry and certain auxiliaries, were released in Aug. 1919. (J. J. P.)

Rehabilitation in America, 1919.—The task of *post bellum* economic adjustment was long and costly. At the end of the War the Federal Government by means of War statutes was controlling the food supply and its distribution, manufactures, the coal supply and shipments, railways, telegraphs and telephones, foreign commerce and shipping. It took over the property of aliens through an Alien Property Custodian. It settled conditions of interstate labour and of labour in other fields For foreign commerce there was still a Shipping Board, an Emergency Fleet Corporation, a War Trade Board and a War Finance Board Two million American soldiers were overseas and wanted to come home as soon as possible. The United States spent on the World War about $35,500,000,000, including $9,500,000,000 lent to the Allies. Expenditures after peace came continued on a scale far beyond any previous experience of the country

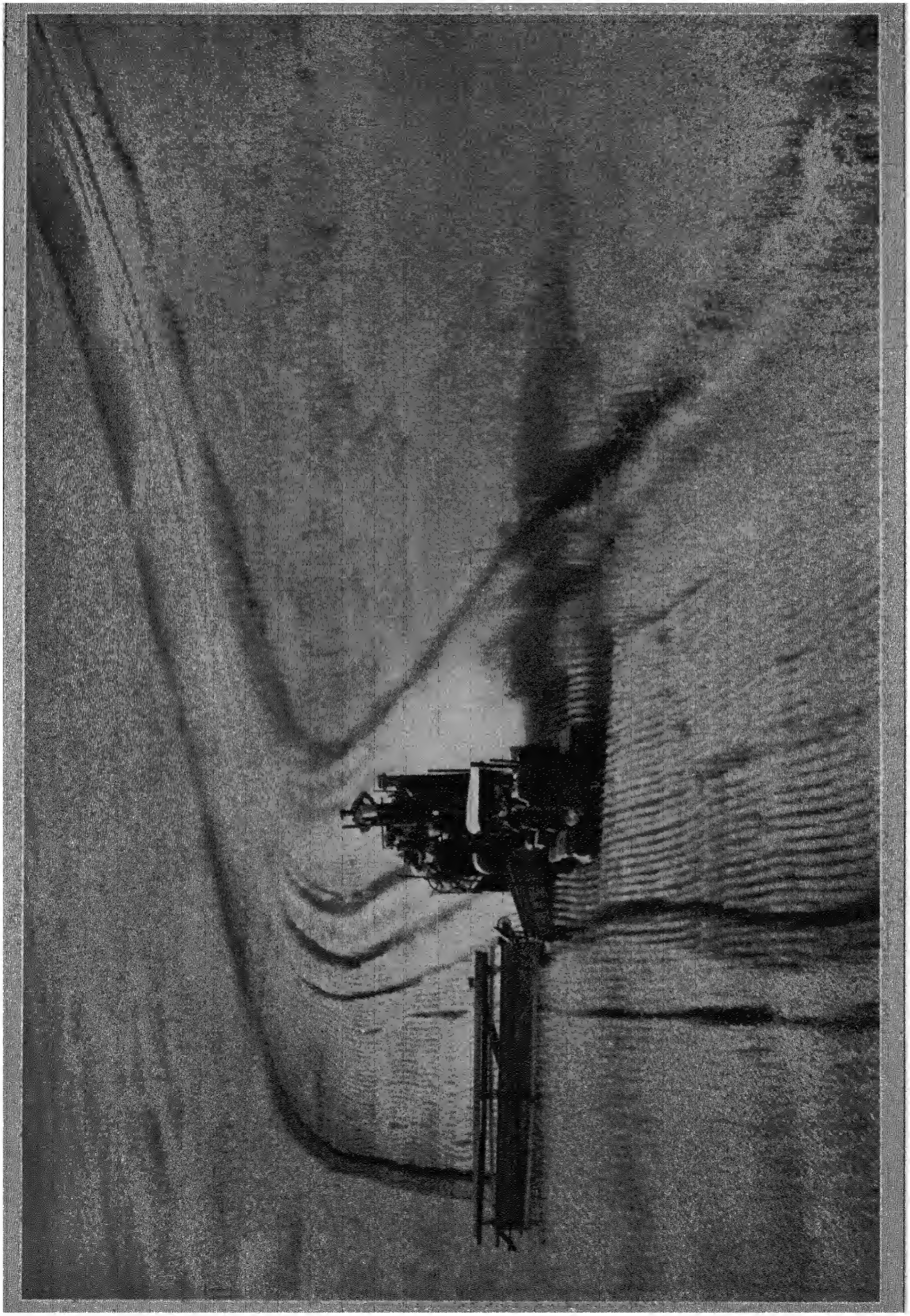
In the course of six months after the Armistice, about two-thirds of the troops were brought back, leaving behind them enormous stores, large parts of which were sold at heavy discounts to European Governments General Pershing, the only U S military man of high rank whose achievements caught the public eye, received the reward of the permanent rank of general In Sept 1919 the American Legion, incorporated by Act of Congress, was formed to look after the interests of the ex-soldiers By 1920 the only American troops left in Europe were an Army of Occupation on the Rhine.

The Election of 1918.—The Armistice came a few days after the State and Congressional elections of the autumn of 1918 The War was a national war Enlistments, whether volunteer or by draft, had no relation to politics Nobody paid any attention to the party affiliations of officers or men or civilian administrators and aids Nevertheless, on Oct 24, a few days before the elections, President Wilson issued a circular letter urging the voters to return a Democratic majority to the Senate and the House, because, if the Republicans were successful, it would be considered an imputation upon the President. The warning was in vain the result of the election made the new House decidedly Republican and the Senate Republican by two votes It was apparent, therefore, that the Administration in making the necessary adjustments after the World War must take into account the preponderant opposition in both Houses of Congress

Throughout the year 1918 the influence of Theodore Roosevelt was manifestly growing As the months passed it became clear that he would probably be nominated by the Republican Convention of 1920 and in all probability would be elected President But he died suddenly, Jan 6, 1919, leaving behind him a long roll of achievements and a place among the greatest of American statesmen and world figures.

The Peace Conference.—In Dec 1918 President Wilson decided that he would attend the necessary Peace Conference in person, and designated as peace commissioners with himself four others—Secretary Lansing, Col Edward M. House of Texas (his most intimate friend and political adviser), Gen. Tasker Bliss of the army, and Harry White, formerly minister to France. These commissioners were not confirmed by the Senate; only one of them was a Republican, and not one was a member of either the Senate or the House. To Republicans it seemed that the President meant it to be a Democratic peace as well as a Democratic war.

In the Peace Conference of 1919 President Wilson, as representative of the richest and most powerful nation in the world, was one of the representatives of the four Great Powers—Great Britain, France, Italy and the United States—who engineered the treaty. He had, and used, the opportunity to draw up a League and Covenant which was a crystallization of long-debated suggestions for a world confederation of States. President Wilson was so interested in the project for the League of Nations that when he found the French were not ready to adopt such a plan without some guarantee of protection, he signed a treaty of



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HARVESTING WHEAT

Farmer and crew of helpers harvesting wheat in one of the vast fields in the western United States. A modern 60 h.p. tractor of the caterpillar type is used to pull a mower and thresher

alliance between the United States, France and Great Britain, pledging the United States to join in war in case of invasion of France by Germany.

American Action on the Treaty, 1919.—No one familiar with the temper of Congress and of the American people should have supposed that such a treaty would be ratified President Wilson returned home for a short stay (Feb. 24–March 4) defending the general terms of the treaty and the Covenant of the League of Nations. On his return to Paris, he reversed decisions made in his absence by Col. House; and thereafter the close co-operation between the two able men diminished. On June 28, 1919, Wilson and his four commissioners signed for the United States the formal Treaty of Versailles, including the Covenant of the League of Nations, which was so interwoven into the text of the treaty that it was impossible to ratify one without the other. The treaty had many powerful supporters among all parties, particularly ex-President Taft, the League of Free Nations Association and the League to Enforce Peace The Senate was divided into strongly opposed groups Most of the Democrats, under the lead of Senator Hitchcock, followed the President in favouring the treaty with the Covenant as it stood. A group of Republicans, headed by Senator Lodge of Massachusetts, favoured "amendments" to the treaty and "reservations" to the league, which would have maimed but not killed the two projects Another group desired reservations that would practically destroy both A small but implacable junto, headed by Borah of Idaho and Johnson of California, were against both the treaty and the Covenant in any form or with any reservations.

The contest ostensibly centred about Art. X of the Covenant, under which the members of the League undertook "to respect and preserve as against external aggression the territorial integrity and existing political independence of all members of the League" The implacable group expressed fear lest the United States be drawn into foreign wars and insisted that "no American soldiers or sailors must be sent to fight in other lands at the bidding of the League of Nations" The President, on the other hand, regarded Art X as the heart of the whole treaty. He declined at the critical moment to accept either amendments or reservations, except certain minor alterations. After strenuous debate and by a test vote, Nov 19, 1919, the Senate refused to ratify the Peace Treaty with reservations—the vote being 55 to 39 in favour, but not the necessary two-thirds. Thus after five months' discussion the treaty was rejected, and the United States was left in the situation of technically remaining at war with Germany and Austria though all hostilities had ceased a year before

President Wilson believed, until the last moment, that he could force ratification of the treaty by his logic and influence On Sept. 26, 1919, while on a speaking tour through the country in favour of the treaty, he was struck down by paralysis, when he rallied sufficiently to think of public business he continued to hope that he would recover. His advisers and closest friends joined in an attempt to minimize the extent of the President's illness, though for months he was unable to see even members of his cabinet

On March 4, 1921, Woodrow Wilson accompanied President-elect Harding to the Capitol as the last act of his official life. He had been president for eight years, during six of which he was the undisputed leader of his party and of the nation Up to the fall of 1919 he carried all his points. He was responsible for a group of important revenue, banking and labour laws. He had a great hold on the affections and opinions of millions of his fellow citizens, and maintained the country's dignity in war and peace The people stood behind him in entering the World War. He supported measures for organizing and transporting millions of American soldiers. For a time in Paris he was the foremost man in the world, and he succeeded in inducing foreign statesmen to accept a League of Nations. At the height of his career he suddenly lost the prestige gained as War president of the whole country, was no longer accepted by his party, and ceased to be the one man who could appeal from Congress to the people. Before illness disabled him, he had already lost his hold upon the minds of the majority of his fellow countrymen. He lived in Washington in retirement, physically unable to take part in public affairs and died Feb. 3, 1924.

Presidential Election of 1920.—The peace revealed underlying elements of dissatisfaction. The soldiers received in many States a money bonus varying in amount, and demanded a similar bonus from Congress The general public complained bitterly against the high cost of living, while many corporations continued to make War profits in time of peace. A multitude saw their incomes and expectations reduced by the fall in the purchasing power of the dollar. As the presidential election came near, the Democratic Party was paralysed by internal dissensions over the Peace Treaty and by lack of the trusted leadership of the President; it had no fixed policy in foreign relations or reconstruction, and no commanding figure to put forward for the presidency.

The Republicans were rent by personal rivalries. The supporters of Gen Leonard Wood, Gov. Lowden of Illinois and Herbert C. Hoover of California struggled against each other for the nomination The Convention at Chicago (June 9, 1920) passed them all by, and gave the nomination to Senator Warren G. Harding of Ohio He was backed by a strong group of stand-patters to whom, however, he seems to have made no pledges as to policy or appointments Calvin Coolidge, Governor of Massachusetts, was put on the ticket as vice-president The Democratic convention held at San Francisco was confronted with similar difficulties. The nomination went to Gov Cox of Ohio, a man little known in national affairs, with Franklin D. Roosevelt, a cousin of the former president, as candidate for the vice-presidency. In the campaign for the first time women were eligible to vote in every State. The election was a complete triumph for the Republicans, who elected Harding by a popular majority of about seven millions, and an electoral majority of 404 against 127 for Cox, besides securing solid majorities in both Houses of Congress.

The presidency was thus transferred to a man little experienced in national politics, whose task it was to take over the discordant elements and build out of them a coherent policy. President Harding began his administration under favouring auspices, although several members of his cabinet had been chosen in the face of strong opposition from various quarters. The new President early showed tact and ability in leading his party in favour of constructive action. Within four months an epoch-making bill providing for a Federal budget system was passed under his pressure (June 9, 1921). He displayed keen interest in all attempts to restore business to a sound basis and urged prompt action in the assistance of the railways. By nature conservative, he laboured to bring the country back to a state of "normalcy."

Harding's foreign policy was set on remaining outside the League of Nations, while coming to amicable understandings on all relations with foreign nations Hence special treaties of peace negotiated with Germany, Austria and Hungary were ratified by the U S Senate Oct 18, 1921 Of world-wide importance was his call for a conference at Washington of the different Powers bordering on and interested in the Pacific Ocean, to discuss both questions of the Pacific and the limitation of armaments. The conference assembled Nov 12, 1921, and closed Feb. 6, 1922. The nine participants were the United States, Great Britain, France, Italy, Holland, Belgium, Portugal, China and Japan Important agreements were signed: to limit construction of capital warships; against improper use of submarines; against gas warfare; for maintenance of the status of Pacific insular possessions; and other questions involving relations with Japan and China (*see* WASHINGTON CONFERENCE)

Before Harding came to the Presidency, two constitutional amendments had crystallized some of the results of the World War. The various prohibition measures passed by Congress on the ground that the use of liquor impeded the success of the World War were powerful aids to the general arguments against liquor.

The active World War patriotism and service of women, together with the votes they already enjoyed, caused Congress (June 7, 1919), to submit the 19th constitutional amendment, annulling all sex restrictions on suffrage It was warmly supported by the former Progressives and by President Wilson, received the ratification of the 36th State, Aug. 24, 1920, and went into force Aug. 26

Conditions of the United States 1921–26.—A study of the political, social, economic and international history of the United

States must take account of the extraordinary national elation following the World War. The War produced a profound and permanent effect upon the national mind It was the beginning of an enlargement of national life in every direction From a World War out of which Great Britain and the British Dominions and France obtained the administration of immense areas of territory under mandates subsequently confirmed by the League of Nations the United States claimed not a single square yard, but the nation felt free to enlarge its influence in the Caribbean and the Pacific Hence the maintenance and enlargement of a policy of paramount interest in the three normally independent countries—Cuba, Haiti and the Dominican republic, and a strengthening of the control over the states of Panama, Honduras and Nicaragua

To carry out great national policies, the United States could call upon a population expanding from year to year beyond any experience of mankind The total continental population rose from 92,000,000 in 1910 to 106,000,000 in 1920 and (estimated) to 117,000,000 in 1926. Net immigration of 818,000 in 1910 sank to 19,000 in the World War year 1918, but rose in 1924 to 663,000 The wealth of the country, estimated at 187 thousand million dollars in 1912 was counted at 321 thousand millions in 1922, and still swelled in volume. Against these figures, what were such burdens as a national debt of 25 thousand million dollars, bearing a thousand million of annual interest, besides six thousand millions of state and municipal debts? Manufacturing, transportation, mining, distribution and financial business were all prosperous.

Political Survey, 1921–26.—Political rancour and party spirit somewhat diminished President Harding was a man of personal charm, and he drew into his cabinet in March 1921, several strong men Secretary of State Hughes had been a Justice of the U.S. Supreme Court and candidate for the presidency in 1916 Secretary of the Treasury Mellon was a rich and successful banker and financier who had never before appeared in public life, but who proved most successful as secretary Herbert C Hoover, Secretary of Commerce, was brought in on account of his extraordinary gift of business organization Henry C Wallace, Secretary of Agriculture, was the editor of a great agricultural newspaper James J Davis, Secretary of Labor, was a Welsh immigrant who had grown up in a steel mill The other members of the Cabinet were: Will H Hays, Postmaster-General; Edwin Denby, Secretary of the Navy; John W. Weeks, Secretary of War; A B Fall, Secretary of the Interior; and Henry M Daugherty, Attorney-General.

President Harding steered the ship of State easily, though without the commanding influence of a Roosevelt or a Wilson He stood steadfastly against a high scale of expenditure As a Middle-western man he was especially interested in the depressed state of agriculture His foreign policy was strong and successful His career was broken by a very brief illness, from which he died in San Francisco, Aug 2, 1923. After his death facts regarding himself and certain members of his cabinet came to light which were far from creditable

Vice-President Coolidge, formerly Governor of Massachusetts, a quiet unostentatious man, set up a new régime in the White House. He proved to be a man of strong character, who consulted those whom he trusted, and then made up his own mind and stood by his decisions His plain common-sense mode of life, his good temper, his patience with the two Houses of Congress, were combined with a keen judgment in public affairs Coolidge for the time being continued Harding's cabinet, but later changes were made, so that at the end of five years, Secretary of the Treasury Mellon, Secretary of Commerce Hoover and Secretary of Labor Davis were the only men left of Harding's first cabinet

Investigations of Officials.—The growth in wealth and enterprise reacted upon the Government where even the President's cabinet was disturbed and dismembered by a painful series of accusations and investigations For some years the Government had conserved certain oil-bearing areas of public land as a supply of oil fuel for the navy On April 7, 1922, jurisdiction over this matter was transferred from the Navy Department to the Interior Department by an order of President Harding, the purpose of which the President apparently did not understand. Under this supposed authority Secretary of the Interior Fall leased to the Sinclair interest a large tract in the Teapot Dome district in Wyoming, and also leased one of the California reserves to Doheny, another oil magnate. For reasons never publicly stated, Doheny turned over to Fall $100,000 in cash. These published facts led in 1924 to an investigation by a Senate committee under the chairmanship of Senator Walsh of Montana. Secretary of the Navy Denby's part, though no corrupt relation appeared, so aroused public opinion that he had to resign He was replaced by Judge Curtis D Wilbur of California. Meanwhile Attorney-General Daugherty was shown to be in close relation with shady characters, a special committee of the Senate under Senator Wheeler unearthed unexplainable transactions Daugherty refused to allow the files of his office to be examined by the Senate committee; whereupon President Coolidge demanded his resignation (March 28, 1924) An attempt was made by Republicans to turn the tables by prosecuting Senator Walsh and his colleague Senator Wheeler on trivial and technical charges, but the courts dismissed the proceedings Criminal proceedings were instituted against Fall, Doheny and Daugherty, but every possible legal technicality was invoked by the defence so that several years after the trouble began proceedings were still pending President Coolidge took rather a neutral attitude in these proceedings, which he considered to be outside the scope of the executive power Daugherty was succeeded as Attorney-General by Harlan F Stone of New York, then Stone was placed on the Supreme Court bench and John G Sargent of Vermont became Attorney-General

Politics and Elections.—In the congressional elections of 1922 the Republicans retained small working majorities in both House and Senate There was, however, a return of earlier conditions in the appearance of a small group of radical Republicans, with Robert La Follette of Wisconsin as leader, who were able sometimes to hold the balance of power between the regular Republicans and Democrats President Coolidge's conduct during his eight months in office seemed to justify the confidence of his party, and when the Republican convention met in Cleveland there was no rival candidate On the first ballot the vote was: Coolidge 1,065, La Follette 34, and Hiram Johnson 10. The vice-presidency offered difficulties In the end the choice fell upon Charles G Dawes, known to the American public through his association with the Commission of 1923, which had devised the scheme for the payment of reparations by Germany The Democratic convention, held in New York, was the longest and fiercest in 60 years The vote was divided between McAdoo former Secretary of the Treasury, and "Al" Smith, a Roman Catholic, who had won a national reputation as Governor of New York

The convention balloted 103 times; but neither candidate could secure the necessary two-thirds The convention finally nominated John W Davis of West Virginia, former ambassador to Great Britain, with Charles Bryan (brother of William J Bryan) as vice-presidential candidate The campaign was quiet, and the result was that in the election (Nov 1924) Coolidge received 15,725,016 votes, as against 8,386,503 for Davis and 4,822,856 for La Follette, who gathered up many discontented Republicans and the considerable vote usually cast for Socialist and other minor candidates La Follette, however, had only the 13 electoral votes of his own state as against 136 for Davis and 382 for Coolidge It was a substantial Republican victory, accompanied by a Republican majority over all of 59 in the House and 16 in the Senate Vice-President Dawes on taking his seat in the Senate for the first time (March 4, 1925) seized the occasion to suggest that the procedure of that body needed reform; and that its first duty was to pass an efficient rule of closure

The Coolidge Administration.—Throughout both his terms of presidential service Coolidge addressed himself to a policy of economy. He stood by the budget bill which President Harding had secured from an unwilling Congress and continued the appointment of Gen Herbert M Lord as chief budget officer. This reform meant simply that Congress would not begin to act on the main appropriation bills until a budget based upon the ascertained needs of all the various departments had been drawn up, totalled

and submitted by the budget officials.

In 1913 the United States adopted an income-tax, made possible by the going into effect of the 17th amendment of the Constitution. During the World War the tax was raised to high rates, intended in part to transfer some of the immense War profits to the public treasury. Thenceforward that income was the largest factor in the national revenue, and was vigorously collected from individuals and corporations. The policy of the Government was to break down the high scale of War expenditure, to dispense with superfluous employees and so to come back to the public needs in time of peace. Several Acts of Congress, begun in 1921, reduced the rate of income-tax. The result was that the amount paid in income-taxes which was $2,600,763,000 in 1919 and $3,956,936,000 in 1920, came down to $1,691,090,000 in 1923 but rose to $1,761,659,049 in 1925. By the Act of Feb. 26, 1926, the rates were still further lowered but without any decrease in the total paid to the government; and the provision in the statute of 1924 under which the amounts paid by individuals or corporations were open to the public, was repealed

The Underwood tariff of 1913, passed by the Democrats and somewhat altered in 1916 and 1921, was repealed by a Republican majority after the inauguration of President Harding; and an emergency Act was passed (May 27, 1921). Soon afterwards the Republicans framed a new bill, the Fordney-McCumber tariff, signed by President Harding Sept. 21, 1922. It included a provision, never before a part of a United States statute, under which the President was to have power (informed by a Tariff commission) to alter rates of duty if necessary to "equalize the differences in cost of production in the United States over similar articles produced elsewhere." The receipts from duties on imports, which were $334,000,000 in 1910 and $324,000,000 in 1920, rose to $549,000,000 in 1925. The public debt, which for many years previous to 1917 stood at about a thousand million dollars was $26,594,268,000 soon after the close of the World War (Aug 31, 1919); but on June 30, 1926, had been reduced to $19,643,183,000, partly by selling the surplus War material and chiefly by payments made out of surplus.

Industry and Commerce.—However much the wealth of the country increased, it was not equally diffused; and large areas of the country were far from prosperous. The rural credits banks (*see* FEDERAL FARM LOAN SYSTEM), established under Wilson, furnished needed capital, and the farmers from 1917 to 1919 had a guaranteed government price of $2 20 per bushel for wheat When that protection was taken off after the World War, a group of members of Congress in both House and Senate, commonly called the Agricultural Bloc, demanded special consideration for the agriculturists Their prices had tumbled, and agricultural land values, inflated during the World War, fell back to or below antebellum prices. The cost of living and hiring farm labourers had been nearly doubled Discontent was reflected in the large popular vote for La Follette in 1924. Various propositions were made by farmers' associations and sympathetic members of Congress that the Federal Government permanently guarantee a price for the principal staples The South was also affected by this movement because the inroads of the boll weevil for a time greatly reduced the output In some degree the conditions of 1885–95 were reproduced; only it was no longer East against West, so much as the farmers of all sections against the group of manufacturers and distributors wherever established

Organized capital in banking, in manufactures, and in trade, was rolling up in this period notwithstanding the Sherman Act, the Mann Elkins Act and other measures against combinations In spite of Federal suits and Supreme Court decisions substantially upholding Federal control, combinations and consolidations of capital went on steadily. The railways, which had been sustained during the World War by the Government, were returned to their owners in 1920. For several years, notwithstanding a great increase in passenger and freight rates during the World War, they were unable to make what they thought a fair profit. Under the Esch-Cummins Act of 1920 they were allowed to retain a profit of 5½% earnings, plus one-half of one per cent to make provision for improvements chargeable to capital accounts, all excess over 6% to be evenly divided with the Government. Meanwhile the administrative commissions which had been so powerful lost prestige. The Tariff commission was weak and disregarded. The Labor Board was unable to enforce its decisions The Interstate Commerce commission and the Federal Trade commission suffered in prestige and influence from internal strains and quarrels. The special Shipping commission, created during the World War to build up a national merchant fleet, was left with a large number of vessels for which profitable business could not be found The Supreme Court decisions, under which great corporations like the Standard Oil Company and the American Tobacco Company were regulated, left them more prosperous than ever. The hold of the great banks and the smaller banks and bankers on the finances of the country was unshaken. Deposits in national and state chartered banking institutions in 1925 aggregated over 40 thousand million dollars

Social Questions.—Many phases of social life went through a similar exaggeration and transition. During the World War the United States offered extraordinary wages in order to activate the pursuits necessary to keep up the Army. This led to a general raising of the scale of wages of skilled workers, some increase for the unskilled and considerable increase in the earnings of domestic and agricultural workers. The Labor Unions made it their business to see that no systematic reduction of wages should succeed Fuel was especially important. The whole anthracite supply comes from a small region in Pennsylvania. In 1923 and again in 1925 came serious strikes of the miners' unions. The last one endured 170 days, and was settled only with great difficulty by a return to previous conditions.

Prohibition.—The most serious social question and most difficult governmental problem of this time was national prohibition (*see* PROHIBITION). In 1918 more than 30 States had laws on their statute books for the restriction of the liquor traffic and 28 States prohibited it outright During the World War, Congress prohibited the sale of liquor to soldiers, and then to the general public A prohibition (Eighteenth) amendment to the Federal Constitution was easily put through Congress, was ratified by a vote of 46 State Legislatures out of 48, and became a part of the Constitution Jan 16, 1919. On Oct. 28, 1919, the Volstead Act for enforcing the amendment was passed by Congress over the veto of President Wilson It forbade the sale or transportation of "intoxicating liquor" which was defined as any liquor which contains one-half of one per cent of alcohol. To administer this act required a large force of officials distributed over the country. The amendment contained a clause under which the States were to have "concurrent jurisdiction," which appeared to mean that State laws might continue in force and be carried out by State courts at the same time with the Federal system From the very beginning there was an organized system of evasion of the laws A regular system of "bootlegging," illegal sale and transportation sprang up. It was informally countered by "high-jackers"—that is bandits who seized bootleggers' supplies and carried them off by force, knowing that they were not likely to be followed by legal proceedings. An organized marine bootlegging trade placed a line of foreign sailing craft and steamers just outside the three-mile limit of the United States, whence they supplied the markets of the adjoining coasts.

The United States entered into treaties by which Great Britain and other nations agreed that vessels carrying their flags might be captured within that distance from the United States coast which can be traversed in one hour by the vessel suspected of endeavouring to commit an offence This might possibly be as much as 30 nautical miles Within the United States large numbers of otherwise law-abiding persons bought and sold or gave away bootleg liquor, and the difficulties of executing the law are shown by the figures of national enforcement In one fiscal year (1924–25) 20,000,000 gal of distilled and fermented liquors were seized; 77,000 persons were arrested; 50,000 criminal cases were entered against bootleggers; 35,000 pleas of guilty were entered and 38,000 convictions were obtained A national law regulating the traffic in habit-forming drugs was enacted May 26, 1922

National Defence.—The Armies were returned and disbanded

as fast as possible; but a demand was made at once by soldiers and officers for some immediate acknowledgment of their sufferings and services The Government attempted to head off this movement, first by an elaborate system of life insurance during the World War with the privilege of continuing afterward, then by money bonuses, passed by a number of the States. The Federal Government instituted an elaborate rehabilitation system for training wounded or otherwise injured men in some pursuit in which they could earn their own living The Government also provided hospitals and care for sick and disabled soldiers. Provision was made for special privileges of alloting government land in favour of ex-soldiers On Sept 20, 1922, a bonus bill was defeated by President Harding's veto On March 18, 1924, a Federal bonus was enacted by a large majority vote in Congress but it was vetoed by President Coolidge It was passed over his veto, May 17–19, by both houses of Congress.

Notwithstanding the experience of the United States in 1917, when it declared a war without any mobile Army, strong pressure was put on Congress to reduce the regular Army By an Act of Feb 12, 1925, the force of the regular Army was set at 125,000 enlisted men and 7,953 enlisted men of the Philippine Scouts. Most of the veterans were interested in the American Legion, the most widely distributed society of service men; and that body had considerable influence in the legislation for ex-soldiers.

International Relations.—The foreign affairs of the United States are always much affected by changes in party and in personnel. President Coolidge, accepting the resignation of Charles E Hughes from the Department of State, appointed as his successor (Feb 1925) Frank B Kellogg, previously a Senator and Ambassador to Great Britain To the powerful chairmanship of the committee on foreign relations, after the death of Henry Cabot Lodge of Massachusetts, who had been head of the opposition to the ratification of the League and Covenant, succeeded William E Borah of Idaho (Dec. 1924), the famous freelance of the Senate A great improvement in the conduct of foreign relations was introduced by the Rogers Act, which took effect July 1, 1924, under which the consular and diplomatic services were merged and the policy of training young men with the prospect of life-long service was entered upon

The general policy of the United States towards other nations was much affected first of all by changes in international trade caused by the disruption of the World War, then by the refusal of the Senate in 1919 to approve the Versailles Treaty and further by a strong popular opposition to any formal relation with the League of Nations. A treaty with Germany (July 2, 1921) formally restored peace, provided for commerce and arranged for an adjustment of claims Similar treaties were made shortly afterwards with Austria and Hungary The Lausanne treaty with Turkey, signed on July 24, 1923, was defeated in the Senate on Jan. 18, 1927

Immigration.—An important question, partly social and partly international, was that of immigration, which went through a new phase because of the rush of people from other parts of the world as soon as the war conditions were cleared up Complaint was made that in the previous two decades the greater part of the immigrants came from southern and eastern Europe, and was made up of persons who were not by tradition and inheritance of the same type as most of the previous immigrants Several changes were made in 1918 and at other dates so as to reduce the number of undesirables, and by the Act of 1924, a permanent quota system was enacted, based on 2% of the number of nationals of that country shown to be in the United States by the census of 1890. This made a total of about 165,000 permissible each year from all countries, besides about 150,000 transient visitors. Unrestricted immigration from Canada and Mexico and some other sources brought the total immigration in 1924 and 1925 up to about 300,000, out of which should be taken about 100,000 emigrants, leaving a total permanent addition of about 200,000 annually.

Reparations.—The United States was no party to the provisions of the Versailles Treaty providing for German reparations, particularly to France, and the payment of an indemnity by Germany However, an American force of occupation was left in the Rhine belt, the costs of which amounted to about $200,000,000 and were to be paid by Germany. In 1921 Germany did not pay the stipulated sums to the Allies and therefore the French occupied the Ruhr valley. The United States suggested a commission, which, headed by Charles G Dawes (later Vice-President of the U. S), succeeded in working out a scheme (1924) that was acceptable to France, Great Britain and Belgium, for a method of payment secured by a lien on German railways and factories Financially the importance of the Dawes plan to the United States was that it cleared the way for considerable investments of private capital in German municipal and corporate securities

General Foreign Relations.—Among the incidents of foreign relations after the World War was the recognition of various new countries created by the Treaty of Versailles. Poland, Latvia, Lithuania, Estonia, Finland, Czechoslovakia, Yugoslavia, Hungary and the enlarged Rumania In 1924 the United States received Prof Timothy A Smiddy as minister from the Irish Free State. The British Government consented to the appointment of a direct Canadian representative at Washington, and in 1924 a diplomatic agreement was made between the United States and Canada as regards halibut fishing, for which, however, the United States insisted upon a formal approval by the British Government This was granted in due course

The last American troops were withdrawn from Germany in 1923 Meanwhile a joint commission on German claims was far advanced in its task A troublesome difficulty was that a treaty with Prussia, entered into in 1828 and assumed in 1871 by the German empire, entitled German citizens in case of war to nine months to dispose of their property in the United States and leave the country. Instead, all discernible property of Germans, and particularly of German corporations, was seized at the beginning of the World War and placed in the hands of a Custodian of Enemy Property Valuable German patents were turned over, for a very small payment, to American manufacturing chemists It was not until March 10, 1928, that President Coolidge signed a bill appropriating $50,000,000 to cover the value of the property seized

Allies' Debts.—A very serious and difficult issue was that of the sums lent by the United States to foreign governments during the World War, aggregating nine and a half thousand million dollars Without those enormous advances the Allies would have broken down economically before an American Army could have been placed in Europe Nearly all the allied European countries shared in these advances For several years interest accumulated, until, at the end of 1922, the total principal was ten thousand million dollars and the accumulated interest one and a half thousand millions more. This enormous sum was funded in United States Government bonds placed at about four per cent interest, mostly in American hands, upon the same footing as other obligations of the Government. The interest was paid by the United States Treasury In 1923 the first important adjustment of the debt was made by an agreement with England (Feb 28, 1923) The whole amount of the principal and interest then due was funded at $4,000,000,000 to be paid in annual instalments beginning with 23 millions a year and increasing, until in the 62nd year the debt and accruing interest would be extinguished Similar settlements were made with Finland and other small nations. The obligations of Armenia and Russia were practically written off

Negotiations followed with other countries and a settlement was made with Italy (Nov. 1925), ratified (April 1926), to pay $5,000,000 a year for five years, and thereafter rising payments for 57 years The principal was reduced from a nominal value of two thousand million dollars to a present value at 5% of £430,000,000 the low rate of interest on long-deferred payments being thus equivalent to a reduction of about one-half the debt

In April 1926, following an unsuccessful visit of a French debt commission to the United States in Sept. 1925, the Berenger-Mellon settlement was finally arrived at with France

The total amount of the French indebtedness to be refunded, after a cash payment to adjust the sum to round figures, was de-

clared to be $4,025,000,000, and the repayment of this amount with interest was to be spread over 62 years as in the other World War debt settlements. The total sum to be received by the United States under this agreement amounted to $6,847,674,104, being an increase of approximately $627,000,000 over the previous French offer made by M Caillaux in 1925. The French Chamber, however, has not ratified the Berenger-Mellon agreement

Comparing the French settlement with those of Great Britain and Italy, the figures worked out as follows Great Britain's agreement discounted represented slightly over 80% of her total obligation, France's approximately 50% and that of Italy 26% The House of Representatives voted approval June 2, but ratification by the Senate was deferred pending the action of the French legislature The various agreements made to the end of April 1926 left only $295,000,000 unfunded World War debts to the United States, including $193,000,000 owing by Russia In nearly all cases the period of payment is so long and the interest so low that the settlements involve payment at the value of from one-quarter to over three-quarters of the original advances by the United States

Latin America.—With Latin America the United States in the main enjoyed peaceful relations The long-standing question over the Isle of Pines was adjusted by a treaty (March 13, 1925), under which the title of Cuba was acknowledged At the request of Chile and Peru, President Harding agreed in 1922 to arbitrate the obstinate dispute over the ownership of the Tacna-Arica region. After Harding's death President Coolidge took up the task and rendered his decision (March 4, 1925) to the effect that the delayed plebiscite of the inhabitants should now be taken; and General Pershing was made the head of a commission to preside over this process Chile objected, and nothing was done (*See* TACNA-ARICA) With Mexico relations became strained by a dispute over the application of the new Mexican constitution of 1917 under which aliens were forbidden to hold lands or concessions Mexicans claimed that this was in accord with the practice of several States in the United States. In 1925 Secretary Kellogg protested against the attitude of Mexico as unfriendly and declared that the Government of Mexico was on trial before the world In March 1926 a financial understanding was reached The United States was also concerned in the outbreak of anti-foreign feeling in China and her representatives took part in a conference at Peking in Oct 1925 upon questions relating to the withdrawal of the foreign limitation on the laying of tariffs by the Chinese Government

The League of Nations.—After the refusal of the United States to ratify the Treaty of Versailles or to take part in the League of Nations, no official relations with the League were established However, large numbers of American citizens were interested in the work of the League and some of them were appointed to advisory committees in which, however, they did not represent the American Government. Eventually the United States consented to appoint official delegates or "observers" to commissions on the Opium Traffic and other matters, instituted by the League and operating in its headquarters in Geneva. The United States became a party to treaties with regard to the white-slave trade and other matters, drawn up by the League, but to take effect for only such countries as might ratify them Gradually even the warm friends of the League accepted the conviction that it was useless for the time to urge participation in the League by the United States

The World Court.—Down to 1914 the International Court of The Hague, founded in 1899 and strengthened in 1907, was in being and rendered occasional decisions It was, however, entirely ignored by the contending parties in the six wars that broke out from 1900 to 1914 and after the World War it remained ineffective. Elihu Root, who had a share in framing the court, came forward in 1920 as the leader of an unofficial group of experts in international affairs, to propose a new world court with wide powers and jurisdiction. An advisory committee of jurists sat at The Hague and drew up a plan for a Permanent Court of International Justice. The League of Nations modified the project but established the Court (Dec. 1920) and chose the judges (Sept. 1921) (*See* PERMANENT COURT OF INTERNATIONAL JUSTICE) The United States had no official relation with the Court; but the force of American public sentiment for a World League concentrated on a proposition for qualified entrance of the United States into the World Court

This was warmly urged by President Harding and later by President Coolidge. Senator Borah, Senator Hiram Johnson of California and others strongly opposed. The progress of the movement was checked by a proposal, originally drawn by a group headed by Professor J T Shotwell of Columbia University and the Carnegie Endowment, who desired to enlarge the jurisdiction of the World Court and give it a compulsory character. The League of Nations modified this proposal into the so-called Geneva Protocol, which was unanimously approved by the Assembly of the League of Nations (Sept 1924), and sent for ratifications by the nations of the world Strong opposition was made in the United States on the plea that the Court was to decide whether a controversy was justiciable, and could assert jurisdiction over all nations and also arbitrate regarding nations, even if not members of the League of Nations Great Britain declined to accept the compulsory jurisdiction and the whole plan fell to the ground. (A. B H.)

SINCE 1926

Adherence to the World Court Defeated.—The refusal of Great Britain to accept the Geneva Protocol left the original statute constituting the World Court intact and pressure upon the U S Senate to vote for U S participation in the court was renewed President Coolidge and Secretary Kellogg also urged it On Jan 27, 1926, the Senate, by a majority of 76 to 17, voted the adhesion of the United States with five reservations, the most important of which provided that the statute of the Court should not be amended without the consent of the United States and that the Court should not "without the consent of the United States entertain any request for an advisory opinion touching any dispute or question in which the United States has or claims an interest " When the representatives of the powers signatory to the statute of the court, in a meeting at Geneva, in September 1926, refused to grant the United States the favoured position which the Senate reservations demanded, the prospects of joining the Court grew dim In his Armistice Day address at Kansas City (Nov 11, 1926), dedicating the $2 000,000 Liberty Memorial to the heroes of the World War, President Coolidge declared that he should not ask the Senate to modify its position, and that unless its reservations were accepted by the other interested nations he saw "no prospect of this country adhering to the Court "

President Coolidge and Congress.—A few days before the President's Armistice Day address the midterm Congressional elections were held. The Democrats captured seven of the contested seats in the Senate, exactly wiping out the Republican majority in the 69th Congress, and gained thirteen seats in the House, making the complexion of the 70th Congress (1927–29) 237 Republicans, 195 Democrats, 3 Independents in the House, and 48 Republicans, 47 Democrats, 1 Farmer-Labourite in the Senate The election foreshadowed embarrassment for the administration in its last two years. Not only was President Coolidge rebuffed by the defeat of his personal friend and adviser Senator Wm M. Butler of Massachusetts, chairman of the Republican National Committee, by his Democratic opponent David I Walsh, in spite of a letter from the President to the voters of Massachusetts, urging the election of Butler, but the elimination of the Republican margin in the Senate made it necessary for that body to conciliate the "insurgent" members who had supported La Follette in 1924 and had been punished therefor by being dropped from important committee assignments in the 69th Congress The Republican progressives, like La Follette (the younger), Blaine, Frazier and Nye, were now restored to good and regular standing, and exacted from floor-leader Curtis as the price of their support of the party the promise that "certain legislation of paramount interest to the people" (farm relief, investigation of American policy in Latin America, a bill to regulate the issuance

of injunctions) should be brought to a vote during the first session of the 70th Congress. On these questions, as on several others of major importance, such as the details of tax reduction, the disposition of Mussel shoals, the naval programme, the Mississippi flood control, the method of prohibition enforcement, President Coolidge found himself at odds with Congress. He did not, however, attempt to drive Congress, as Roosevelt and Wilson had done, nor did he treat it with sarcastic indignation, like Cleveland. With characteristic patience he held to his policies, vetoing 16 bills and resolutions in the first session of the 70th Congress (Dec. 5, 1927–May 29, 1929), and insisting in his messages and speeches on the blessings of obedience to law and of rigid economy for the preservation of America's prosperity and favoured position among the nations of the world

National Finances.—The era of prosperity which set in at about the time of Mr Coolidge's accession to the presidency continued unabated during his entire administration. Except in a few "spots," such as the bituminous coal, the textile, and some agricultural industries, production mounted steadily, consumption kept pace, labour was well employed and content. The national wealth, which had stood at about $7,000,000,000 in 1850, $25,000,000,000 in 1870, $65,000,000,000 in 1890 and $350,000,000,000 in 1920, was approaching the $450,000,000,000 mark by 1929 The annual income had reached $90,000,000,000 and annual savings were more than $17,000,000,000. The United States was investing about $2,000,000,000 of surplus wealth abroad and diminishing the national debt by nearly $1,000,000,000 each year. The abundant receipts of the Treasury (more than half from income taxes), combined with the careful co-operation of the committees of the administrative departments under President Coolidge and Director of the Budget Lord, resulted in substantial surpluses at the end of every fiscal year On Feb. 26, 1926 the President signed a bill for a tax reduction of $388,000,000 (which he thought was too much), by which the normal rates on incomes were reduced from 2% to 1½% on the first $4,000, from 4% to 3% on the next $4,000, and from 6% to 5% on the excess of $8,000. The exemptions were raised from $1,000 to $1,500 for a single person and from $2,500 to $3,500 for a married couple. In spite of the cut in taxes the surplus continued to come in, and on May 29, 1928 the President signed the third tax reduction bill of his administration (relieving corporations and certain industries, but leaving the personal schedules unchanged), involving a cut of about $220,000,000. The refunding of the second and third Liberty loans in 1928 effected a saving to the Government of $75,000,000 a year in interest charges. As President Coolidge's term drew toward a close, however, the prospect for further tax reduction vanished, and there was even some apprehension that the Treasury might be confronted for the first time in the administration with a deficit instead of a surplus. This was due to certain extraordinary demands on the Government, such as the appropriation of $75,000,000 for the refund of taxes illegally collected, of $50,000,000 for the settlement of claims arising out of taking over alien property during the World War, of nearly $50,000,000 for a public buildings program, and of some $20,000,000 for initiating work on the vast $315,000,000 programme for Federal engineering work on the lower Mississippi river, to avert a repetition of the terrible floods that had occurred in the spring of 1927, breaking the levees and deluging millions of acres of farm lands in Missouri, Arkansas, Tennessee, Mississippi and Louisiana, drowning hundreds of persons and making hundreds of thousands homeless The commission for the settlement of the debts of foreign countries to the United States incurred in the World War was dissolved on Feb. 9, 1927, after having negotiated settlements with thirteen countries for the eventual payment of principal and interest amounting to $11,522,354,000. The Government later arranged with Greece for the funding of her debt to the United States of $15,000,000 Austria was granted a moratorium on her debt of $12,000,000 until 1943. The Mellon-Berenger agreement for the settlement of the French debt to the United States over a period of 62 years has not (June, 1929) been ratified by the Chambers at Paris.

National Defence.—Since the fortunate position of the United States brings immunity from fear of attacks by strong and hostile neighbours, the country follows the traditional policy of a small and well-equipped army supplemented by State militia. The regular army of about 132,000 men means only 1·1 soldiers to every thousand of population and every $3,250,000 of national wealth, as against 12·5 soldiers to every thousand of the population and every $135,000 of the national wealth of France. Reduction of land armaments is not a problem in which the United States is directly interested. But the Government has worked diligently in the last few years for the reduction of naval armaments To supplement the work of the Washington Conference of 1921–22, which limited the tonnage of battleships and aircraft carriers, President Coolidge, on Feb 10, 1927, sent an identic note to Great Britain, France, Italy and Japan, asking these nations to empower their delegates to the forthcoming Preparation Conference on Disarmament at Geneva to negotiate treaties with the United States for the limitation of the construction of cruisers, submarines and destroyers. France and Italy, however, declined the invitation outright, and Great Britain hedged her acceptance with such conditions as meant, in the President's words, "not a limitation but an extension of war fleets." Moreover, details were published of a naval agreement between England and France in 1928, which seemed to be aimed against the cruiser strength of the United States. Disappointed by the failure of his proposed conference, President Coolidge came out more positively for a "policy of adequate defence," using rather strong phrases in praise of the American army and navy and air force in his Armistice Day address (Nov 11, 1928) at Washington under the auspices of the American Legion. A five-year building programme had been approved by Secretary of the Navy Wilbur in the summer of 1926, calling for 71 new vessels (cruisers, submarines, destroyers and carriers) to cost nearly $800,000,000 Cutting this programme to 15 cruisers and one aeroplane carrier, the House, on March 17, 1928, passed a bill for the construction of the 16 vessels in three years at a cost of $274,000,000. The cruiser bill was put over to the short session of the Senate, where it met sharp opposition, especially as it was pending at the same time as the ratification of the Kellogg Pact for the renunciation of war as an instrument of national policy. However, the bill was passed on Feb. 5, 1929 by a vote of 68 to 12, and was signed by the President, although he was opposed to the time limit requiring that five of the cruisers be laid down in each of the years 1929, 1930, 1931. On Feb 28, 1929 Congress agreed to a $12,370,000 addition to the Naval Appropriation for the new vessels, $200,000 to be available at once for starting the 1929 group of five, and $200,000 to be available on July 1, 1929 for beginning the 1930 group The marvellous progress of aviation in the last few years has played a great part in the field of national defence as well as in the carrying of passengers, goods and mail. Bombing, scout, pursuit and combat planes, aircraft carriers and rigid airships have been important parts of army and navy equipment. Some critics have urged the creation of a unified cabinet department of national defence, with under-secretaries of army, navy and air. In 1925 the army and navy departments spent $12,769,689 and $14,743,348 respectively for aviation. President Coolidge in his final statement on the budget (Dec 5, 1928) declared that by the end of 1931 the navy would have a "well balanced fleet of 1,000 aeroplanes" and that a year later the number of army planes would reach 1,800. The total sum contemplated for national aviation projects in 1930 is over $140,000,000, including about $18,000,000 for air mail contracts, $6,400,000 for the Department of Commerce's activities, and $582,000 for the Department of Agriculture (forest patrol, weather observation and fighting the boll weevil).

Railroads and Shipping.—In the stress of the World War these two major agencies of transportation had been taken over by the Government. The railroads were restored to their owners on March 1, 1920, by the Esch-Cummins Transportation Act, which besides providing for substantial Government loans to the railroads and a six months' guarantee against deficit, created a Railroad Board of nine members, to which disputes on wages and hours had to be submitted, required the roads to pay to the

Government one-half of their earnings above 6% of their valuation, and ordered the Interstate Commerce Commission to make regional railroad consolidations to the end that the stronger roads might bear the infirmities of the weak But the Transportation Act was more honoured in the breach than in the observance The Commission did not effect a single compulsory consolidation, and in 1927 it was relieved from this duty by the Parker bill and allowed to approve or deny applications for consolidation from the railroads themselves. Most such requests have been denied as prejudicial to the stockholders or the public. Labour was dissatisfied with the decisions of the compulsory Labour Board, and it was not until the Watson-Parker bill of May 20, 1926 had set up in its place a voluntary Board of Mediation that the first successful mediation of a railroad wage dispute in 20 years was effected (Feb 5, 1927). A large number of wage increases, generally averaging 7½% were secured by the railroad workers under the new Mediation Board in the years 1927 and 1928. The physical valuation of the railroads by the Interstate Commerce Commission, as a basis for rate fixing, which had been authorized in 1913 and interrupted by the War, was virtually completed by the summer of 1928. The Commission's valuation of the property of the roads was to serve as the basis of the "recapture" clause of the act of 1920, by which one-half of the earnings in excess of 6% should go to the Government This provision promises endless litigation The validity of the Commission's method of valuation was presented to the Supreme Court of the United States in the case of the St Louis and O'Fallon railroad, called "the greatest law-suit in history" because of the immense sums involved in the right of the government to recapture excess earnings This railroad's earnings in excess of 6% of the Commission's valuation had been ordered paid to the Government The court, with Justices Holmes, Brandeis, and Stone dissenting, rejected the Commission's valuation on the ground that no weight had been given to "reproduction" cost (49 Sup Cl. Rep. 384) But, since no criteria were laid down as to how much weight was to be given to this factor, the decision could not be said to be decisive In no year since 1920 have the railroads even of the first class earned so much as 6% on their own property valuation in which cost of reproduction figures largely

At the close of the World War the United States Shipping Board had on its hands a large number of merchant ships seized from Germany or constructed by the Emergency Fleet Corporation since 1917 Many of the smaller cargo ships the Board sold as junk, but it maintained the larger vessels in the passenger and freight service, operating them at a loss of millions a year The arrangement was confessedly provisional, and the Board was continually inviting bids for the merchant fleet from private operators In 1923 five ships of the "President" class were purchased by the Dollar Line. By the Jones-White act of May 1928, Congress reluctantly appropriated $250,000,000 for the maintenance of the fleet and loans for the construction of new vessels On Jan 16, 1929 the Shipping Board received a bid from the P W Chapman Company of New York, which it accepted a few weeks later by a vote of six to one The Chapman company is to pay $16,082,000 for the "Leviathan," the "George Washington," the "America," the "Republic," the "President Harding," the "President Roosevelt," and the five ships of the American Merchant Line, and promises to build, with the aid of a Government loan, two new vessels "superior in type and size to the 'Leviathan' " Thus the Government may go out of the shipping business with the assurance that the flag of the American merchant marine will be upheld in world trade

Efforts at Farm Relief.—In the midst of general prosperity the farmers complained that they were poorer The value of their capital investment had shrunk from $79,000,000,000 to $59,000,000,000 in the five-year period 1922–27, and the return on this capital was less than 3% While over-production kept the prices of their products down, State and local taxes and the cost of farm implements and machinery were rising. The farmers asked the Government to come to their relief (as it helped the manufacturers by the tariff and labour by the restriction of immigration) by purchasing their surplus product of wheat, corn, cotton, hogs and tobacco and selling it abroad for what it would bring in the world market, assessing the loss and the cost of the operation on the industries benefited (the "equalization fee"). The McNary-Haugen bills embodying these demands were kept before Congress during the last three years of the Coolidge administration. The first bill failed of passage in the late spring of 1926, but in Feb 1927 a McNary-Haugen bill went through both houses President Coolidge vetoed it because it put the Government into the farming business, though he was willing to help the farmers help themselves by generous contributions to co-operative marketing projects and by aid from the Department of Agriculture The veto was accompanied by an opinion from Attorney-General Sargent condemning certain features of the bill as unconstitutional. Nothing daunted, the advocates of farm relief came forward with a third McNary-Haugen bill, which passed Congress by increased majorities in the spring of 1928, only to meet with a second veto from the President (May 23) The Senate failed by the margin of 50 votes to 31 to pass the bill over the veto. On the first day of the short session of the 70th Congress (Dec 4, 1928) the fourth McNary-Haugen bill was introduced, this time without the equalization fee No action was taken on it during the session, but President Hoover called an extra session of the 71st Congress to meet on April 15 to deal with farm relief and the revision of the tariff President Coolidge's vetoes of the farm relief bills roused opposition in the west and led to predictions that the farming sections of the country would not support an administration candidate for the presidency in the campaign of 1928. But Mr Hoover carried every one of the agricultural States.

Latin-American Relations.—The controversy with Mexico over her legislation to put into effect the provisions of Article 27 of the Constitution of 1917, regulating alien exploitation of mineral and agricultural lands, was further embittered by the appeal made to the Catholics of that country against President Calles' measures against the foreign clergy of the Roman Catholic Church in Mexico, and by the report that the Mexican Bolshevists were encouraging the rebels in Nicaragua in their resistance to the American marines So serious was the situation at the beginning of 1927 that the United States Senate by a unanimous vote asked President Coolidge to submit the controversy with Mexico to arbitration The President ignored the request, but in the autumn he sent Dwight M Morrow, of the firm of J P Morgan & Co as ambassador to Mexico Mr. Morrow's friendly and tactful diplomacy resulted in an early agreement with President Calles, and the amicable relations of the two countries were greatly strengthened when Col Charles A Lindbergh, after a non-stop flight from Washington, arrived at Mexico City (Dec. 14, 1927) as an American "ambassador of good-will" President Coolidge, in spite of criticism in Congress and in the Liberal press of the country, held to his policy of maintaining some 5,000 marines in Nicaragua to quell the revolt against Díaz and to protect American lives and property The Sacasa and Díaz forces agreed to lay down their arms when President Coolidge sent Col Henry L Stimson to Nicaragua with an ultimatum in April 1927, but the rebel leader Sandino continued a guerrilla warfare in which more than 20 American marines were killed and 50 wounded When Sandino was overcome, both parties agreed to a fair election which was held under the supervision of American troops (Dec 4, 1928) and resulted in the victory of the Liberal candidate, Moncada The Sixth Pan-American Congress was opened by President Coolidge in person, at Havana, Cuba, on Jan 16, 1928 Charles E. Hughes headed the American delegation, and skilfully steered the conference away from the embarrassing political questions raised by the United States intervention in Nicaragua A supplementary Pan-American Conference on Arbitration and Conciliation met at Washington on Dec. 10, 1928, which not only negotiated a score of arbitration treaties between the Latin-American nations, but was influential in keeping Bolivia and Paraguay from going to war over disputed territory in the heart of South America President Coolidge in an address at George Washington university, on Feb 22, 1929, declared that our relations with Central and South America were then better than they had been at any time in the past 25 years.

The Briand-Kellogg Peace Pact.—On the tenth anniversary of the entrance of the United States into the World War (April 6, 1927), the French Foreign Minister, Aristide Briand, proposed that the United States and France should agree to a treaty renouncing war as an instrument of national policy, and agreeing to settle disputes of whatever origin or nature by pacific means. Rather tardily Secretary of State Kellogg replied, suggesting that the treaty be extended to other nations. On Aug. 27, 1928, the representatives of 15 nations met at Paris and signed the Briand-Kellogg Pact. Secretary Kellogg represented the United States at Paris, making a visit to the Irish Free State after he had left Paris On Jan. 15, 1929, the Senate ratified the pact.

The Election of 1928.—President Coolidge and Charles E Hughes, the two most conspicuous leaders of the Republican party, having announced that they would not run for the presidency in 1928, the field was left open for Secretary of Commerce Herbert C. Hoover, who was easily nominated over his senatorial rivals (Curtis of Kansas, Watson of Indiana, Goff of West Virginia, Norris of Nebraska), receiving 837 out of the 1,084 votes cast in the first ballot, at the nominating convention at Kansas City, June 12–15, 1928. The delegates to the Democratic nominating convention at Houston, Texas, on June 26–29, cast 849⅔ votes out of 1,100 for Alfred E. Smith, then serving his fourth term as governor of New York Senators Charles Curtis of Kansas and Jos T Robinson of Arkansas were named as the respective vice-presidential candidates Each of the four nominations was made on the first ballot cast The platform of the Republican party promised farm relief and a careful revision of the tariff, defended the Coolidge policy in Nicaragua, and adopted a prohibition plank written by Senator Borah, pledging the administration to a "vigorous enforcement" of the 18th Amendment. The Democratic platform contained a scathing denunciation of the "sordid corruption and unabashed rascality" of Republican rule, which had left "agriculture prostrate, industry depressed, and workmen without employment," and pledged action instead of broken promises for the relief of the farmer. Governor Smith telegraphed to Chairman Robinson of the Convention endorsing the platform in general, but adding that it was his duty as the chosen leader of the party to say that he advocated "fundamental changes in the present provisions for national prohibition." Mr. Hoover made only a few campaign speeches, and in them he confined himself to generalities. Governor Smith, on the other hand, toured the country and discussed definite policies which he proposed to adopt if he were elected On election day, Nov. 6, 1928, Mr. Hoover carried 40 of the 48 States, including four (Virginia, North Carolina, Florida and Texas) which had been solidly Democratic since the days of reconstruction The electoral vote was 444 for Hoover to 87 for Smith But the popular vote of 21,429,109 to 15,005,497 indicated no such crushing defeat for the Democratic candidate. He had, indeed, proved a stronger candidate with the people than either Cox in 1920 or Davis in 1924. The Socialist candidate, Norman Thomas of New York, polled 267,835 votes; the Radical Workers' (Communist) party candidate, Wm. Z. Foster, 48,228, the Social-Labour candidate, Reynolds, 21,181; and the Prohibitionist candidate, Varney, 20,101. Mr. Hoover's invasion of the "Solid South" was attributed by the Democrats to the prejudice in that section against Governor Smith as a "wet" and a Roman Catholic, while the Republicans affected to see in it the swing of the South towards tariff-protected industry and the recognition of Mr Hoover's wide experience as an executive. Soon after the election Hoover sailed from San Diego, California, on the battleship "Maryland," for a good-will tour to the countries of Central and South America He visited Honduras, Nicaragua, Costa Rica, Ecuador, Peru, Chile, Argentina, Uruguay and Brazil, sailing for home on the "Utah," Dec. 21, 1928. The tour afforded the president-elect the occasion not only to pay his respects to the statesmen of the sister republics to the South, but also to get some acquaintance at first hand with a region in which United States investments of capital had increased from $1,500,000,000 in 1913 to over $5,000,000,000 in 1928, and with which the annual trade had passed the $1,000,000,000 mark. While the "lame duck" session of the 70th Congress was drawing to a close, with the enactment of the Jones bill for a marked increase in penalties (maximum of $10,000 fine and 5 years' imprisonment, instead of $2,000 fine and 6 months' imprisonment) for the violation of the prohibition law, Mr. Hoover was studying the problems which would confront him after March 4, receiving hundreds of political visitors at his home in Washington or on his vacation in Florida, and wrestling with the task of selecting his cabinet On March 2 the names of the cabinet officers were given to the public. Secretary of the Treasury Mellon and Secretary of Labor Davis of the Coolidge cabinet were retained in office. The eight new appointees (none from the States of the South which Hoover had carried) were Col. H. L. Stimson, governor-general of the Philippines, for Secretary of State; James W. Good of Iowa, Secretary of War; William De W. Mitchell of Minnesota (a conservative Democrat), Attorney-General; Charles Francis Adams of Massachusetts, Secretary of the Navy; Walter F. Brown of Ohio, Postmaster General; Ray L. Wilbur of California, Secretary of the Interior; Arthur M Hyde of Missouri, Secretary of Agriculture; and Robert P. Lamont of Illinois, Secretary of Commerce

Beginning of Hoover Administration.—On March 4, Mr Hoover took the oath of office administered by Chief Justice Taft, and read his inaugural address, while a vast crowd stood patiently in the cold, drizzling rain before the east front of the Capitol He pledged the administration to a vigorous enforcement of law, to co-operation with the agencies of public health, education, agriculture and business, and to continued efforts for the promotion of world peace. He announced that he would shortly call the 71st Congress (Senate 55 R, 39 D., 1 F. L; House 269 R., 165 D., 1 F. L.) in extra session to consider the problems of farm relief and the tariff He closed with a glowing confession of his faith in the American people

The special session opened on Apr. 16. A farm relief bill, embodying the creation of a Federal Farm Board and a $500,000,000 revolving fund to be used at the board's discretion in the aid of agriculture, quickly passed the House The Senate drew up its own bill, like that of the House in all essentials except that it contained a plan for debentures on farm exports This met with opposition from President Hoover, but the bill was passed by a vote of 47 to 44. A deadlock between the houses followed which was not broken until June 13 when the President secured a vote in the House on the debenture plan alone in which the plan was defeated 250 to 113 The Senate then allowed the House bill, as slightly modified in conference, to pass, and it was signed on June 15 The tariff also provided difficulties. Instead of "limited revision," as the President had requested in his message to Congress the Smoot-Hawley bill which was introduced into the House on May 7 proposed changes in every schedule except tobacco and revision of about one-fourth of the rates, mostly upward. The smooth-running House organization passed it in spite of protests from the Democrats and insurgent Republicans. The issue was met squarely in the Senate when Senator Borah introduced a resolution which would limit changes in the schedule to agricultural and related products. The resolution was defeated 38 to 39 on June 18. The next day the Senate voted a recess until Aug. 19, and the House until Sept. 23. Both bodies, meantime, had passed a bill providing for reapportionment of the House of Representatives immediately following the 1930 census. (D. S. Mu.)

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UNITED STATES COAST GUARD, THE: see Coast Guard.

UNITED STATES NAVAL ACADEMY, an institution of higher learning conducted by the U S. Navy Department and located at Annapolis, Md., for the purpose of preparing young men to enter the lowest commissioned ranks of the Navy. It is the principal source of officers It was founded as the Naval School in 1845 by the Hon George Bancroft, historian, educator and secretary of the navy, to improve the then unsatisfactory methods of instructing midshipmen (*q v*). At first the course was five years, of which only the first and last were spent at the school. It was reorganized in 1850–51 as the U.S. Naval Academy, with a course of study of four consecutive years. A summer practice cruise replaced the omitted sea service, and gave better opportunities for intensive training During the Civil War the academy was moved to Newport, R I, but was brought back to Annapolis in 1865 In the following years great improvements were effected in the organization and curriculum. During the Civil, Spanish-American and World Wars, the course was shortened to provide more officers for the fleets During the World War large classes of reserve officers were also trained.

Under the superintendent, the academy is organized into the following departments. the executive department, headed by the commandant of midshipmen, who is charged with interior discipline, drills and tactical instruction; and the academic departments. The superintendent, commandant of midshipmen, and the heads of the academic departments constitute the academic board, which determines policies. There are also medical and supply departments, station ships, a hospital, a rifle range and a post-

graduate school

Considering that the Naval Academy does not attempt to produce specialists in any one subject, the course is equal to those of the best colleges and technical schools. Candidates are appointed upon nomination by the president from the United States at large, and from the several States and Territories upon nomination by the senators, representatives and delegates in Congress Also 100 each year from the Navy and Marine Corps and 25 from the Naval and Marine Corps Reserve by competitive examination; and 40 by competitive examination from among the sons of officers, soldiers, sailors and marines who died as a result of the World War The entrance examinations are designed to admit competent graduates of first-class secondary schools. The physical requirements are rigid A fourth-classman or "plebe" enters in June or July, between 16 and 20 years of age, and spends the summer in drills designed to fit him for his new environment. Each succeeding summer he spends on a three months' practice cruise, usually on a battleship The academic year runs from October to June The course covers higher mathematics, physics, chemistry, engineering, naval construction, electricity, seamanship, communications, military and international law, elementary strategy and tactics, military tactics, aeronautics, ordnance and gunnery, navigation, English, naval history, modern history, French or Spanish, hygiene and physical training Theoretical and practical instruction are combined to the fullest extent.

In the early part of the century, the academy was almost completely rebuilt. The grounds, comprising 224 ac, present a most pleasing appearance, with imposing buildings in granite, reinforced concrete, white brick and terra cotta, in the French Renaissance style, after the designs of Ernest Flagg. There are 125 major buildings, including officers' quarters, the estimated value of which is (1928) about $28,000,000 In 1928 there were 1,790 midshipmen In 1912 the Postgraduate School was established Selected officers are sent there from sea for a year or more of advanced work in engineering subjects, to provide experts in design, repair, construction and operation of material. They are then usually given a year's work at certain universities and technical schools In 1927 a "general line course" was established, consisting of a year's work at the Postgraduate School in professional subjects, followed by a year at the Naval War College, Newport, R I

See Benjamin, *The United States Naval Academy;* Earle, *Life at the U S Naval Academy*, Soley, *Historical Sketch of the United States Naval Academy*, Naval Academy Registers, and *Regulations Governing the Admission of Candidates into the U.S Naval Academy*, published by the Bureau of Navigation, Navy Department (S S. R.)

UNITED STATES OF EUROPE, THE. After the end of the World War, there was a widespread feeling among men of all nations that the old formula of the balance of power, unstable and precarious as it had always been, was obsolete and must be replaced by an organized system for the preservation of peace, based on permanent institutions It was for this reason that the League of Nations was created It is however gradually becoming clear that owing to its necessarily world-wide character, the League includes nations too different in race and civilization to be bound closely together by common institutions; and moreover, since it recognizes the principle of the sovereignty of States, the only method at its disposal is arbitration, which only too often cannot be enforced by any kind of sanction.

Conception of Closer Union.—The nations of Europe on the other hand are all similar in race and culture, and it would be possible to conceive of a closer union between them, the aim of which would be not to settle their disputes, but rather to prevent their arising Since quarrels between the countries of Europe are the greatest menace to world peace, this would make the task of the world-wide League at Geneva much easier of accomplishment. At the time of the Locarno agreement the Assembly of the League recognized that regional agreements between neighbouring States were legitimate; and there thus arose the idea of a European Union developing within the framework of the League of Nations.

Geographical Limits.—The European Union was first conceived on political lines, as a federation of States, each of which would retain full political, administrative and fiscal autonomy. Above the local Governments there would however be a parliament, with either one or two chambers, to deal with relations between the countries forming part of the Union, and a central executive authority which would have at its disposal the forces necessary to protect the group against attack from without. This is the system which has been adopted, with differences of detail, by the Swiss cantons, Germany, the American people and the British dominions. The example of the United States shows that the system is capable of maintaining peace among hundreds of millions of men inhabiting a whole continent. It is simple and easily grasped, and it has the advantage of being based on precedent It is therefore accepted almost without discussion by many men whose training is exclusively political.

Differences of opinion begin to appear when an attempt is made to fix the limits of the new Federation. Some would include the whole of traditional Europe from the Urals to Gibraltar. including the British Isles. This is the view taken by the *Fédération pour la Coopération européenne.* Others would exclude Soviet Russia, because the political and social principles on which that country is constituted are absolutely opposed to those of other countries; at the same time they consider that Great Britain could not be included because it is bound up with a vast oversea empire which cannot be incorporated in a European Federation and from which Great Britain would not separate itself. This is the position of *Paneuropa* According to this theory the European Union would consist simply of the European peninsula from the Baltic to the Strait of Gibraltar and the mouth of the Danube, with the addition of Scandinavia.

Economic Aspects.—Whatever be the solution adopted, it is evident that there is an economic as well as a political problem to be considered It is impossible to conceive of a Federation whose members engage in tariff wars with one another All existing Federations have established free circulation of goods, capital and persons between the States of which they are composed. Economic unity has always preceded or immediately followed both the formation of great nations and the federation of small States Some have therefore thought that action should first of all be taken in the economic sphere. This is the object of the *Union Douanière européenne* What countries could however be included in such a customs union? Not Soviet Russia, which will not abandon the State monopoly of foreign trade. It would also be difficult to include Great Britain, on account of the preferential tariffs accorded to the dominions. The only possibility would thus be a peninsular customs union reaching from Poland and Rumania to Spain, and from Scandinavia to Greece. Such a customs union would imply a unified currency, with a federation of the banks of issue, the disappearance of undertakings which are artificially kept in existence by protectionism, and consequently a great regrouping of industries, with specialization according to the districts naturally best suited to each, modernization of plant, and agreements for the distribution of markets in the form of cartels, or financial amalgamations in the form of trusts. This would of course be an exceedingly complicated matter to bring about, but unless it were accomplished, any attempt at political federation would be doomed to collapse as rapidly as the Frankfurt Parliament at the time of the 1848 Revolution.

The suppression of customs duties within the Federation, combined with the rationalization of industry, would clearly result in a general lowering of selling prices, an increase in the purchasing power of the population, and greatly enhanced activity for European industry.

Another question however arises—what would be the relations of the European customs union with other groups of countries? Some believe that it would at once take steps to exclude British and American manufactured products from the continental market, and would endeavour, by means of dumping if necessary, to eliminate its rivals on the principal markets of the world Others on the contrary, including some circles in Great Britain and the United States, consider that it would be easier for Anglo-Saxon industry to conclude tariff agreements with a single customs union than with 24 different States, and that its trade would

rapidly develop on the extensive and newly opened markets of continental Europe, where the purchasing power of the population would have suddenly increased. However this may be, all are agreed that the economic unity of the continent is a necessary preliminary to political union.

Let it be assumed that both problems have been solved. The United States of Europe would then form a great block of 300 million white men, placed between:—Soviet Russia, with 92 million Slavs and 54 million of other races; the British empire, with 67 million whites (plus 413 million natives). The United States of America, with 105 million whites and a coloured population of 13 million

The United States of Europe would far outstrip the others in the size and homogeneity of its population, industrial equipment and military strength. Might it not be tempted to establish its hegemony? The preservation of peace between the four great groups would have to be entrusted to the League of Nations. It may well be asked, however, whether the task of the League would not be rendered much more difficult instead of easier.

Centralization and Decentralization.—The whole of the conception described above rests on one postulate: that it is necessary to adjust the political and economic mechanism of the various countries by widening them to the dimensions of Europe Some however doubt whether this is really the best way of ensuring peace They point out that as elementary education and democracy extend their influence among the population, there is an increasing tendency towards the formation of close ethnic groups This is particularly striking in Central and Eastern Europe, but even the oldest established centralized States of the West are not entirely exempt from regionalist or autonomist movements Simultaneously there is a contrary movement; the enormous development of means of communication, and the constantly accelerated pace of trade, tend to form increasingly large economic units This results in one of two things; either an attempt is made to reduce the economic mechanism to the dimensions of the ethnic group (autarchy), thus paralyzing its material development, or else different ethnic groups are included within the customs frontiers of a great State, and this is liable to result in the oppression of minorities. In either case the causes of dispute between adjoining Powers are multiplied, and the lack of unity in Europe is accentuated The Federalists consider that it would be better to let each of the two mechanisms develop on its own lines. The United States of Europe would thus be the outcome of a twofold movement: political decentralization and economic centralization.

The Two Europes.—If the matter is regarded from the technical point of view, it will be seen that there are in reality two Europes of widely different structure Suppose a line to be drawn through Stockholm, Dantzig, Cracow, Budapest, Florence, Barcelona and Bilbao, let it continue round France, pass between England and Ireland, and continue through Glasgow and Bergen back to Stockholm. Within the circle thus formed are concentrated nearly all the coal mines, the great factories for the production of machinery and manufactured goods, and the great financial markets. Even agriculture within the circle is highly industrialized, and is carried on with machinery, tractors and chemical fertilisers There is a close network of roads and railways, and all the undertakings are highly specialized and produce goods for commerce. Outside the circle there lives an almost exclusively agricultural population: the peasant cultivates his land by human labour with the assistance of a few beasts of burden, he produces little, trades still less, and lives under an economic system of a family character. The first of the two Europes is the Europe of mechanical power, the second the Europe of animal power. The latter has a population of about 230 million souls, living scattered in the country districts (32 persons per sq km.), and cultivating land with a low yield; it cannot feed the annual surplus of the population, and the social equilibrium is only maintained by emigration The former on the other hand has a dense population of about 210 million (92 persons per sq.km.), most of whom are concentrated in the towns. In spite of intensive cultivation, the land cannot provide enough food for the population, and it is necessary to import ever-increasing quantities of foodstuffs as well as th necessary raw materials; in order to pay for these, larger an larger quantities of manufactured goods must be sold to othe countries Thus one of the two Europes exports human beings and the other goods.

During the last century millions of emigrants, most of then coming from the agricultural districts of Europe, crossed th ocean, in order to find in the various countries with a temperat climate (Canada, the United States, Argentina, Uruguay, Chile South Africa, Australia and New Zealand) land which they coul cultivate or on which they could raise stock just as they did i their native country Industrial Europe supplied them, on credit with agricultural machinery, railways, textiles and so on, for whicl they paid with cereals, meat, fruit, wool, etc. Thus there cam into being a third Europe, the offspring of the two others; agricul tural like the second, but equipped like the first, and having to-da a population of 140 millions.

In addition, about 20 million whites have settled in exoti countries (tropical districts, countries inhabited by semi-nomadi Mohammedans, Asiatic countries inhabited by sedentary tillers o the soil) in order to obtain from them certain foodstuffs and ra materials which are not produced by temperate countries, such a cotton, rubber, ground-nut, tea and coffee. In exchange, they sel to the natives such of the products of European industry as thei habits of life permit them to utilize, such as textiles, alcoholi liquors and arms; for the rest, they endeavour to compel them t work or to buy goods by various measures, fiscal and other.

The total exports of the various countries of industrial Europ (not including the goods exchanged among themselves) amounte in 1925 to a value of about 7,400 million dollars They wer distributed as follows:

	Millions of dollars	Percentage of whole
To agricultural Europe	2,033	27·5
To Europe overseas	2,845	38·4
To exotic countries	2,519	34·0
	7,397	99·9

It will be seen from these figures that the Europe of anima power absorbs little more than one-quarter of the surplus pro duction of the Europe of mechanical power, and naturally i supplies it with little more than one-quarter of the foodstuff and raw materials needed by the excess of its urban populatior This shows how utopian it is to imagine that Europe can be self supporting to-day As a matter of fact, the economic and socia equilibrium of industrial Europe depends on oversea countries fo nearly three-quarters of its trade Until recently this has been n disadvantage Now, however, trade currents are beginning t change their direction. Before the World War, it was to the Unite States that most of the emigrants, goods and capital of the Ol World made their way Now however the United States is no only closing its doors to emigration from agricultural Europe an raising customs barriers against imports from industrial Europe but is in its turn exporting an increasing quantity of raw materials foodstuffs, manufactured goods and capital. In face of this nev competition, Great Britain has not succeeded without difficulty i maintaining its exports at their pre-war level (value as in 1913)

Continental industry has not yet suffered greatly from thi state of affairs, because the depreciation of the various Europea currencies has enabled it to sell its goods at less than America and British prices Now however that the currencies of the variou European countries have been stabilized, their costs of produc tion, reckoned in gold value, have begun to come up to those o their competitors, and the premium on export is thus tending t disappear. In spite of what has been done for the rationalizatio of industry, Europe must expect to lose more and more of it oversea markets Compensation cannot be looked for in th exotic countries, for Japan, China and India are becoming increas ingly industrialized; and the coloured races are showing a tendenc to revolt against excessively one-sided exploitation of their re sources Thus only one outlet remains for the industry of th

continent; the development of Eastern and Southern Europe, which has been too much neglected. At the present time the 230 million inhabitants of agricultural Europe absorb 2,033 million dollars' worth of the products of industrial Europe, or on an average rather less than 9 dollars' worth per head per year. The 140 million inhabitants of Europe overseas absorb 2,845 million dollars' worth, or over 20 dollars' worth per head per year. Yet these men, whether they live in Canada, the United States, Argentina or Australia, are similar to the men of agricultural Europe, and cultivate similar land in a similar climate The only difference is that for half a century industrial Europe has been supplying them on credit with plant and transport facilities to a value of milliards of dollars; these have been amply repaid in the form of foodstuffs and raw materials.

Let us suppose that by the same means the purchasing power of the agricultural population of Europe had been raised to the level of that of the oversea populations. In that case the exports of industrial Europe to agricultural Europe would have amounted to 20 times 230 million, or 4,600 million dollars, instead of 2,000 million as at present, thus giving an increase of 2,600 million dollars This would represent an increase of 35% as compared with the total present exports of industrial Europe to all parts of the world, which amount to 7,400 million dollars This would not merely solve the unemployment problem both in Great Britain and on the continent, but would also settle the agrarian question which is at the present time so acute throughout Eastern and Southern Europe. The two parts of the continent would then be on the same level technically, and Europe would thus recover its material and moral unity

Conclusion.—Three conditions appear to be necessary if this is to be attained:

(1) The stream of gold which for the last three generations has flowed from the money markets of the Old World to oversea countries must turn back from America to Europe. This process has already begun; but it would be better if instead of lending their capital to industries which lack customers, New York and London would lend it to agricultural countries, which would then be able to give industrial undertakings the orders which they need

(2) Credit however presupposes confidence, and capital is not risked in countries which are at any time likely to go to war with one another. It is therefore necessary that the Kellogg pact should become a reality; this is an indispensable condition for the necessary supply of credit

(3) In order that the spirit of peace may penetrate more profoundly into the masses of the population, they must learn to think less in terms of the nation and more in terms of Europe.

The latter object may be greatly promoted by the idea of the United States of Europe. Imperfect though it may be, it provides the masses with a readily comprehensible idea of what a united Europe might be; it may thus act on the popular mind as an idea capable of being translated into action In this sense it may be a sort of myth; but the myth may become a reality provided that it is accompanied by a practical economic policy Such a policy would necessitate the financial collaboration of Great Britain and the United States, and thus there could be no opposition between them and the European union. (F Del.)

UNITED STATES RUBBER COMPANY was formed in 1892 through the merging of nine companies manufacturing rubber boots, shoes and clothing Later, many other companies were acquired. In 1929, with more than 50 factories in the United States and Canada, the United States Rubber Company is producing rubber articles of every description, and has distribution points throughout the world

Among the company's most important assets are its great rubber plantations in Sumatra and Malaya. The annual production is more than 30,000,000 pounds. The development of super-yielding trees by means of bud grafting has been successfully accomplished The research laboratories of the United States Rubber Company are concerned with the study of new manufacturing processes and have made important contributions such as the flat-band method of tire building; the use of latex in the treatment of cord fabric for tires, and in the manufacture of inner tubes for tires. The sales of the United States Rubber Company approximate $200,000,000 per annum. (E. C. Bu.)

UNITED STATES SHIPPING BOARD, a board created by an act of Congress approved Sept. 7, 1916, entitled:—

An act to establish a United States Shipping Board for the purpose of encouraging, developing and creating a naval auxiliary and naval reserve and a merchant marine to meet the requirements of the commerce of the United States with its territories and possessions and with foreign countries; to regulate carriers by water engaged in foreign and interstate commerce of the United States; and for other purposes.

Under the act the board was authorized to form a shipping corporation with a capital stock not exceeding $50,000,000, of which a majority was to be held by the United States, for the purchase, construction, equipment, lease, charter and operation of merchant vessels in the commerce of the United States. The act provided that the $50,000,000 to be placed at the disposal of the board would be raised through the sale of Panama Canal bonds. The shipping corporation provided for in the act was incorporated under the name of the Emergency Fleet Corporation, but in 1927 Congress changed the name to the U.S. Shipping Board Merchant Fleet Corporation.

In the spring of 1917, when the United States entered the war, there were in the country 37 steel ship-yards with 162 ways and 24 wooden ship-yards with 72 ways, capable of launching vessels of 3,500 dead-weight tons At the signing of the Armistice in 1918, there were in all 223 ship-yards, steel and wood, with a total of 1,099 ways. At the close of the war the Shipping Board controlled a total fleet of 1,196 vessels of 6,540,205 dead-weight tons. These vessels were acquired by: (1) New ships built by the Shipping Board. (2) American ships requisitioned on "time" and "bare boat" charters. (3) Seized German ships. (4) Commandeered Dutch ships (5) Chartered neutral ships

The Shipping Board is an independent department of the executive branch of the Government. The powers given the board under the act to regulate the operation of common carriers by water make its powers not unlike those of the Interstate Commerce Commission However, it is expressly provided in the act that the board has not concurrent jurisdiction with the Interstate Commerce Commission in matters within the latter's power.

Following the directions of Congress, contained in the Merchant Marine Act of 1916, as amended in 1920, the Shipping Board has gradually disposed of its vessels to American citizens Some vessels were disposed of with the obligation that the vessel would be used in a definite service and trade The sale of some vessels carried with it the obligation to undertake alterations, betterments and reconditioning under approved plans and specifications.

UNITED STATES STEEL CORPORATION, an American holding company, was incorporated under the laws of the State of New Jersey, on Feb. 25, 1901 Its principal manufacturing subsidiary companies are Carnegie Steel Company, Clairton Steel Company, Union Steel Company, Illinois Steel Company, Illinois Steel Warehouse Company, Minnesota Steel Company, American Steel and Wire Company, American Sheet and Tin Plate Company, National Tube Company, The Lorain Steel Company, American Bridge Company, Canadian Bridge Company, Limited, Tennessee Coal, Iron and Railroad Company, Federal Shipbuilding and Dry Dock Company, Universal Portland Cement Company and Cyclone Fence Company. Its export subsidiary is the United States Steel Products Company which sells about 15% of the corporation's total production for export. The subsidiary manufacturing companies operate 133 works with 109 blast furnaces, 32 Bessemer converters, 335 open hearth and electric steel furnaces, with finishing mills for all steel products.

The corporation owns through other subsidiaries extensive iron ore, coal and coke and limestone properties. Its subsidiary railroal companies own or lease 1,132 main line tracks, with 443 m. of second tracks, 332 m. operated under trackage rights, 618 m. of industrial tracks and 1,369 m. of yard tracks and sidings Its marine equipment includes 34 steamers for overseas trade and 72 steamers on the Great Lakes. Its ingot capacity is about 24,000,000 gross tons annually or about 40% of the total ingot capacity of the United States. For 1927 the average number of

employees was 231,549 with a total pay roll of $430,727,095. The total sales for 1927 had a value of $870,235,942, representing about 13,000,000 tons of finished products.

Capital stock of the corporation consisted (1928) of 7,116,235 shares of common and 3,602,811 shares of preferred, with a par value of $1,071,904,600. Undivided surplus as of Dec 31, 1927, was $363,044,913 62 and the number of stockholders was 151,596.

(J A FA)

UNITED SYNAGOGUE, one of the six chief organizations of London Jews. These are, in order of seniority (1) the Spanish and Portuguese Jews' congregation, founded in 1657· principal synagogue, Bevis Marks, Aldgate (built 1699–1701); three constituent synagogues The post of *Haham* has not been filled since Dr. M. Gaster resigned in 1917 after 37 years' tenure. President of the Elders, Sir Francis Montefiore, Bart. (2) West London synagogue of British Jews (Reform), founded in 1841 mainly by members of the preceding synagogues, 34 Upper Berkeley street, W.I Minister Emeritus, Rev M Joseph; minister, Rev V. C. Simmons, B A.; Chairman of Council, P S Waley. (3) The United synagogue, founded by Act of Parliament in 1870 by a union of the Duke's place and other Ashkenazic synagogues and consisting of 18 constituent, two district and 13 associated synagogues. the chief Rabbi is Dr J H Hertz (*q v*) and the president is Lionel de Rothschild, O B E (4) The Federation of Synagogues (38 constituents). (5) The Adas Yisroel (Rabbi V. Schonfeld), 124, Green lanes, N 16. (6) The Liberal Jewish synagogue, established 1910, 28 St. John's Wood road, N W 8 Rabbi I. I Mattuck and Rev. M L Perlzweig. President, Dr C. G Montefiore Besides these six organizations there are many independent synagogues The United synagogue is confined in its direct spiritual, educational and charitable work to London, but it exercises considerable influence over the Jews of the empire by reason of the high respect felt towards its Chief Rabbi (*See* pp. 18. *sqq*. of H P Stokes, *Studies in Angl. Jew. Hist.* 1913)

BIBLIOGRAPHY—Details of the United Synagogue and other bodies, metropolitan, provincial and colonial, will be found in the current issue of the *Jewish Year Book*

The United Synagogue of America is a federation of Jewish congregations, sisterhoods and young people's organizations, in the United States, Canada and Cuba It was founded in 1913 by the late Prof Solomon Schechter, for the purpose of advancing the cause of Judaism in America and the maintenance of Jewish tradition in its historical continuity It was incorporated on April 24, 1916 The United Synagogue of America does not endorse innovations introduced by any of its constituent bodies, yet embraces all elements essentially loyal to traditional Judaism. In 1918, the Women's League was organized with the object of advancing traditional Judaism by furthering Jewish education among women, by creating and fostering Jewish sentiment in the home, by promoting the observance of Jewish dietary laws and home ceremonials, Sabbath and Festivals, and by generally strengthening the religious institutions of the home and the community In 1921, the Young People's League was established for the purpose of enlisting the activity of the Jewish youth in the advancement of traditional Judaism by extending their knowledge of Judaism, deepening their devotion to its precepts and establishing closer relations between them and the Synagogue; to foster a knowledge of Hebrew and to encourage an active interest in the Zionist cause.

UNITS, DIMENSIONS OF (including the principles of DYNAMIC SIMILARITY.) In the article on PHYSICAL UNITS it is shown how certain units, or standards, of physical quantities have been chosen, enabling other amounts to be specified as multiples of the respective standards. It is further described how, in accordance with the lines along which physical science has developed, it has been found to be necessary to select three only as fundamental, namely, the standards of mass, length and time; other physical quantities are not independent but can be expressed in terms of these three by an application of the laws of mechanics. For example, a velocity is a length divided by a time, an acceleration is a velocity divided by a time, a force is a mass multiplied by an acceleration, and so on. The particular way in which the fundamental quantities enter into the specification of the secondary or derived quantities can be indicated by a type of algebra based upon the definition of the quantity in question. The most explicit representation is obtained by including the name of the unit as well as the numerical magnitude. Thus when a length of x feet is traversed in t seconds the velocity is $\frac{x}{t}\frac{\text{feet}}{\text{sec}}$ and not merely $\frac{x}{t}$, the area of a rectangle is $[x \text{ feet}]\times[y \text{ feet}]=xy \text{ feet}^2$ where x and y are the numerical lengths of the two sides and the symbol (feet^2) merely indicates the number of lengths (expressed in feet) that are multiplied together in calculating the area In the same way if we write the velocity $\frac{x}{t}$ feet sec^{-1} we are again indicating, by usual algebraic symbols, the operation that is carried out in calculating the velocity Metaphysical arguments as to what the possible meaning of a *reciprocal* second may be are completely out of place. The fundamental quantities of mass, length and time are denoted by M, L, T and the indices for the respective quantities are indicated in square brackets, thus $[M]^{n_1}$, $[L]^{n_2}$, $[T]^{n_3}$, that is to say the first term indicates that the numerical values of n_1 masses were multiplied together, the second, that n_2 lengths were multiplied and the third that n_3 times were multiplied. Such equations indicate what are called the dimensions of the quantity to which they refer.

Principle of Homogeneity.—The basic fact which makes a knowledge of the dimensions important is that we can add, subtract or equate together only things of like kind We can add any number lengths, for example, or of times, or of velocities, but to add the numerical values of a length and a time, or a length and a volume, is a meaningless act so far as rational physics is concerned. This can be stated, as a positive general principle in the following words:—

In any physical equation every term must have the same dimensions

It is perhaps unfortunate that the same word—*dimensions*—is used in popular conversation for size (as when we speak of a hall of large dimensions), if we do not use it in this sense in connection with scientific problems no harm is done

Every term may consist of one or more factors or elements; there is nothing constraining the separate elements to have the same dimensions Thus, by definition

$$[v]=[LT^{-1}]$$
$$\text{and } [\text{acceleration}]=[a]=[LT^{-2}]$$

Further, when a is constant, space $=\frac{1}{2}at^2$ or $[L]=[LT^{-2}\cdot T^2]=[L]$. Thus both sides have the same dimensions, though on the right the term is built up of elements having various dimensions

$$\begin{aligned}\text{Again work done} &= Fs=\text{force}\times\text{distance},\\ \text{kinetic energy} &= \tfrac{1}{2}mv^2.\\ \text{Thus [work done]} &= [M\cdot LT^{-2}\,L]=[ML^2T^{-2}]\\ [\text{energy}] &= [M\cdot LT^{-1}\cdot LT^{-1}]=[ML^2T^{-2}]\end{aligned}$$

Hence work done and energy have the same dimensions. This could have been foreseen because energy is defined as that which diminishes, when work is done, by an amount *equal* to the work so done

The greater part of this article will be concerned with applications of this principle of homogeneity

Change-ratios.—A second application is concerned with the change of the numerical value of a quantity when the unit is changed. This arises from the fact that we are not yet content with having only one unit for each kind of quantity. Thus in ordinary life, money is measured in pounds, shillings, pence, francs, marks, dollars, kopecs, pesetas, etc. These do not even preserve invariable relations to one another. Keeping to the British system, if we estimate the value of an estate in shillings the numerical value is 20 times its value expressed in pounds sterling since the shilling is $\frac{1}{20}$ of a pound; or, in general, the numerical value of a physical quantity varies inversely as the

value of the unit in terms of which it is expressed. This is true also for derived units. The method of applying the idea of dimensions is best seen from an example which will be set out in full·—

To find the number of dynes in 10 lb. weight.

Let x be the desired number then

$$x \text{ dynes} = x\,\frac{\text{g.}\times\text{cm.}}{\text{sec}^2} = 10\,\frac{\text{lb}\times 32{\cdot}2\text{ ft}}{\text{sec}^2}$$
$$= 10\,\frac{453{\cdot}6\text{ g}\times 32{\cdot}2\times 30{\cdot}48\text{ cm}}{\text{sec.}^2}$$
$$= 10\times 445170\,\frac{\text{g.}\times\text{cm}}{\text{sec}^2}$$
$$\therefore\quad x = 4451700.$$

Here a lb. weight is taken as the force which gives an acceleration $g\left(\equiv 32{\cdot}2\,\frac{\text{ft}}{\text{sec}^2} = 32{\cdot}2\times 30{\cdot}48\,\frac{\text{cm}}{\text{sec}^2}\right)$ to a mass of one pound ($\equiv 453{\cdot}6$ grammes). These substitutions are introduced on the right, the names of the units are then identical on both sides; finally the numerical coefficients are reduced to one which gives the value of x. The above formal method serves to effect the change of units in any case whatever

The need for homogeneity in regard to the dimensions of the terms of an equation may be based upon the fact that the course of a phenomenon cannot be supposed to vary with a change of the units employed. Now if one term involves a mass to the second power and we increase the unit of mass ten times the numerical value of the term changes in the ratio 1/100; if another term involved the mass to the first power, it would change in the ratio 1/10, thus the relative values of the terms would alter and this would imply that the phenomenon represented by their sum would follow a different mode of change. Phenomena of nature, however, proceed quite independently of our mode of analysis.

Applications.—The chief application of the method of dimensions arises, however, owing to the possibility it provides of effecting a partial solution of problems in physics. It does not provide a complete answer in any case; there is always a constant, or even a function, left undetermined by it. The method is best explained by means of examples.

Simple pendulum—One of the simplest is the problem of the time period of a simple pendulum. The first step is to decide on the various properties that can possibly take part in the determination of the value of the time period. For simplification, we suppose the motion to be frictionless. The quantities that determine the period are the force due to gravitation *i e.* the weight of the *bob*, W, the mass M, and the length L of the suspending cord The amplitude of the swing, A, may be important but for small oscillations it may be ignored. The dimensional equation is therefore $[T]=[M^x]\,[W^y]\,[L^z]$ where the indices must be chosen so that the principle of homogeneity is satisfied; that is the sum of the indices for any one fundamental quantity must be the same on both sides of the equation. Each element must now be expressed in terms of the fundamental units; this gives the equation

$$[T]=[M^x]\,[(MLT^{-2})^y]\,[L^z].$$

Hence considering time $1 = -2y$
considering length $0 = y + z$
considering mass $0 = x + y.$

These three equations give for the three unknowns,

$$y = -\tfrac{1}{2},\qquad z = +\tfrac{1}{2} = x$$
$$\therefore\quad [T] = [(MW^{-1}L)^{\frac{1}{2}}].$$

Hence we conclude that

$$\text{Time period} = \text{constant}\left(\frac{ML}{W}\right)^{\frac{1}{2}}.$$

The constant is left entirely undetermined by the method so that the solution of the problem is not complete. Newton completed the solution by experiment and found that the time period was independent of the weight of the bob. Hence he was able to conclude that *the weight of a body must be proportional to its mass;* the proportionality is g, the acceleration due to gravity, so that finally $T = \text{constant}\sqrt{\frac{L}{g}}$. A complete solution obtained by applying the laws of motion proves that the constant is 2π for small oscillations, while for a large angular amplitude, α, it is equal to the numerical series $2\pi\left(1+\frac{\sin^2\alpha}{4}+\text{etc}\right)$ It should be observed that α is the ratio of two lengths and is therefore of zero dimensions. We could have inferred that it could only depend upon the ratio of the lengths of the arc and of the pendulum and not upon their absolute magnitudes because the "constant" must be of zero dimensions.

The dependence of the time-period upon the *square-root* of the determining length is characteristic of cases in which forces proportional to the *volume* are the sole motive power. "As examples coming under this head may be mentioned the common pendulum, sea-waves whose velocity varies as the square-root of the *wave-length*, and the whole theory of the comparison of ships and their models by which Froude predicted the behaviour of ships from experiments made on models of small dimensions." (Rayleigh, *Theory of Sound*, Art 381, 2nd edition.) We return to this more general problem later.

Dynamic Similarity.—In geometry, plane figures are said to be similar when a single length is sufficient to specify for each its distinction from the rest Thus, for equilateral triangles it is sufficient to specify for each the length of one side, and for circles, the radius. For example, the areas of circles are given by πr^2, those of equilateral triangles are given by $\sqrt{3}\,r^2/4$. In each case the area is proportional to the square of the length x but the factors of proportionality are different when the figures are different The constancy of the numerical factor is, therefore, a characteristic of similar figures.

Now, in the problem of the pendulum we can write, in general, allowing for the effect of the arc of swing

$$T\sqrt{\frac{g}{L}} = \text{a function of (arc/length).}$$

If, however, we restrict attention to those cases only for which the ratio arc/length is constant we can consider them as constituting a family (analogous to the family of similar triangles). All members of such a family are said to be *dynamically* similar and for these the right hand and therefore the left side also, is a constant. The similarity consists in the circumstance that different members of the family are distinguished from one another by the *single* quantity L. Take two pendulums in the same locality (g=const.) and having the same value of arc/length, then $T^2 \propto L$. If we observe one pendulum at intervals of time T_1 and find it is always passing through its central position at each observation; and then take a second pendulum of twice the length (and twice the maximum arc of swing) then the intervals of time must be four times as great in order that the observations shall take place at passages through its central position.

For the experimental determination of the constant, on the right, use may be made of either shorter or longer pendulums according to convenience. This is the principle underlying the use of models in dynamical problems, to which Lord Rayleigh referred.

Planetary Motion.—As a more complicated case, which brings out the weakness as well as the power of the method we may consider planetary motion under the influence of universal gravitation. Putting F for the attraction between the sun and planet the law of gravitation gives $F=\gamma\,\frac{PS}{L^2}$ where P and S are the masses of planet and sun respectively, L the distance apart and γ the gravitation constant; and consequently

$$[\gamma]=\left[\frac{FL^2}{PS}\right]=\left[\frac{L^3}{T^2M}\right].$$

The eccentricity of the orbit is a pure number and does not contribute to the dimensional equation; therefore we may assume $[T]=[R^x\gamma^z S^u P^v]$, where R is the radius of the orbit. From this it follows that

$$0=x+3z$$
$$0=-z+u+v$$
$$1=-2z$$

so that $z=-\frac{1}{2},\quad x=\frac{3}{2},\quad u+v=-\frac{1}{2}$

and therefore $[T^2]=[R^3\gamma^{-1}S^{-1}(P/S)^n]$.

There is nothing here enabling one to specify how the time period depends upon the eccentricities of the orbits. However, provided we restrict attention to a group of cases for which the eccentricity is the same, we have

$$T^2=\frac{R^3}{\gamma S}\left(\frac{P}{S}\right)^n\times\text{constant}$$

There is however a subsidiary principle which should be attended to concerning the choice of the equations which determine the dimensions of the "physical elements" upon which the character of the phenomenon depends For example, in finding the dimensions of γ from the law of gravitation $F=\gamma\frac{PS}{L^2}$ since $F=P\times$acceleration it is seen that P enters *in the same way* on both sides and it can be cancelled, in other words, we can define γ in terms of the acceleration instead of in terms of the force. If this is done, the mass P does not come into the equations at all and therefore n *must* be zero This subsidiary principle may be stated thus: the dimensions of any one of the physical elements of the equation must be defined by the simplest mechanical equation by which its definition is possible.

The factor $(P/S)^n$ therefore disappears from the equation The other factor can be compared with that determined by applying the laws of mechanics in the simple case of circular orbits The centripetal force on the planet is $P\omega^2R$ where ω is the angular velocity and this must equal $\gamma PS/R^2$ whence $\omega^2=\gamma S/R^3$. Since $\omega=2\pi/T$ this is of the same form as that obtained by considering the dimensions

It may be added that if we had assumed a force (or acceleration) proportional to the inverse k^{th} power of the distance the index of R would be $k+1$ instead of 3.

Indeterminateness.—In the examples given not more than three indices are required to be determined. In most cases, however, the number is greater than three. It is obvious that there are only three dimensional equations depending respectively on the indices of mass, length and time Hence any additional indices must remain undetermined. A complete mechanical treatment of the problem (if possible) would show that all these values are definite and would determine them. Since however the real utility of the method of dimensions is in connection with those problems, which, owing to the complexity of the mathematical relations cannot be solved in detail, it follows that for the determination of all but three of the unknown quantities it is necessary to have recourse to experiment. The possibility of solving the equation even for only three variables is however an immense advantage since it reduces the range of experiments necessary for the determination of the rest.

Motion of Fluids.—Casual examination of the flow of liquids in pipes, such as can be made by watching the motion of solid particles carried down with the stream, is sufficient to show that it is different in character for sufficiently slow and for sufficiently high rates of flow. Careful investigation demonstrates that for a circular pipe of definite diameter there is a particular outflow at (or very near) which the change occurs. The change is detected by varying the pressure-head and finding at each stage the corresponding outflow; for low heads the two quantities are proportional to one another; at very high velocities the head varies more nearly as the square of the outflow. The difference is traceable to the formation of eddies when the speed is great enough. The problem of eddying flow has not yet been solved by means of mechanical theory and this is exactly the type of problem which it is useful to investigate as far as possible by means of the method of dimensions. The data upon which the velocity of outflow depends are (i.) the diameter D of the tube which is assumed in the first place to be cylindrical, (ii.) the density ρ of the fluid; (iii.) the viscosity, μ; (iv.) the resistance per unit area R. The temperature will be regarded as fixed, in any case it only enters in a secondary way owing to the above quantities depending upon it. The dimensions of D and ρ are [L] and $[ML^{-3}]$; while for μ, which is defined as a force per unit area per unit gradient of velocity the dimensions are $[ML^{-1}T^{-1}]$, and for R, they are $[ML^{-1}T^{-2}]$. The dimensional equation is

$$[LT^{-1}]=[L^x(ML^{-3})^y(ML^{-1}T^{-1})^z(ML^{-1}T^{-2})^u].$$

Equating dimensions, we have,

from lengths, $1=x-3y-z-u$

from times, $-1=-z-2u$

from masses, $0=y+z+u$

whence $x=2u-1$, $y=u-1$, $z=1-2u$ and u is undetermined.

Hence $$[v]=\left[\frac{\mu}{D\rho}\right]\left[\frac{RD^2\rho}{\mu^2}\right]^u.$$

Since the value of u is undetermined it is clear that *any* value will be consistent with dimensional requirements. Not only is this so but a series of terms of powers of $RD^2\rho/\mu^2$ will also be consistent. Instead of assuming a single power a more general solution is obtained by writing the last factor as an unknown function of the term in brackets, or finally

A. $$\frac{vD\rho}{\mu}=f_1\left(\frac{RD^2\rho}{\mu^2}\right)\quad\text{where}\quad f_1\left(\frac{RD^2\rho}{\mu^2}\right)$$

stands for such a function. It is important to observe that both sides of the equation have zero dimensions—they are purely numerical quantities (such a pure number was named by James Thomson a *numeric*). The equation therefore asserts that the numeric on the left is some function of that on the right It can be written in various ways for since $\frac{RD^2\rho}{\mu^2}=\frac{RD}{\mu v}\cdot\frac{vD\rho}{\mu}$, and so on, we can assert that

B. $$\frac{vD\rho}{\mu}=f_2\left(\frac{RD}{\mu v}\right)=f_3\left(\frac{R}{\rho v^2}\right)$$

where f_2 and f_3 indicate different functions. Each of the terms in brackets is a numeric.

These equations represent the most general conclusions that can be drawn, in this problem, from the method of dimensions. Since each side is a pure number its value is an absolute constant, *i.e.*, it is independent of the particular system of units in terms of which the values of v, D, ρ, μ, etc., are expressed. (Although of course if mixed systems are employed the value will be different; for example if v is in feet per second, D must not be in inches without a suitable change being made in the "constant." Such mixed units will not be further referred to though they are frequently employed). This forms the basis of the use of a model. The expression $vD\rho/\mu$ can be determined experimentally by means of a single experiment and must be constant for dynamical similarity *if it be assumed that the above specification of the problem is complete.* It is useful to enquire at this stage in which particulars it may be incomplete. It has already been restricted to *cylindrical* tubes A truly cylindrical tube is an ideal one; real tubes depart from the ideal in possessing irregularities of surface. The degree of roughness may be specified by the maximum deviations, d, from a perfectly smooth surface, in which case the ratio d/D is another numerical factor on which $vD\rho/\mu$ will depend; a function of it requires to be introduced on the right, and the single experiment will only determine the numerical value of $vD\rho/\mu$ for those cases in which the roughness bears a constant proportion to the diameter. Similar remarks require to be made if the tubes are smooth

but not cylindrical. If they are elliptical in section a function of the eccentricity will be concerned; this will, however, be a mere number; hence, provided, the eccentricity is the same in the group of cases considered, the "constant" will not be affected. Further, the question of the possible influence of the elastic properties of the fluid must in any case be raised; in practice it is found that they are of no importance until velocities comparable with the velocity of sound in the fluid are set up. These questions are raised here in order to indicate that some degree of caution is necessary; but since, in any case, the results arrived at are intended to be checked by suitable experiments no irreparable harm is done if some important variable is at first left out of account

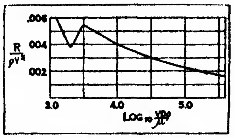

FIG 1—DIAGRAM FOR THE FLOW OF FLUID THROUGH PIPES, SHOWING HOW BEHAVIOUR IS DETERMINED

The outcome of the foregoing discussion is that dynamical similarity will exist between all cases for which $vD\rho/\mu$ is a constant; the characteristic constant will be different for each characteristic feature of the flow that may be examined.

Further elucidation is obtained if we examine the various experimental results which have been obtained for various velocities, diameters and *fluids*. These include fluids as diverse as air and water. If $vD\rho/\mu$ be plotted horizontally on a single diagram against $R/\rho v^2$ vertically, for all cases a *single curve* is obtained, the ordinates decreasing at first, then rapidly increasing for a short range of values of the abscissae and then gradually falling continuously. The diagram can be compressed into less space if $\log vD\rho/\mu$ is plotted horizontally instead of the quantity itself (fig. 1). Any single point on the curve represents a whole group of cases which are dynamically similar. The most characteristic case is the position of the almost discontinuous middle region where a sudden change in the law of flow is indicated. This region is, in fact, that in which the flow changes from linear to turbulent. This change occurs in each case for a certain velocity V_c; but this *critical velocity* depends upon the other data for the same point on the diagram, it occurs, in fact, for a definite value of $V_c D\rho/\mu$, the same for the whole group. Doubling the viscosity alone, doubles the critical velocity; using the same fluid (*i e.*, μ/ρ = const.) and doubling the diameter of the tube *halves* the critical velocity and so on The value of this critical constant is called the *Reynolds number* after Osborne Reynolds who first examined the problem both theoretically and experimentally. It is, from what has been said, a pure number independent of the system of units employed; its value is a little over 2,000. Any lack of perfect definiteness can be attributed to fortuitous circumstances such as different roughnesses of the tube, accidental tremors, etc. It is evident from the experimental curve that these accidents play only a very subordinate part. In passing along the curve the change of $R/\rho v^2$ (which is also a numeric), in the critical region is from ·0038 to ·0054 or thereabouts (Stanton and Pannell *Phil. Trans. Roy. Soc.* A vol. 214, p. 109, [1914]). Professor C. H. Lees from an examination of this diagram has concluded that the resistance per unit area, R, can be represented by the following formulae in the region of turbulent flow; for water at 15° C, $R=0{\cdot}0191v^{1{\cdot}65}/D^{0{\cdot}35}+0{\cdot}0009v^2$, and for air at 15° C and 76 cm. pressure, $R=0{\cdot}0000468v^{1{\cdot}65}/D^{0{\cdot}35}+0{\cdot}00000110v^2$ where C.G.S. units are employed. These formulae show that the unknown function can be represented sufficiently well by two terms, one of which is practically independent of the diameter of the tube. The velocity referred to is the mean velocity for the whole cross-section of the tube. The formulae are considered to be valid for at least a range of diameters from 0·3 to 12 cm. (*Roy. Soc. Proc.* A. Vol. 91, p. 60, 1914). If a single term be used instead of two the best index of v is not far from 1·75.

It was by no means certain that a single curve would represent the facts for tubes of various diameters because the principle of dynamical similarity requires that the eddies when present should have diameters proportional to those of the tubes and this is not known to be the case. Our knowledge concerning the curve must, in this repect, rest on experimental results.

Flow Past Obstacles.—From the dimensional point of view the flow past fixed obstacles is dealt with in the same way as that through pipes. The diameter, D, of the obstacle takes the place of the diameter of the pipe and further we naturally deal with the total force, F, which the obstacle experiences from the fluid instead of a force per unit area. The final result obtained as before is

$$\frac{vD\rho}{\mu} = f_1\left(\frac{F}{\rho v^2 D^2}\right) = f_2\left(\frac{F\rho}{\mu^2}\right).$$

Since the practical problem is usually to find the force corresponding to a given velocity we may conveniently write $\frac{F\rho}{\mu^2} = f_3\left(\frac{vD\rho}{\mu}\right)$. The velocity referred to here is the relative velocity of the fluid at a great distance from the obstacle (*i e.*, what may be called the undisturbed velocity) to that of this obstacle (which we have supposed fixed). The same equation also represents the case of a body moving with velocity v through a fluid which is stationary at a great distance and in which the body is completely immersed. No factor dependent on the shape is introduced, therefore for similarity between the several members of a group they must all have the same shape. The formula shows that for this family $F\rho/\mu^2$ will have a constant value provided $vD\rho/\mu$ remains constant. The corresponding values of these terms can be determined by experiments on small-scale models and once determined should be applicable to all cases having the same geometrical shape. All the results for different media and different sizes and the different forces that correspond can be plotted as a curve with ordinates $F\rho/\mu^2$ and abscissae either $vD\rho/\mu$ or its logarithm (or any other convenient function of it). Any one point on such a diagram gives a group of cases which are dynamically similar to one another.

For sufficiently slow speeds the force and speed are proportional to each other, hence $F = \text{constant} \times \frac{\mu^2}{\rho}\frac{D\rho}{\mu}v = \text{const.} \times \mu Dv$ which is Stokes' Law. For a sphere, experiment and dynamical theory indicate that the constant is 3π. The motion is non-turbulent. For very rapid motion F is found to vary more nearly as the square of the velocity and the equation for it must then approach the form

$$F = const.\ \frac{\mu^2}{\rho}\left(\frac{vD\rho}{\mu}\right)^2 = const. \times D^2\rho v^2$$

which is independent of the viscosity. To illustrate the use of these results in connection with small-scale models consider cases in which it is required to find the force in air of a machine of linear dimension D_a by means of measurements in water with a model of linear dimensions D_w. The data required are:

Ratio of viscosities of air and water 1/60 approx.
Ratio of densities of air and water 0·0013 approx.
Ratio of μ/ρ of air and water 10 approx.
Ratio of μ^2/ρ of air and water 0·6 approx.

Hence going back to the general equation the condition for dynamic similarity is that $\frac{v_a}{v_w} = 10\frac{D_w}{D_a}$ and F_a/F_w is then 0·6. The object gained by driving the model in water is to diminish the speed necessary to about one-tenth the very high speed that would be required in air. The numbers given are only approximate since both μ and ρ vary with temperature. A rise of 25 degrees C diminishes the viscosity of water to one-half so that particular attention must be paid to its temperature during the experiments.

If however the model is used in the same medium as the main apparatus—for example in air for all aeroplane work—it is usually impossible to work with velocities that satisfy the principle of similitude. It is necessary then to make experiments with as large a variation of velocity as possible and to *extrapolate* the curve of F plotted against vD, the values of μ and

ρ being now constants; or, what is more usual, to take the left side of the equation in the alternative form already given, $F/(\rho v^2D^2)$, and to plot $F/(v^2D^2)$ against vD (at high speeds F varies nearly as v^2 and the extrapolation is safer if this choice of ordinate is made). A useful guide in design is thereby provided which is subsequently tested out on the full scale machine.

Plates.—Difficulties arise in many cases Experiments on square plates placed in a stream of fluid do not accord with the deductions from the above equations and have given rise to a great deal of discussion. In applying the deductions it must, of course, be borne in mind that it is only the group of plates whose thickness varies in the same proportion as the other lengths that are comparable. According to the formula a reduction in D should carry with it the same effect as an increase in μ/ρ whereas the opposite effect has been observed The only possible conclusion is that phenomena arise which are not contemplated in the dimensional specification. Appeal has been made by Bairstow and Booth to the compressibility of air in front of the plate but examination shows that this does not provide a large enough effect at the usual velocities concerned. They show, however, that all the reliable results can be represented by a formula of the type $F=a(vD)^2+b(vD)^3$ for values of vD from 1 to 350 (foot-second units). This would fit in with the requirements for different fluids provided $a\propto(\rho/\mu)^2$ and $b\propto(\rho/\mu)^3$; but this does not seem as yet to have been proved. Stanton (*Proc. Inst. Civil. Eng.* 171) has brought forward evidence that a negative pressure on the leeward side of the plate is responsible for the complication.

Influence of Boundary.—When the fluid is bounded by a tube and the obstacle is on its axis the mean velocity at which turbulence begins is changed For example, it has been found experimentally by Hisamitu Nisi, *Phil Mag.* XLVI. 754 (1923) (using in succession two tubes of square section of 2·6 and 2·0 cm. lengths of sides and containing, in any single experiment, a cylinder at right angles to the length of tube or a small sphere), that the velocity of air at which turbulence begins in the tube can be expressed very closely by the formula

$$v_c=\frac{\mu}{\rho D}\left\{A_1+A_2\left(\frac{D}{\Delta}\right)^n\right\}$$

where Δ is the diameter of the tube, $n=\frac{1}{2}$, $A_1=8{\cdot}15$, $A_2=68{\cdot}2$ for spheres, and $A_1=2{\cdot}65$, $A_2=48{\cdot}2$ for cylinders. The form of the equation was chosen to suit dimensional requirements but for the index n resort had to be made to experiment.

Floating Bodies.—In the case of a floating body gravity is a determining factor. Since gD/v^2 is a non-dimensional term we can allow for it most generally by writing

$$F/D^2v^2\rho=f\left(\frac{vD\rho}{\mu},\frac{gD}{v^2}\right).$$

Dynamical similarity requires that the right hand side should be a constant and this requires that $vD\rho/\mu=$ const. and $gD/v^2=$ const. If both the small and the large scale body are intended to float in water, μ, ρ and g are all constants; therefore we require that $vD=$ const. and $D/v^2=$ const. simultaneously; but this is impossible. No similitude can exist therefore between bodies of different sizes. Viscosity however, only plays a small part, owing to the force varying nearly as the square of the velocity. The right hand side must, to this approximation, be independent of μ and therefore of $vD\rho/\mu$ and we need only consider the term D/v^2 which must be the same both for model and original and therefore so must F/D. That is to say the forces are directly as the linear dimensions when the velocities are as the square roots of the linear dimensions. The assumption throughout is, as usual, that the bodies compared are geometrically similar.

Oscillations.—The oscillations of a simple pendulum were taken as the introductory example. In that case the force was proportional to the volume of the moving body. A tuning fork presents a case where the force is proportional to an area, viz., the area of cross section of the prongs. According to what law will the time-period of geometrically similar tuning-forks depend? The elements of the dimensional equation are, the density, ρ, Young's modulus, Y, Poisson's ratio, P and a length L. Poisson's ratio is a mere number and may at first be left out of account. Hence putting $[T]=[Y^x\rho^yL^z]$ and recalling that Y has the dimensions of a force per unit area it is found that $x=-\frac{1}{2}=-y$ and $z=1$; $\therefore$ Time-period $=$ constant $L\sqrt{(\rho/Y)}$ Since with any selected material, ρ and Y and P are constant the time period is proportional to the characteristic length. Strictly for complete similarity the amplitude should be varied in the same proportion in order that this conclusion may apply. The time period however is so nearly independent of the amplitude that we may disregard this restriction

"If the tuning forks are not similar to one another, the problem is more complicated and can only be solved by reference to the mechanical equations." (Rayleigh.)

Miscellaneous Vibrations.—The following results can also easily be obtained by this method, the controlling elements are in each case specified. The velocity of propagation of periodic waves controlled by gravity on the surface of deep water is as the square root of the wave-length. $V_1=f(g,\lambda)$.

For short ripples, which are governed principally by surface tension, σ, the velocity is proportional to the inverse square-root of the wave length. $V_2=f(\sigma,\rho,\lambda)$. Waves of intermediate wave length are controlled both by gravity and by surface tension so that we should expect the velocity to be a function of V_1 and V_2. Mechanical theory gives $V^2=\dfrac{g\lambda}{2\pi}+\dfrac{2\pi\sigma}{\rho\lambda}$.

The time period of a Helmholtz resonator is directly as the linear dimension.

The frequency of vibration of a globe of liquid vibrating in any of its modes under its own gravitation, is independent of the diameter and directly as the square root of the density The frequency of vibration of a drop of liquid, vibrating under "capillary" force is directly as the square root of the surface tension and inversely as the square root of the density and as the $\frac{3}{2}$ power of the diameter.

Weight of Drops.—In the article on SURFACE TENSION the weight, W, of drops from tubes of various diameters is discussed. If the diameter of the delivery tube is D, surface tension σ, the acceleration due to gravity, g, and if these data determine W completely, Rayleigh has shown that $W/(\sigma D)=f\{\sigma/(g\rho D^2)\}$. Experiment shows that for wide changes in the variables on the right the term on the left is nearly a constant but has a minimum value Approximately, therefore, we expect the weight for a given liquid to be proportional to the diameter of the tube. The deviation from strict dynamic similarity is no doubt due to omitted quantities which have some control over the situation. The most important one is viscosity and since $\mu^2/(\rho\sigma D)$ is a non-dimensional quantity the solution is made more general by writing

$$\frac{W}{\sigma D}=f\left\{\frac{\sigma}{g\rho D^2},\frac{\mu^2}{\rho\sigma D}\right\}$$

This can also be written

$$\frac{W}{\sigma D}=f\left\{\frac{\rho\sigma^3}{g\mu^4},\frac{\sigma^2\rho^2}{\mu^4}D^2\right\}$$

where the first term on the right depends only upon the nature of the fluid while the second involves D^2 Experiments are lacking by which algebraic laws based upon this dimensional examination can be tested. The terms on the right seem to have comparatively little influence for the size of an oil drop from a given tube is much the same as that of a water drop although the viscosity is nearly 100 times as great and enters as the second power. This is what might be expected if the rate of formation of the drop is sufficiently slow.

This problem is a very instructive one. If we take Rayleigh's formula as the standard it might be expected that $\sigma/(g\rho D^2)$ must be constant for the cases to be dynamically similar, whereas wide variation of this term has scarcely any influence. There is, however, a variety of possible independent variables Since $W/(\sigma D)$ is a numeric so also is $[\sigma/(g\rho D^2)][W/(\sigma D)]$.

Now, assuming the diameters of the drops to be proportional to the diameters of the tubes, W varies as $g\rho D^3$; whence this new "variable" is an absolute constant. This is nearly the case in practice. We may now attribute the departure from precise similarity to the diameters of the drops and tubes not being strictly proportional to one another. Let D_2 be the characteristic linear dimension of the *drops*. If their weight be expressed in terms of D_2 the above substitution gives finally $W/(\sigma D) = f(D_2/D)$. The approximate constancy of each side of this equation is now easier to understand. It must be added that large and small drops are not *geometrically* similar before falling; this fact also needs to be taken into account.

Temperature.—In all the cases that have been considered, up to this point, temperature has only entered in a secondary way. For example, the density, ρ, *depends* upon the temperature, but if we write $\rho = \rho_0(1 - at)$ the term at must be a mere numeric and provided that we know the law of variation the value ρ can be calculated from the standard value ρ_0 and the temperature does not further concern us. The same remark applies to other variables such as σ and μ. But there are many cases in which the question cannot be dealt with so simply and we are obliged to ask what are the dimensions of temperature. At first sight it appears to be a new fundamental quantity; and it can be so treated in many problems, so that we then expect it to turn up to the same power on both sides of the equation. In other cases we must seek to find a relation by which it can be expressed in mechanical units.

Now absolute temperature is defined in terms of the laws of ideal gases for which the characteristic equation is $pv = K\theta$ where v is the molecular volume and K is a universal constant. By suitably altering the size of a degree the factor K might be made unity and then it would be clear that θ would represent energy for pv has the dimensions of energy. Mechanical theory identifies it with the kinetic energy of the molecular motion.

Viscosity and Temperature.—Let the problem be to examine how viscosity will depend upon molecular motion when molecules repel each other with a force varying inversely as the pth power of their distance apart. Let $R = \text{force} \times L$ where R is the force at unit distance, let the data for the molecules be $m = \text{mass}$, $v = \text{mean velocity of agitation}$, $N = \text{number per unit volume}$; and let it be supposed that the viscosity μ varies as $m^x v^y N^z R^n$. In the usual way it is found that

$$[\mu] = mvN^{\frac{1}{3}}\{N^{(p-1)/3}m^{-1}v^{-2}R\}^n.$$

The values of n and p are both indeterminate by the present method and, as usual, resort must be made to experiment Now v is proportional to the square root of the kinetic energy $\frac{1}{2}mv^2$; and μ has also been considered by experimentalists to vary in the same way If this were the case n would equal zero; and further, since μ is found to be independent of the density except for low pressures, $2 + np = 0$ and $\therefore\ p = \infty$. This would correspond to an infinite power for the repulsive force, that is, the molecules would behave as rigid bodies. However, it is found that μ varies more nearly according to the 2/3 or even higher powers of the temperature Putting the power of θ as κ and solving for p the following values are obtained

κ	2/3	3/4	1
p	13	9	5

The last case is the one which Maxwell gave as illustrating gas theory. These calculations assume that a single power law n is sufficient. As in other cases all we can infer in general is that

$$\mu = mvN^{\frac{1}{3}}f\{N^{(p-1)/3}m^{-1}v^{-2}R\}$$

and mechanical theory as developed by Sutherland and afterwards more rigorously by S. Chapman shows that the equation

$$\mu\left(1 + \frac{S}{\theta}\right) \propto \theta^{\frac{1}{2}}$$

is the form to be expected. Here S (known as Sutherland's constant) is of the dimensions of θ and is in fact nearly equal to the critical temperature of the gas. The index 1/2 indicates as before that the molecules are behaving as rigid spheres.

Thermal Conduction.—Further examples are to be found in connection with thermal conduction. Heat itself can be expressed either as energy or, in a secondary way, as the number of degrees change of temperature it can produce in a given mass of water. Conductivity, k, is defined by the equation $\text{Heat} = ka\frac{d\theta}{dr} \times \text{time}$. To free the equation from dimensional difficulties it would be better to write $K\theta$ instead of θ where K is the gas constant, and define k/K as the thermal conductivity, because as we have seen $K\theta$ has the dimensions of energy On the other hand if Heat is measured as (mass of water $\times$ degrees rise of temperature) the temperature enters on both sides of the equation and, as far as dimensions go, it can be cancelled

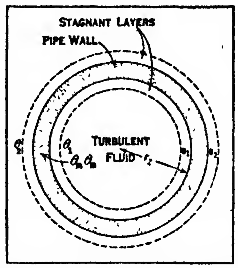

FIG 2 —CROSS SECTION THROUGH A CIRCULAR PIPE, SHOWING SURFACES COVERED BY THIN LAYERS

The chief problems involving dimensions concern the transfer of heat through pipe walls between the fluids on the inside and outside The actual transfer in the case of metal pipes is controlled mainly by the presence of a stagnant layer of fluid on each side In the body of each fluid it is transferred from point to point (except for the case of very slow motion) mainly by turbulent convection, but in the stagnant layers it is by conduction through media which usually are bad conductors. In describing his work on steam condensers Joule adopted a new term at the suggestion of Lord Kelvin (1859)—the coefficient of heat transmission, C—which he defined as the amount of heat flowing per unit area of the pipe surface in unit time per unit difference of temperature between the fluids, *i e*, $H = CA(\theta_2 - \theta_1) \times \text{time}$ where H is positive if $\theta_2 > \theta_1$. If θ_m is the temperature of the metal pipe (it is practically constant *across* the section) Fig 2 we can write

$$H = C_1A_1(\theta_m - \theta_1)t = C_2A_2(\theta_2 - \theta_m)t$$

where C_1 and C_2 are coefficients of transmission of heat across the two stagnant layers. Whence $\frac{1}{CA} = \frac{1}{C_1A_1} + \frac{1}{C_2A_2}$. In this way we can calculate the effective over-all coefficient from the coefficients for the separate films. If r_1 is the inside radius of the pipe and e_1 the thickness of the film $\theta_m - \theta_1 = \frac{H}{2\pi k_1}\log\frac{r_1}{r_1 - e_1}$ where H is the heat transmitted per unit length of the pipe, or, approximately, $\theta_m - \theta_1 = \frac{H}{2\pi}\frac{e_1}{r_1k_1}$ so that $C_1 = \frac{k_1}{e_1}$; similarly for the outside film $C_2 = k_2/e_2$. If the pipe wall is thin it is possible usually to write $A = A_1 = A_2$ so that

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}.$$

So much by way of introduction. The real problem is to find C_1 (or C_2), and the essential part of it is to find e_1 or e_2 It can be shown from the equations already given that the resistance per unit area of the pipe wall can be expressed as $\frac{\mu^2}{D^2\rho}\left\{\frac{vD\rho}{\mu}\right\}^n$; but in the non-eddying film it must be equal to $\mu\frac{dv}{dl} = \mu\frac{v}{e}$ where e is the effective thickness of the film;

$$\therefore\quad [e]^{-1} = \left[\frac{\mu^2}{D^2\rho}\right]\left[\frac{vD\rho}{\mu}\right]^n\left[\frac{1}{\mu v}\right]$$

$$= \text{constant}\left(\frac{v\rho}{\mu}\right)^{n-1}D^{n-2}.$$

The coefficient of transmission C_1 is this quantity multiplied by k_1. In usual practice n can be taken as 1·75 hence

$$C_1, \propto k_1 \left(\frac{v\rho}{\mu}\right)^{\frac{3}{4}} \cdot \frac{1}{D^{\frac{1}{4}}}.$$

The value of C_2 is determined in a similar way and thence the over-all coefficient is obtained except for numerical constants. To find the constants recourse must be made to a few experiments with various values of the variables. To show the importance of a knowledge of C in technical practice the following figures, calculated from the formula are given. They are based partly upon the thermal measurements of Stanton at the National Physical Laboratory but mainly upon those by H. Greenwood made for the Ministry of Munitions in 1918. The values are the over-all coefficients (C) in British Cent. Units per sq.ft. per deg. C per hour, v_1 and v_2 are the velocities in feet/min. inside and outside a pipe of 1 inch diameter at 20° C carrying water on both sides.

v_2 \ v_1	100	200	300	400	500
100	160	185	224	240	251
200	185	220	277	302	318
300	224	277	375	421	454
400	240	302	421	480	523
500	251	318	454	523	570

For a six inch pipe the values range from 97 to 352. Reference should be made to No 9 of the *Technical Reports* published for the Ministry of Munitions (London, H.M.S. Stationery Office) for further information and for charts enabling the coefficient to be calculated easily for various temperatures, diameters, viscosities and for gases as well as liquids.

To prevent unjustifiable use of the formula and table it must be added that the values are for *turbulent* flow in *clean* pipes. A layer of incrustation only .02 inch thick may reduce the values to one half. In many actual interchangers where the velocity is very small and the motion only fortuitously turbulent (if at all) the value falls as low as 2 and is rarely more than 15.

The idea that the passage of heat from solids to liquids moving past them is governed by the same principles as apply, in virtue of viscosity, to the passage of *momentum*, was originated by Osborne Reynolds though with some misgivings and has been further developed by others. Lord Rayleigh has shown, however, that the analogy is not complete owing to the existence of a pressure-gradient term in the momentum problem which has no counterpart in the thermal problem. (*Advisory Comm. for Aeronautics*, T. 941, 1917) In the same place, considering the flow of heat between two planes, distance D apart, with fluid flowing in the space between the planes he derives the equation for the heat flow $H = \frac{K\theta}{D} f\left[\frac{Dv\rho}{\mu}, \frac{C\mu}{k\rho}\right]$. Where C is the specific heat per unit volume. For a given fluid the last term is a constant and may be omitted and dynamic similarity is attained when vD is constant so that a complete determination of the function can be made by varying *either* v or D. It is best to vary v not D; variation of the latter would require the roughness of the surfaces to vary in the same proportion.

Turn again to the theoretic side To take C as proportional to k does away temporarily with the necessity of answering the question as to the dimensions of temperature. Nevertheless the question calls for an answer. If temperature can be identified with the energy of agitation its specification involves a velocity. If it be so expressed in the equation for the transfer of heat a different set of dimensions is obtained: this uncertainty as to dimensions throws doubt on the method. This point has been discussed by Lord Rayleigh and others (see *Nature*, 1915) but without it being cleared up satisfactorily. The real cause of the difference seems to be that when temperature is recognized as involving molecular velocity there are two velocities entering into the problem—the velocity of molecular agitation and the velocity of the stream of fluid. In order to obtain true dynamical similarity both these velocities must be varied *in the same proportion;* in other words the temperature must be *varied* as the square of the stream velocity. The solution given above corresponds to the case of *constant* temperature: that is the stream velocity changes without any change in the velocity of agitation. To pass from one case to another is like passing from similar tuning forks to those that are not similar (*see* above).

Electric and Magnetic Quantities.—A similar indeterminateness arises when electric and magnetic phenomena are considered. In an electric charge we meet with a kind of thing which can be connected with mechanical data in more than one way. On the electrostatic system it is defined in terms of the force between two charges (q) in vacuum by means of Coulomb's law $F=qq^1/d^2$ and the dimensions are those of $\sqrt{Fd^2}$. The fact that the measurements must be made in vacuum indicates that for other media the force would be different and the ratio found is $1/K$ where K is called the dielectric constant. Since we know nothing about the real nature of electricity, and provided we knew nothing further about other electric phenomena, it would be quite sound to treat K as a numerical constant and to take the dimensions of q as $\sqrt{Fd^2}$ or $\mathrm{M}^{\frac{1}{2}}\mathrm{L}^{\frac{3}{2}}\mathrm{T}^{-1}$. These dimensions would strictly be those of $q/\sqrt{K_0}$ where K_0 represents a property of vacuum. If we chose to call this quantity electricity there is nothing to prevent us and this is virtually what we do on the electrostatic system.

But electricity can be measured in other ways. Magnetic forces between poles are measured in units depending on an inverse square law of force, $F=\mathrm{MM}'/(\mu d^2)$ where μ again depends on the medium. If we take μ as having no dimensions the dimensions of M are $\sqrt{Fd^2}$. In addition electric currents are measured in terms of the force on unit pole when flowing in a circuit of unit radius; and a current has the dimensions of an electric charge divided by a time. It is clear that from such data a second unit of charge is definable and its dimensions are $\mathrm{M}^{\frac{1}{2}}\,\mathrm{L}^{\frac{1}{2}}$, it is called the electromagnetic unit of charge. In this case indeterminateness arises since μ for vacuum may be a mere number or may represent another property of vacuum. What we measure as a pole of strength M may perhaps be definable as M_0/μ_0 where M_0 is a more fundamental physical quantity independent of the medium.

It follows from this summary that it is not merely a question of choosing two units of different sizes (like an inch and a metre for lengths) but of choosing two units which fail to satisfy the law of dimensional homogeneity. Homogeneity can be brought about by regarding K_0 and μ_0 (both for vacua) as not being mere numbers but as having such dimensions that $\mu^{-\frac{1}{2}}\mathrm{M}^{\frac{1}{2}}\,\mathrm{L}^{\frac{1}{2}}$ is homogeneous with $K^{\frac{1}{2}}\mathrm{M}^{\frac{1}{2}}\mathrm{L}^{\frac{3}{2}}\mathrm{T}^{-1}$. This requires that $[\mu K \mathrm{L}^2\mathrm{T}^{-2}]$ = a numeric or in other words, that μK has the dimensions of the reciprocal of the square of a velocity. This velocity has been shown to be that with which electric waves are propagated in the medium (*see* ELECTRIC WAVES); its value for vacuum is equal to the ratio of an electromagnetic unit of charge to an electrostatic unit, that is (as nearly as is known) 3×10^{10} cm./sec

In this article we are not concerned with the details of electric measurements but with applications of the law of dimensional homogeneity. On the two systems of units we treat either K or else μ as a numeric. Their real dimensions we do not know; those of their product alone are known. We know neither the properties of the medium which the symbols represent nor (in consequence) the physical nature of an electric charge or of a magnetic pole. The situation from the point of view of dimensions can be best illustrated by an example.

Suppose that in the flow of liquids through tubes we had found that its character depended upon the liquid not owing to difference of density alone but that another factor was necessary which varied from liquid to liquid, *e.g.*, the viscosity which we assume we have not learned how to express in terms of mechanical data and which we treat as a numeric Dimensionally we write

$$[v] = f\left[\frac{\mu}{\mu_0}\right]\cdot[D^x\rho^y R^z]$$

the symbols having the same meanings as before. This yields the equation

$$\left[\frac{v\rho^{\frac{1}{2}}}{R^{\frac{1}{2}}}\right] = f[\mu/\mu_0] = \text{a numeric}$$

Dynamic similarity will exist if the right hand is a constant Hence the critical velocity, *for such cases*, can be given as v_c = constant $R_c^{\frac{1}{2}}/\rho^{\frac{1}{2}}$ where R_c will be the critical value of the resistance. Further than this it would not be possible to go, except to declare that the value of the constant must in general be a function of μ/μ_0. The value obtained for v_c is, however, consistent with that obtained by recognizing the dimensions of μ. For previously it was obtained that

$$\frac{vD\rho}{\mu} = f\left(\frac{RD^2\rho}{\mu^2}\right)$$

or

$$\frac{vD\rho}{\mu} = f\left(\frac{R}{v^2\rho}\right)$$

When μ is constant the critical velocity is therefore given *either* by $v_cD\rho$ = const. or $R/(v_c^2\rho)$ = const. The latter is the result arrived at by ignoring the dimensions of μ The *general* theorem just given enables one, however, to go further and discuss the cases where μ is a variable.

In very much the same way, limited applications of the law of homogeneity can be made in electromagnetic problems. For example, the time required for a current to fall to $\frac{1}{e}$ of its value in a linear, conducting, electric circuit is directly as the self-inductance and inversely as the resistance, *both* being measured in electromagnetic units (or *both* in electrostatic units).

The time-constant of circumferential, electric currents in an infinitely long conducting cylinder is as the square of the diameter.

The amplitude of a periodic current (frequency constant = p) in a circuit of resistance R and self-inductance L must be given by $C_{max} = \frac{E}{R}f\left(\frac{Lp}{R}\right)$ where E is the maximum electromotive force.

Although many valuable hints may be obtained in this way the chief problem in electricity is the logic of the method in which certain quantities have their dimensions suppressed. If the time comes when electric charges, magnetic poles etc. are analyzed into more fundamental entities a greater logical simplicity will be obtained. But when that time comes it is possible, or even probable, that the notion of mass will also have been further analyzed.

General.—Let z_1, z_2, z_3, etc. be any terms of zero dimensions each consisting of powers and products of physical elements (such as length, velocity, force, viscosity, electric charge, etc.) some of which may be ratios of like elements (such as a ratio of two masses or of two lengths). Let Q be any term, completely defined by them so that Q$=f(z_1, z_2, z_3$, etc). From the principle of dimensional homogeneity it follows that Q, which may consist of powers and products of physical elements, must also be of zero dimensions.

If z_1, z_2, z_3, etc. are all constant during any phenomenon, any systems satisfying the equation are said to be *dynamically similar*. For such systems Q is necessarily a constant.

In practice it is usually sufficient to retain only two or three of the z-terms it being assumed that the more "remote" causes of an event have so little influence that they can be ignored or treated as constant. Thus, in considering the motion of the earth round the sun we may at first ignore the influence of the other planets, and the possible influence of magnetic forces. These secondary effects may subsequently be treated as *perturbations.* Again, in considering the flow of liquids in pipes, any possible electrification has not been considered. One of the most important considerations in the design of an experimental investigation is the exclusion of such extraneous effects in order thereby to reduce the number of the z-terms that need to be taken into account.

Any or all of the z-terms may be changed by multiplying by powers of Q or of each other for they will still remain terms of zero dimensions. In this way they may be selected so as best to suit particular problems. For example, any one of them may so be changed that its elements depend upon the intrinsic properties of the medium under examination (density, viscosity, etc) and not at all on induced properties (such as velocity or acceleration) If this is so, the particular z-term will be a constant so long as the same medium is dealt with and thereby drops out of the list automatically.

If the retained terms are Q, z_1, z_2 and their experimental values are plotted as the x y z co-ordinates of points in space any one such point represents all the members of a group of cases which are dynamically similar to one another. The behaviour of any one member of the group can be determined by measurements made on any other member of the same group If the curve through the points is *nearly* parallel to one of the planes of co-ordinates say x y it shows that the third co-ordinate, z, is nearly constant. Hence, for approximate purposes it may be treated as a constant and if it be a z-term it can be ignored.

History.—The subject of dynamic similarity was originated by Newton (*Principia*, Lib. ii prop 32) The explicit formulation of the idea of the dimensions or the exponents of dimensions of physical quantities was first made by Fourier, *Theorie de la chaleur*, 1822, ch ii sec 9, where he insists upon the necessity for homogeneity in the dimensions of all the terms of an equation. Both the logical statement of the principles and the practical applications have advanced very rapidly during the last 20 years.

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(A W. Po)

UNIVERSAL, in logic, means that which our thought conceives to be common to several instances which are thus considered to be of the same kind, whether as instances of the same quality or relation or as members of the same class Universals in this sense can not be apprehended in sense-perception, only in thought, that is by means of ideas or concepts Hence the tendency sometimes to identify "universals" with "ideas" (or "Ideas" with a capital), as in Plato, for instance, without however confusing them with mental processes as such. The predicate of a judgment or proposition is always a universal term, except perhaps in the unimportant cases in which the proposition simply refers singular terms to the same subject Hence universals are sometimes called predicates, and the five predicables (*q v*) are known as *the* universals or the highest universals

See B. Bosanquet, *Logic* (1911), *The Principle of Individuality and Value* (1912), *Implication and Linear Inference* (1920), F H. Bradley, *Principles of Logic* (1922).

UNIVERSALIST CHURCH, a religious body organized in the United States, and represented chiefly by parishes and churches in that country and Canada. A distinction should be noted between Universalism and the Universalist denomination Universalism—the belief that the whole human race will be "saved"—was a doctrine of some of the greatest of the Church fathers, notably Clement of Alexandria and Origen, and is now held by many in other communions The Universalist denomination arose in the United States in the latter part of the 18th century.

History.—The origin of this Church is commonly associated with the landing and preaching of Rev. John Murray at Good Luck, N.J., in September 1770. Murray, a disciple of James Relly (1720–1778), a Calvinistic Universalist of London, was seeking refuge in the new world from sorrow and trouble. Per-

suaded that he should be an apostle of this new faith, he became an itinerant minister in Massachusetts, New York, New Jersey, Pennsylvania and settled in Gloucester, Mass. (1774). His Universalism was a protest against the doctrine of endless punishment

Under the leadership of Hosea Ballou (1771–1852), the most influential and honoured minister of the sect for half a century, Universalists became largely Unitarian and also broke with the Calvinism of Murray. The first period of the denomination's history was largely controversial. Religious and sectarian feeling pro and contra Universalism was intense After 1820, ministers and churches began to multiply, and newspapers were established.

Doctrine.—The fundamental tenet of Universalism may be said to be the illimitable love and goodness of God, assuring triumph over evil in human society as a whole and in the life of every individual The historic symbol of the denomination is the Winchester Profession, adopted at the meeting of the General Convention—then a spontaneous yearly gathering of Universalists, without ecclesiastical authority—in Winchester, N.H, in Sept. 1803. It consists of three brief articles

Article I —We believe that the Holy Scriptures of the Old and New Testaments contain revelation of the character of God and of the duty, interest and final destination of mankind.

Article II —We believe that there is one God, whose Nature is Love, revealed in one Lord Jesus Christ, by one Holy Spirit of Grace, who will finally restore the whole family of mankind to holiness and happiness

Article III —We believe that holiness and true happiness are inseparably connected, and that believers ought to be careful to maintain order and practise good works, for these things are good and profitable unto men

At a session of the General Convention in Boston in 1899 a brief statement of essential principles was adopted as follows

1. The Universal Fatherhood of God, 2 The Spiritual Authority and leadership of His Son, Jesus Christ, 3 The Trustworthiness of the Bible as containing a revelation from God; 4. The certainty of just retribution for sin, 5 The final harmony of all souls with God

Polity.—Universalist parishes govern themselves but acknowledge (theoretically) the authority of the Universalist General Convention, constituted of its officers, a board of trustees of 11 members, active ordained clergymen, two lay delegates (one a woman) from each parish and officers of the several State conventions, which are subordinate to the General Convention

Statistics.—According to the Universalist Year Book (1927) the denomination had 623 churches, 553 ordained ministers and 55,000–60,000 church members

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UNIVERSAL LANGUAGE. The term international language is generally used to denote a second, or auxiliary, language for international use. The concept has been a constant one, as we are reminded by the story of the curse of Babel; but the ancient and modern solutions have a crucial point of differentiation. Formerly the universal language was the language of the conqueror, and that concept has been urged in modern times in support of French, as the traditional language of diplomacy, and of English, as that of commerce. The modern world, however, tends to favor the adoption of some new linguistic medium, because it has been found that such a medium is easy to use and because it is inoffensive to national pride

Greek, Latin and Arabic have had, at various times, the status of international languages. French occupied a similar position, particularly in the 18th and early 19th centuries, in diplomacy, social life and literature; it is still the usual international language of Europe and the Levant. English, however, has come to share the prestige of French in diplomacy, while in the Orient the normal international language is English, often in the debased forms known as *Pidgin* (*q v.*), or "business" English. Italian was used as the basis for a similar international commercial language in the Mediterranean countries during the Crusades, and has persisted in common use under the designation *lingua franca.* The international language of high local prestige has been a constant phenomenon along linguistic frontiers the Chinook of the Columbia river valley and the "pidgin" Malay of Polynesia are examples in point

Of some 200 schemes for the creation of a suitable language on scientific principles the vast majority are projects only They may be roughly divided into (a) *a priori* (philosophical, arbitrary) and (b) *a posteriori* (based on one or more existing languages)

Most early schemes were of the *a priori* type alluded to by Roget in his *Thesaurus* Solresol, based on the seven notes of the scale (1817), Lingualumina (1875), Blaia Zimondal (1884), Cabe aban (1887), Zahlensprache (1901) are more recent examples Such schemes are based on a classification of ideas translated into words bearing no relation to any other language Obviously they depend on the caprice of the inventor, though usable as codes, they impose a great strain on the memory One such scheme still advocated is Ro, invented in 1904 by the Rev P. Foster It has some vocabularies, a monthly sheet *Roia,* and as literature the first chapter of St John

It is, however, now generally agreed that the international language must be *a posteriori* It should be international, easy for all, neutral, euphonious, phonetic, flexible, unambiguous, logical, regular, adaptable, and must be tested by long-continued practical use on a large scale.

Esperanto.—Initiated in 1887 by Dr L L Zamenhof, Esperanto is claimed to possess all these characteristics It is neutral and international in its elements, logical and regular in construction, and euphonious The grammar can be grasped in half an hour, every rule is without exception, the spelling is phonetic and the dictionary small Nevertheless, it has literary power, beauty, precision, flexibility and power of growth There are some 4,000 Esperanto books, original and translated, including the Bible, the literature is rapidly growing, 100 magazines appearing regularly The League of Nations has published a favourable memorandum (compiled from Government reports) on the teaching of Esperanto in the schools of the world. The Paris Chamber of Commerce and the London County Council teach Esperanto in their commercial schools, the London Chamber of Commerce examines in Esperanto In 1925 the International Telegraphic Union officially recognized Esperanto as a "clear language." The British Association in 1919 appointed a committee, which in 1924 definitely recommended Esperanto as its choice. In May 1927 the Union Internationale de Radiophonie recommended broadcasting stations to use Esperanto, and in December 1927, 44 stations were giving regular Esperanto transmissions Twenty annual International Esperanto Congresses have already been held, attended by from 1,000 to 4,000 members from all parts of the world On a foundation they regard as sound they are rearing a superstructure of technical vocabularies with the co-operation of expert committees The majority of universal language partisans, and nearly all the literature, are Esperantist, but there are considerable differences in pronunciation in different countries

Ido.—In 1907 Couturat and de Beaufront produced a modification of Esperanto which they named simplified Esperanto. Owing to Esperantist protests, the "linguo internaciona" was renamed Ido (an Esperanto word meaning offspring) Ido is said to be Esperanto rendered more scientific and natural; it abolishes accented letters, correlatives, the compulsory accusative, the agreement of the adjective with the noun.

Over 50 schemes have appeared for "reformed" Esperanto, "reformed" Ido or some compromise; none of these projects, however, has had any success Prof. R de Saussure, believing that some minor features of Esperanto handicap propaganda, proposed to eliminate them while preserving the essential qualities of the language From 1907 onwards a stream of experimental projects and literature has issued from his language laboratory—Antido I, Antido II, Lingvo Kosmopolita, Esperantido and finally Nov-Esperanto (1925) His attitude of scientific detachment and re-

search, however, has been insufficiently appreciated

The first international language to be used in fact was the once famous Volapuk This was invented in 1880 by an Austrian priest, the Rev F Schleyer It was founded, as to 40%, on English, but the roots were so distorted in accordance with arbitrary rules that they were almost unrecognizable, and the language was further encumbered by an almost Greek profusion of terminations and variations The collapse of Volapuk, which in 1889 claimed a million adherents and had held three successful congresses, was ensured by the refusal of Bishop Schleyer to permit any modification The central Volapuk academy, Kadem Bevuretik Volapuka, directed by Dr W Rosenberger (d. 1918), nevertheless continued its researches into the best possible form of an international language. In 1898 it issued a vastly improved language which it called Idiom Neutral and changed its own name to *Akademi de Lingu Internasional.* From that time, both within and without the academy, research has not ceased, nor has the stream of proposed languages Latinesce (by Henderson), Nov-Latin (by Rosa), Monario (by Lavagnini), Occidental (by de Wahl), Europan (by Weisbart), Optez (by S Bond), Romanal (by Michaux), deserve particular mention

The greatest advance has perhaps been made by Prof G. Peano, since 1908 director of the academy, now the Academia pro Interlingua. Peano's Interlingua arises out of an address written by him in 1903; he began in good classical Latin and pointed out that certain features—*e g*, conjugation, gender, irregularity of verbs, agreement of adjectives—were no longer necessary. As he proved each point he removed the offending practice from his own text and the address, which began in Ciceronian Latin, finished in "Latino sine flexione," a tongue now known as Interlingua, which consists of the living Latin roots in all European languages, with the modern rules of the order of words, and without grammar

See L Couturat and L Leau, *Histoire de la langue universelle* (1903), W J Clark, *International Language, Past, Present and Future* (1912); G. Peano, *Vocabulario Commune* (1915), A. L Guérard, *Short History of the International Language Movement* (1922); Otto Jespersen, *An International Language* (1928)

UNIVERSE OF DISCOURSE, in logic, is the limited sphere of reference within which an assertion is intended to hold good. Hence the alternative name, "limited universe" The expression "universe of discourse" was first introduced by A. De Morgan, who states his meaning as follows. "For the most part the objects of thought which enter into a proposition are supposed to be taken, not from the whole universe of possible objects, but from some more definite collection of them Thus when we say 'All animals require air' . . . we should understand that we are speaking of things on this earth. the planets, etc. . . . not being included" (*Formal Logic,* ch iv.) Boole and Jevons used the term in the same sense, namely, for a part of the real world Subsequently the notion was extended so as to include also merely imaginary spheres of reference—the world of illusions, supernatural worlds, worlds of sheer madness and vagary, etc (*see* W. James, *Principles of Psychology*, vol. ii., ch. xxi). In logic the question is of some importance in connection with the problem of the existential import of propositions, especially of categorical propositions. *See* A. Wolf, *The Existential Import of Categorical Predication: Studies in Logic* (1905).

UNIVERSITIES. The mediaeval Latin term *universitas* was originally employed to denote any community or corporation. When used in its modern sense of a body devoted to learning and education, it required the addition of other words, such as *magistrorum et scholarum* In the course of time, probably towards the latter part of the 14th century, the term began to be used by itself, with the exclusive meaning of a lawfully recognized community of teachers and scholars But the more ancient and customary designation of such communities in mediaeval times (regarded as places of instruction) was *studium* (and subsequently *studium generale*), a term implying a centre of instruction for all.

A university often had a vigorous virtual existence long before it obtained that legal recognition which entitled it, technically, to take rank as a *studium generale.*

The university appears to have started as a scholastic gild—a spontaneous combination, that is to say, of teachers or scholars, or of both combined, and formed, probably, on the analogy of the trades gilds, and the gilds of aliens in foreign cities, which, in the course of the 13th and 14th centuries, sprang up in most of the great European centres. The design, in the first instance, was little more than that of securing mutual protection. And so the university, composed as it was to a great extent of students from foreign countries, was a combination formed for the protection of its members from the extortion of the townsmen and the other annoyances incident in mediaeval times to residence in a foreign State

Meaning of "Studium Generale."—In the north of Europe licences to teach were granted by the chancellor scholasticus, or some other officer of a cathedral church; in the south it is probable that the guilds of masters (when these came to be formed) were at first free to grant their own licences, without any ecclesiastical or other supervision Gradually, however, towards the end of the 12th century, a few great schools claimed, from the excellence of their teaching, to be of more than merely local importance Practically, a doctor of Paris or Bologna would be allowed to teach anywhere; and those great schools began to be known as *studia generalia, i e*, places resorted to by scholars from all parts Eventually the term came to have a more definite and technical signification The emperor Frederick II set the example of attempting to confer, by an authoritative bull, upon his new school at Naples the prestige which the earlier *studia* had acquired by reputation and general consent In 1229 Gregory IX did the same for Toulouse, and in 1233 added to its original privileges a bull by which anyone who had been admitted to the doctorate or mastership in that university should have the right to teach anywhere without further examination. Other *studia generalia* were subsequently founded by papal or imperial bulls, and in 1292 even the oldest universities, Paris and Bologna, found it desirable to obtain similar bulls from Nicolas IV From this time the notion began to prevail among the jurists that the essence of the *studium generale* was the privilege of conferring the *ius ubicunque docendi*, and that no new *studium* could acquire that position without a papal or imperial bull There were, however a few *studia generalia* (*e g*, Oxford), whose position was too well established to be seriously questioned, although they had never obtained such a bull; these were held to be *studia generalia ex consuetudine.* A few Spanish universities founded by royal charter were held to be *studia generalia respectu regni*

ITALIAN UNIVERSITIES IN THE MIDDLE AGES

Rise of University of Salerno.—The origins of the first European university—that of Salerno in Italy, which became known as a school of medicine as early as the 9th century—are uncertain. The most authoritative researches point to the conclusion that the medical system of Salerno was originally an outcome of the Graeco-Roman tradition of the Old Roman world, and the Arabic medicine was not introduced till the highest fame of the Civitas Hippocratica was passing away. It *may* have been influenced by the late survival of the Greek language in southern Italy, though this cannot be proved. In the first half of the 9th century the emperor at Constantinople sent to the Caliph Mamoun at Baghdad a considerable collection of Greek manuscripts, which seems to have given the earliest impulse to the study of the Hellenic pagan literature by the Saracens. The original texts were translated into Arabic by Syrian Christians, and these versions were, in turn, rendered into Latin for the use of teachers in the West. Of the existence of such versions we have evidence, according to Jourdain, long prior to the time when Constantine the African (d. 1087) began to deliver his lectures on the science at Salerno. Under his teaching the fame of Salerno as a medical school became diffused all over Europe; it was distinguished also by its catholic spirit, and, at a time when Jews were the object of religious persecution throughout Europe, members of this nationality were to be found both as teachers and learners at Salerno. In 1231 it was constituted by the emperor Frederick II. the only school of medicine in the kingdom of Naples.

Bologna.—The great revival of legal studies which took place at Bologna about the year 1000 had also been preceded by a corresponding activity elsewhere—at Pavia by a famous school of Lombard law, and at Ravenna by a yet more important school of Roman law. And in Bologna itself we have evidence that the Digest was known and studied before the time of Irnerius (1100–30), a certain Pepo being named as lecturing on the text about the year 1076. The secular character of this new study, and its close connection with the claims and prerogatives of the Western emperor, aroused papal suspicion, and for a time Bologna and its civilians were regarded by the Church with distrust. But in the year 1151 the appearance of the *Decretum* of Gratian, largely compiled from spurious documents, invested the studies of the canonist with fresh importance; and numerous decrees of past and almost forgotten pontiffs now claimed to take their stand side by side with the enactments contained in the *Corpus Iuris Civilis*. They constituted, in fact, the main basis of those new pretensions asserted by the papacy in the course of the 12th and 13th centuries. It was necessary, accordingly, that the *Decretum* should be known and studied beyond the walls of the monastery or the episcopal palace. Such a centre of instruction was in Bologna, which became recognized as the chief school of civil and canon law. But the statement, that university degrees were instituted there as early as the pontificate of Eugenius III (1145–53), rests on no good authority. The students found their first real protector in the emperor Frederick Barbarossa. Finding that their grievances were real, especially against the landlords in whose houses they were domiciled, he granted the foreign students substantial protection by conferring on them certain special immunities and privileges (Nov. 1158). These privileges were embodied in the celebrated *Authentica, Habita,* in the *Corpus Iuris Civilis* of the empire (bk iv. tit. 13), and were eventually extended to all the other universities of Italy.

Nevertheless Bologna did not possess a university so early as 1158. Its first university was not constituted until the close of the 12th century. The "universities" at Bologna, were, as Denifle has shown, really student guilds These were originally only two in number, the *Ultramontani* and the *Citramontani,* and arose out of the absolute necessity, under which residents in a foreign city found themselves, of obtaining by combination that protection and those rights which they could not claim as citizens Originally, they did not include the native student element, and were composed exclusively of students in law. Denifle thinks that the "universities" at Bologna were at one time certainly more than four in number, and we know that the Italian students alone were subdivided into two—the Tuscans and the Lombards. In the centres formed by secession from the parent body a like subdivision took place. At Vercelli there were four *universitates,* composed respectively of Italians, English, Provençals and Germans; at Padua there were similar divisions into Italians, French (i e , *Francigenae,* comprising both English and Normans), Provençals (including Spaniards and Catalans). According to Odofied, in the time of the eminent jurist Azo, who lectured at Bologna about 1200, the number of the students there amounted to some 10,000, of whom the majority were foreigners. It seems, therefore, reasonable to conclude that the number of these confederations of students (*societates scholarium*) at Bologna was yet greater.

The Rector.—In marked resemblance to the guilds, these confederations were presided over by a common head, the "rector scholarium," an obvious imitation of the "rector societatum" or "artium" of the guild, but to be carefully distinguished from the "rector scholarum," or director of the studies, with whose function the former officer had, at this time, nothing in common. Like the gilds, again, the different nations were represented by their "consiliarii," a deliberative assembly with whom the rector habitually took counsel. The students at Bologna were mostly of mature years. As the civil law and the canon law were, at first, the only branches of study, the class whom they attracted were often men already filling office in some department of the Church or State—archdeacons, the heads of schools, canons of cathedrals, and like functionaries forming a considerable element in the aggregate.

About the year 1200 were formed the two faculties of medicine and philosophy (or "the seven liberal arts"), the former being somewhat the earlier. It was developed, as that of the civil law had been developed, by a succession of able teachers, among whom Thaddeus Alderottus was especially eminent. The faculty of arts, down to the 14th century, scarcely attained to equal eminence. The teaching of theology at Bologna remained for a long time exclusively in the hands of the Dominicans; and it was not until the year 1360 that Innocent VI. recognized the university as a *studium generale* in this branch.

Colleges, as places of residence for students, existed at Bologna at a very early date, but it is not until the 14th century that we find them possessing any organization; and the humble *domus,* as it was termed, was at first designed solely for necessitous students, not being natives of Bologna. A separate house, with a certain fund for the maintenance of a specified number of scholars, was all that was originally contemplated. Such was the character of that founded by Zoen, bishop of Avignon, in Feb 1256 (O.S), the same month and year, it is to be noted, in which the Sorbonne was founded in Paris It was designed for the maintenance of eight scholars from the province of Avignon, under the supervision of three canons of the Church, maintaining themselves in the university Each scholar was to receive 24 Bolognese lire annually for five years. The college of Brescia was founded in 1326 by William of Brescia, archdeacon of Bologna, for poor foreign students, without distinction as to nationality The Spanish college, founded in 1364, for 24 Spanish scholars and two chaplains, is noted by Denifle as the one college, founded in mediaeval times, which still exists on the Continent.

Other Italian Centres.—The earliest foundations in Italy after that of Bologna were the universities of Reggio nell' Emilia and Modena, both of which had flourishing schools of civil law before the close of the 12th century Vicenza (founded 1204) and Padua (founded 1222) both originated in migrations of students from Bologna. The University of Naples was founded by the Emperor Frederick II in 1225 and was temporarily suppressed after his death It was reconstituted in 1258. Piacenza, founded by papal charter in 1248, had little importance until 1398 when it was reconstituted by Galeazzo Visconti, duke of Milan, who caused the University of Pavia to be transferred to Piacenza Pavia had long been famous as a school of Roman law, and for a time its fame was transferred to Piacenza From 1404 to 1412 both universities ceased to exist. But after that date Pavia became almost as famous a school of civil law as Padua itself Arezzo was a centre for legal study from 1215 to 1470 Rome had a university with schools of canon and civil law for poor foreign students in the 14th and 15th centuries Perugia University (founded 1308) specialised in law, and Pisa (founded by charter from Clement VI in 1343) had a period of prosperity under the patronage of Lorenzo de' Medici. The University of Florence (founded by the same pontiff in 1349) had a brilliant existence in the first half of the 15th century, but was closed in 1472. Siena, whose importance dates from 1357, though it was nominally founded in 1241, had faculties of jurisprudence, arts and medicine. The University of Ferrara was famous in the 15th century Parma and Turin had no universities in the middle ages Their foundation dates from the 15th century

PARIS IN THE MIDDLE AGES

Origin of University of Paris.—The early universities rose in response to new wants, and the commencement of the University of Paris supplies us with a further illustration of the fact. The study of logic, which, prior to the 12th century, was founded exclusively on one or two meagre compends, received, about the year 1100, on two occasions, a powerful stimulus—in the first instance from the memorable controversy between Lanfranc and Berengar; in the second, from the no less famous controversy between Anselm and Roscellinus. Dialectic was looked upon as "the science of sciences"; and when, somewhere in the first decade of the 12th century, William of Champeaux opened, in Paris, a school for the more advanced study of dialectic as an art, his teaching was attended with marked success. Among his pupils was Abelard, in whose hands the study made a yet more notable ad-

vance; so that, by the middle of the century, we find John of Salisbury relating how all learned Paris had gone well nigh mad in its pursuit and practice of the new dialectic. Abelard taught at first at the cathedral school at Notre Dame, and later at the schools on the Mont Ste Geneviève, of which he was the founder, and where he imparted to logic its new development.

The schools out of which the university arose were those attached to the cathedral on the Île de la Cité, and presided over by the chancellor—a dignitary who must be carefully distinguished from the later chancellor of the university. For a long time the teachers lived in separate houses on the island, and it was only by degrees that they combined themselves into a society, and that special buildings were constructed for their class-work. But the flame which Abelard's teaching had kindled was not destined to expire. Among his pupils was Peter Lombard, who was bishop of Paris in 1159, and widely known to posterity as the compiler of the famous volume of the *Sentences*. The design of this work was to place before the student, in as strictly logical a form as practicable, the views (*sententiae*) of the fathers and all the great doctors of the Church upon the chief and most difficult points in the Christian belief. The logicians seized upon it as a great storehouse of indisputable major premises, on which they argued with renewed energy and with endless ingenuity of dialectical refinement; and upon this new compendium of doctrine, which became the theological text-book of the middle ages, the schoolmen based their successive treatises *Super sententias*.

Early Organization of University of Paris.—The University of Paris became the model, not only for the universities of France north of the Loire, but also for the great majority of those of Central Europe as well as for Oxford and Cambridge.

The original university, as already stated, took its rise entirely out of the movement carried on by teachers on the island, who taught by virtue of the licence conferred by the chancellor of the cathedral. In the second decade of the 13th century, it is true, we find masters repairing to the left bank of the Seine and placing themselves under the jurisdiction of the abbot of the monastery of Ste Geneviève; but it was around the bestowal of this licence by the chancellor of Notre Dame, on the Île de la Cité, that the University of Paris grew up. It is in this licence that the whole significance of the master of arts degree is contained; for what is technically known as admission to that degree was really nothing more nor less than receiving the chancellor's permission to "incept," and by "inception" was implied the master's formal entrance upon, and commencement of, the functions of a duly licensed teacher, and his recognition as such by his brethren in the profession. The previous stage of his academic career, that of bachelordom, had been one of apprenticeship for the mastership; and his emancipation from this state was symbolized by placing the magisterial cap (*biretta*) upon his head, a ceremony which, in imitation of the old Roman ceremony of manumission, was performed by his former instructor. He gave a formal inaugural lecture, and was then welcomed into the society of his professional brethren with set speeches, and took his seat in his master's chair. (*See* also EXAMINATIONS.)

Some time between the years 1150 and 1170 the University of Paris came formally into being. Its first written statutes were not, however, compiled until about the year 1208, and it was not until long after that date that it possessed a "rector." Its earliest recognition as a legal corporation belongs to about the year 1211, when a brief of Innocent III. empowered it to elect a proctor to be its representative at the papal court. By this permission it obtained the right to sue or to be sued in a court of justice as a corporate body.

With papal support Paris became the great trans-Alpine centre of orthodox theological teaching. Successive pontiffs, down to the great schism of 1378, cultivated friendly relations with the University, and systematically discouraged the formation of theological faculties at other centres. In 1231 Gregory IX., in the bull *Parens Scientiarum*, gave full recognition to the right of the several faculties to regulate and modify the constitution of the university. The fully-developed university was divided into four faculties—three "superior," viz., those of theology, canon law and medicine, and one "inferior," that of arts, which was divided into four "nations." These nations, which included both professors and scholars, were:—(1) the French nation, composed, in addition to the native element, of Spaniards, Italians and Greeks; (2) the Picard nation, representing the students from the north-east and from the Netherlands; (3) the Norman nation; (4) the English nation, comprising, besides students from the provinces under English rule, those from England, Ireland, Scotland and Germany. The rector, in the first instance, was head of the faculty of arts, by whom he was elected. Eventually he became the head of the collective university, by the incorporation under him, first, of the students of the canon law and of medicine (which took place about the end of the 13th century), and, secondly, of the theologians, which took place about half a century later.

In the course of the 16th and 17th centuries this democratic constitution of the middle ages was largely superseded by the growth of a small oligarchy of officials. The tribunal of the university—the rector, deans and proctors—came to occupy a somewhat similar position to the old "Hebdomadal Board" of heads of colleges at Oxford and the *Caput* at Cambridge. Moreover, the teaching functions of the university, or rather of the faculty of arts, owing chiefly to the absence of any endowment for the regents or teaching graduates, practically passed to the colleges. Almost as much as the English universities, Paris came to be virtually reduced to a federation of colleges, though the colleges were at Paris less independent of university authority, while the smaller colleges sent their members to receive instruction in the larger ones (*collèges de plein exercice*), which received large numbers of non-foundation members. This state of things lasted till the French Revolution swept away the whole university system of the middle ages. It may be noted that the famous Sorbonne (*see* PARIS UNIVERSITY) was really the most celebrated college of Paris—founded by Robert de Sorbonne *c.* 1257—but as this college and the College of Navarre were the only college foundations which provided for students in theology, the close connection of the former with the faculty, and the use of its hall for the disputations of that body, led to the word Sorbonne becoming a popular term for the theological faculty of Paris.

In the 14th century the University of Paris had 40 colleges, governed either by secular or religious communities, and numbered among its students representatives of every country in Europe (Jourdain, *Excursions historiques*, c. xiv.). The university became known as the great school where theology was studied in its most scientific spirit, and the decisions of its great doctors upon those abstruse questions which absorbed so much of the highest intellectual activity of the middle ages were regarded as almost final. The popes themselves, as already stated, discouraged the creation of faculties of theology elsewhere. The apparent exceptions to this policy are easily explained: the four faculties of theology which they sanctioned in Italy—Pisa (1343), Florence (1349), Bologna (1362) and Padua (1363)—were designed to benefit the Italian monasteries, by saving the monks the expense and dangers of a long journey beyond the Alps; while that at Toulouse (1229) took its rise under circumstances entirely exceptional, being designed as a bulwark against the heresy of the Albigenses. The popes, on the other hand, favoured the creation of new faculties of law, and especially of the canon law, as the latter represented the source from which Rome derived her most warmly contested powers and prerogatives.

ENGLISH MEDIAEVAL UNIVERSITIES

Oxford.—Of the universities modelled on that of Paris, Oxford (*q.v.*) would appear to have been the earliest, and the manner of its development was probably similar. Certain schools, opened within the precincts of the dissolved nunnery of St Frideswyde and of Oseney abbey, are supposed to have been the nucleus round which the university grew up. In the year 1133 one Robert Pullen, a theologian of considerable eminence (but whether an Englishman or a Breton is uncertain), arrived from Paris and delivered lectures on the Bible. H. S. Denifle (*Die Entstehung der Universitäten*, p. 241), maintains that we have at best, only presumptive evidence of a *studium generale* at Ox-

ford in the 12th century. Of this, Rashdall inclines to find the beginning in a migration of English students from Paris about 1167 or 1168. In the first-mentioned year we are told by John of Salisbury that "France, the mildest and most civil of nations," has "expelled her foreign scholars" (*Materials for the History of Thomas Becket*, edit. Robertson, vi. pp. 235–236). At about the same time we hear of an edict of Henry II., during the quarrel with Becket, recalling all clerks holding benefices in England (as they loved their benefices), and forbidding all clerks in England to cross the Channel (*ibid.* i pp 53–54) Paris was at this time the great place of higher education for English students Immediately after 1168 allusions to Oxford as a *studium* and a *studium generale* begin to multiply. The natural inference is that the breaking off of relations between England and Paris, in 1167 or 1168, led to the growth of a *studium generale* in Oxford, formed, no doubt, in the first instance of seceders from Paris In the 13th century mention first occurs of university "chests," especially the Frideswyde chest, which were benefactions designed as funds for the assistance of poor students Halls, or places of licensed residence for students, also began to be established. In the year 1257, when the bishop of Lincoln, as diocesan, had trenched too closely on the liberties of the community, the deputies from Oxford, when preferring their appeal to the king at St. Albans, could venture to speak of the university as *schola secunda ecclesiae*, or second only to Paris. Its numbers about this time were probably some 3,000, but whenever plague or tumult led to a temporary dispersion, a serious diminution in its numerical strength generally ensued for some time after. Against such vicissitudes the foundation of colleges proved the most effectual remedy. Of these the three earliest were University college, founded in 1249 by William of Durham; Balliol college, founded about 1263 by John Balliol, the father of the king of Scotland of the same name; and Merton college, founded in 1264. The last-named is especially notable as associated with a new conception of university education, viz., that of collegiate discipline for the secular clergy, instead of for any one of the religious orders, for whose sole benefit all similar foundations had hitherto been designed The statutes given to the society by Walter de Merton are not less noteworthy, as characterized not only by breadth of conception, but also by a careful and discriminating attention to detail, which led to their adoption as the model for later colleges, not only at Oxford but at Cambridge

Cambridge.—The University of Cambridge (*q.v.*) although it rose into existence somewhat later than Oxford, may reasonably be held to have had its origin in the same century. There was probably a certain amount of educational work carried on by the canons of the church of St Giles, which gradually developed into the instruction belonging to a regular *studium*. In the year 1112 the canons crossed the river and took up their residence in the new priory in Barnwell, and their work of instruction acquired additional importance. In 1209 a body of students migrated thither from Oxford. Then, as early as the year 1224, the Franciscans established themselves in the town, and, somewhat less than half a century later, were followed by the Dominicans. At both the English universities, as at Paris, the Mendicants and other religious orders were admitted to degrees, a privilege which, until the year 1337, was extended to them at no other university. Their interest in and influence at these three centres were consequently proportionably great. In the years 1231 and 1233 certain royal and papal letters afford satisfactory proof that by that time the University of Cambridge was already an organized body, with a chancellor at its head. In 1229 and 1231 the numbers were largely augmented by migrations from Paris and from Oxford. Cambridge, however, in its turn suffered from emigration; while in the year 1261, and again in 1381, the records of the university were wantonly burnt by the townsmen Throughout the 13th century, indeed, the university was still only a very slightly and imperfectly organized community. Its endowments were of the most slender kind; it had no systematic code for the government of its members; the supervision of the students was very imperfectly provided for. Although both Oxford and Cambridge were modelled on Paris, their higher faculties never developed the same distinct organization; and while the two proctors at Cambridge originally represented "north" and "south," the "nations" are scarcely to be discerned. An important step in the direction of discipline was, however, made in the year 1276, when an ordinance was passed requiring that everyone who claimed to be recognized as a scholar should have a fixed master within 15 days after his entry into the university The traditional constitution of the English universities was, in its origin, an imitation of the Parisian chancellor, modified by the absence of the cathedral chancellor. But the feature which most served to give permanence and cohesion to the entire community at Cambridge was, as at Oxford, the institution of colleges The earliest of these was Peterhouse, first founded as a separate institution by Hugh Balsham, bishop of Ely, in the year 1284. In 1323 was founded Michaelhouse, and two years later, in 1326, Edward II. instituted his foundation of "king's scholars," afterwards forming the community of King's hall. Both these societies, in the 16th century, were merged in Trinity college. To these succeeded Pembroke hall (1347) and Gonville hall (1348) All these colleges were expressly designed for the benefit of the secular clergy. The foundation of Trinity hall (*Aula*) in 1350 by Bishop Bateman, on the other hand, as a school of civil and canon law, was probably designed to further ultramontane interests. That of Corpus Christi (1352), the outcome of the liberality of a guild of Cambridge townsmen, was conceived with the combined object of providing a house of education for the clergy, and at the same time securing the regular performance of masses for the benefit of the souls of departed members of the guild But both Trinity hall and Corpus Christi college, as well as Clare hall, founded in 1359, were, to a great extent, indebted for their origin to the ravages caused among the clergy by the great plague of 1349.

FRENCH AND SPANISH MEDIAEVAL STUDIA

France.—Montpellier was a recognized school of medicine as early as the 12th century Before the end of the century it possessed also a faculty of jurisprudence The university of medicine and that of law continued, however, to be totally distinct bodies, with different constitutions. On Oct. 26, 1289, Montpellier was raised by Nicholas IV to the rank of a *studium generale*

The University of Toulouse is to be noted as the first founded in any country by virtue of a papal charter. It took its rise in the efforts of Rome for the suppression of the Albigensian heresy, and its foundation formed one of the articles of the conditions of peace imposed by Louis IX. on Count Raymond of Toulouse. In the year 1233 it first acquired its full privileges as a *studium generale* by virtue of a charter given by Gregory IX The University of Orléans had a virtual existence as a *studium generale* as early as the first half of the 13th century, but in the year 1305 Clement V. endowed it with new privileges, and gave its teachers permission to form themselves into a corporation. The schools of the city had an existence long prior—as early, it is said, as the 6th century In the 14th century its fame as a school of law was surpassed by no other university in Europe. Prior to the 13th century it had been famed for its classical learning.

The other French universities famous in the middle ages were Angers, Avignon, Cahors and Grenoble At Perpignan and Orange there were schools of small note.

Spain.—Valladolid, which received its charter from Pope Clement VI. in 1346, attained great celebrity. In 1418, however, at the Council of Constance, Martin V. not only decreed that Valladolid should take rank as a *studium generale*, but also as a *universitas theologiae*. From this time, accordingly, the advance of the university in numbers was steady and continuous throughout the 15th century, and, along with Salamanca, it served as the model for Alcalà in 1409.

Seville was founded in 1254 by Alphonso the Wise, simply for the study of Latin and of the Semitic languages, especially Arabic. Salamanca had been founded in 1243 by Ferdinand III of Castile as a *studium generale* in the three faculties of jurisprudence, the arts and medicine. But the main stress of its

activity, as was the case with all the earlier Spanish universities, was laid on the civil and the canon law. In the early part of the 15th century, however, the efforts of Martin V. established a school of theology which was afterwards regarded almost as an oracle by Catholic Europe. About the year 1600 the students are shown by the matriculation books to have numbered over 5,000. According to Cervantes they were noted for their lawlessness. The earliest of the numerous colleges founded at Salamanca was that of St Bartholomew, long noted for its ancient library and valuable collection of manuscripts, which now form part of the royal library in Madrid

The only Portuguese university in mediaeval times had its seat alternately in Lisbon and in Coimbra, until, in the year 1537, it was permanently attached to Coimbra It had received from King Diniz a charter, the provisions of which were mainly taken from those of the charter given to Salamanca. In 1772 the university was entirely reconstituted.

MEDIAEVAL UNIVERSITIES IN CENTRAL EUROPE

Prague.—Of the universities included in the Austrian empire, Prague, which existed as a *studium* in the 13th century, was the earliest It was at first frequented mainly by students from Styria and Austria, countries at that time ruled by the emperor Charles IV, who was also king of Bohemia, and at whose request Pope Clement VI., on Jan. 26, 1347, promulgated a bull authorizing the foundation of a *studium generale* in all the faculties. In the following year Charles himself issued a charter for the foundation. Charles had himself been a student in Paris, and the organization of his new foundation was modelled on that university, a like division into four "nations" (although with different names) constituting one of the most marked features of imitation. The numerous students—and none of the mediaeval universities attracted in their earlier history a larger concourse—were drawn from a gradually widening area, which at length included, not only all parts of Germany, but also England, France, Lombardy, Hungary and Poland.

Cracow.—The University of Cracow, in Poland, was founded in May 1364, by virtue of a charter given by King Casimir the Great, but its real commencement must be considered to belong to the year 1400, when it was reconstituted Towards the close of the 15th century the university is said to have been in high repute as a school of both astronomical and humanistic studies

Vienna.—The Avignonese popes appear to have regarded the establishment of new faculties of theology with especial jealousy; and when, in 1364, Duke Rudolph IV. founded the University of Vienna, with the design of constituting it a *studium generale* in all the faculties, Urban V. refused his assent to the foundation of a theological school. Owing to the sudden death of Duke Rudolph, the university languished for the next 20 years, but after the accession of Duke Albert III., who may be regarded as its real founder, it acquired additional privileges.

Heidelberg.—The University of Heidelberg (the oldest of those of the German realm) received its charter (Oct. 23, 1385) from Urban VI. as a *studium generale* in all the recognized faculties save that of the civil law. It was granted at the request of the elector palatine, Rupert I But the real founder, as he was also the organizer and teacher, of the university was Marsilius of Inghen, to whose ability and energy Heidelberg was indebted for no little of its early reputation and success. In spite of the omission of the civil law in the original charter, it was included among its faculties almost from its first creation. No mediaeval university achieved a more rapid and permanent success.

Cologne.—Owing to the labours of the Dominicans, Cologne had gained a reputation as a seat of learning long before the founding of its university; and it was through the advocacy of some leading members of the Mendicant orders that, at the desire of the city council, its charter as a *studium generale* (May 21, 1388) was obtained from Urban VI. It was organized on the model of the University of Paris, as a school of theology, and canon law, and "any other recognized faculty"—the civil law being incorporated as a faculty soon after the promulgation of the charter. In common with the other early universities of Germany—Prague, Vienna and Heidelberg—Cologne owed nothing to imperial patronage, while it would appear to have been, from the first, the object of special favour with Rome. This circumstance serves to account for its distinctly ultramontane sympathies in mediaeval times, and even far into the 16th century.

Erfurt.—Erfurt, no less noted as a centre of Franciscan than was Cologne of Dominican influence, received its charter (Sept 16, 1379) from the anti-pope, Clement VII., as a *studium generale* in all the faculties. Ten years later it was founded afresh by Urban VI. In the 15th century the number of its students was larger than that at any other German university—a fact attributable partly to the reputation it had acquired as a school of jurisprudence, and partly to the ardour with which the nominalist and realist controversies of the time were debated in its midst; its readiness in according a hearing to novel theories causing it to be known as *novorum omnium portus*.

Budapest.—In Hungary, the university at Ofen (Hungarian *Buda*) was founded in 1475. It had a school of law at Pressburg, the sole remains of the university there founded by Mathias Corvinus in 1465. This, in 1914, was turned into a university, and forms to-day the Czechoslovak university of Bratislava.

Foundation of Louvain.—In the Netherlands the growing wealth and prosperity of the different States especially favoured the formation of new centres of learning. In the flourishing duchy of Brabant the University of Louvain (1426) was to a great extent controlled by the municipality; and their patronage, although ultimately attended with detrimental results, long enabled Louvain to outbid all the other universities of Europe in the munificence with which she rewarded her professors In the course of the next century the "Belgian Athens," as she is styled by Lipsius, ranked second only to Paris in numbers and reputation It possessed no less than 28 colleges, while its active press afforded facilities to the author and the controversialist of which both Cambridge and Oxford were at that time almost destitute. It embraced all the faculties, and no degrees in Europe stood so high as guarantees of general requirements Erasmus records it as a common saying, that "no one could graduate at Louvain without knowledge, manners and age."

Leipzig.—In Germany the conditions connected with the rise of the University of Leipzig are especially noteworthy, it having been the result of the migration of almost the entire German element from the University of Prague This element comprised. (1) Bavarians, (2) Saxons, (3) Poles (this last-named division being drawn from a wide area, which included Meissen, Lusatia, Silesia and Prussia), and, being represented by three votes in the assemblies of the university, while the Bohemians possessed but one, had acquired a preponderance in the direction of affairs which the latter could no longer submit to Religious differences, again, evoked mainly by the preaching of John Huss, further intensified the existing disagreements; and eventually, in the year 1409, King Wenceslaus, at the prayer of his Bohemian subjects, issued a decree which exactly reversed the previous distribution of votes—three votes being assigned to the Bohemian nation and only one to all the rest. The Germans took deep umbrage, and seceded to Leipzig, where, a bull having been obtained from Alexander V. (Sept 9, 1409), a new *studium generale* was founded by the landgrave of Thuringia and the margraves of Meissen. The members were divided into four nations—composed of natives of Meissen, Saxony, Bavaria and Poland

Rostock.—At Rostock, in the north, the dukes John and Albert of Mecklenberg conceived the design of founding a university from which the faculty of theology should be excluded The university was accordingly founded as proposed in 1419; but in 1431 Eugenius IV. instituted a faculty of theology. Six years later, the whole academic community having incurred the papal ban, was fain to migrate to Greifswald, returning, however, to Rostock in 1443, but with one important exception, that of a master of arts named Henry Rubenow, who remained to become burgomaster of the former city, and succeeded in persuading Duke Wratislaw of Pommern to make it the seat of a university. Calixtus III. granted a bull in 1456, but it was stipulated that the rector should be a bishop, and the professorial chairs were also

made partially dependent for endowment on canonries. Greifswald thus became exposed to the full brunt of the struggle which had ensued when the endeavour to nationalize the German Church was terminated by the Concordat of Vienna (1448).

Freiburg.—The universities of Freiburg, in Baden, and Tubingen, in Württemberg, alike owed their foundation to the countess Matilda, by whose persuasion her husband, the archduke of Austria, known as Albrecht VI, was induced to found Freiburg in 1455, and Count Eberhard (her son by a former marriage) to found Tubingen in 1477. At Freiburg, under the supervision of its first rector, Matthew Hummel of Villingen, the numbers were soon largely augmented by migrations of students from Vienna and from Heidelberg, while its resources, which originally were chiefly an annual grant from the city council, were increased by the bestowal of canonries and prebends Erasmus had made Freiburg his residence from 1529 to 1535, during which time he may have originated the tradition of liberal learning, but in 1620, under the rule of the archduke Maximilian, the control of the humanistic studies and of the entire faculty of philosophy was handed over to the Jesuits, who also gained possession of two of the chairs of theology

THE RENAISSANCE

Tübingen.—The University of Tubingen was founded in 1477 with the usual four faculties, and numbered John Reuchlin and Melanchthon among its teachers. (*See* TÜBINGEN)

France.—The earliest 15th century university in France was that of Aix in Provence. It had originally been nothing more than a school of theology and law, but in 1409 it was reorganized as a *studium generale* on the model of Paris Its students were divided into Burgundians, Provençals and Catalans

The University of Poitiers was instituted by Charles VII in 1431 with the design of creating a centre of learning less favourable to English interests than Paris had at that time shown herself to be He conferred on Poitiers all the privileges collectively possessed by Paris, Toulouse, Montpellier, Angers and Orleans, and at the same time placing the university under special royal protection

The University of Caen was founded under English auspices during the short period of the supremacy of the English arms in Normandy in the 15th century Its charter (May 1437) was given by Eugenius IV, and the bishop of Bayeux was appointed its chancellor After the expulsion of the English from France, it received a new charter From this time the University of Caen was distinguished by its loyal spirit and firm resistance to ultramontane pretensions; and, although swept away at the French Revolution, it was afterwards restored, owing to the sense of the services it had thus once rendered to the national cause. Other French 15th century foundations are Bordeaux (1441), Valence (1452), Nantes (1463), and Bourges (1465)

Central and Northern Europe.—The University of Basle was opened in 1460, under the auspices of its own citizens, and Pius II (Aeneas Sylvius) granted the charter (Nov 12, 1459) During the first 70 years of its existence the university prospered, and its chairs were held by eminent professors, among them historical scholars, such as Sebastian Brant and Jacob Wimpheling But with the Reformation, Basle became the arena of contests which menaced the very existence of the university itself, the professors being, for the most part, opposed to the new movement with which the burghers warmly sympathized Eventually, the statutes were revised, and in the latter half of the 16th century the university may be said to have attained its apogee.

The University of Ingolstadt was founded on April 7, 1459 But it was not until 1472 that the work of teaching was actually commenced there. Some long-existing prebends, founded by former dukes of Bavaria, were appropriated to the endowment. Nowhere did the Reformation meet with more stubborn resistance, and it was at Ingolstadt that the Counter-Reformation commenced. In 1556 the Jesuits made their first settlement in the university.

At Trier and Mainz universities were established in the second half of the 14th century. Trier received its charter as early as 1450; but the first academical session did not commence until 1473 In 1722 the assembly of deputies, by a formal grant, relieved the university from the difficulties in which it had become involved Sixtus IV. granted the charter to Mainz (Nov. 23, 1476) at the request of Archbishop Diether, who was himself a great humanist.

Other foundations were those of Uppsala (1477) and Copenhagen (1479), which, although lying without the political boundaries of Germany, rejected her influence The charter for Copenhagen was given by Sixtus IV as early as 1475.

The university founded at Wittenberg by Maximilian I (July 6, 1502) was the first established in Germany by imperial decree Its charter is, however, drawn up with the traditional phraseology of the pontifical bulls, and is evidently not conceived in any spirit of antagonism to Rome Wittenberg is constituted a *studium generale* in all the four faculties—the right to confer degrees in theology and canon law having been sanctioned by the papal legate some months before, on Feb 2, 1502 Wittenberg was the first academic centre north of the Alps where the Latinity and antiquated methods of the scholastic era were overthrown

Frankfurt-on-the-Oder received its charter in 1506

Scotland.—The first Scottish foundation was at St Andrews, founded in 1411 by Henry Wardlaw, bishop of that see, and modelled chiefly on the constitution of the University of Paris It acquired all its three colleges—St Salvator's, St Leonard's and St Mary's—before the Reformation The most ancient of the universities of Scotland, with its three colleges, was thus reared in an atmosphere of mediaeval theology, and undoubtedly designed as a bulwark against heresy and schism But "by a strange irony of fate, two of these colleges became, almost from the first, the foremost agents in working the overthrow of that Church which they were founded to defend" St Leonard's more especially, like St John's or Queen's at Cambridge, became a noted centre of intellectual life and Reformation principles

The University of Glasgow was founded as a *studium generale* in 1453, and possessed two colleges.

The University of Aberdeen, founded in 1494, at first possessed only one college, namely, King's, which was co-extensive with the university and conferred degrees Marischal college, founded in 1593, was independent of the university in Old Aberdeen, being itself also a college and a university, with the power of conferring degrees

The "College of Edinburgh" was founded by charter of James VI, dated April 14, 1582 The new foundation rose comparatively untrammelled by the traditions of mediaevalism Its first course of instruction was commenced in the Kirk of Field, under the direction of Robert Rollock, who had been educated at St Andrews under Andrew Melville, the eminent Covenanter In 1585 Rollock subscribed the National Covenant, and a like subscription was, from that time, required from those admitted to degrees in the college

General Aspects.—Generally speaking, the universities were conservative Hegius, John Wessel and Rudolphus Agricola carried on their work as reformers at places like Deventer remote from university influences That there was a considerable amount of mental activity going on in the universities themselves is not to be denied; but it was mostly of that unprofitable kind which, while giving rise to endless controversy, turned upon questions in connection with which the implied postulates and the terminology employed rendered all scientific investigation hopeless. At almost every university—Leipzig, Greifswald and Prague (after 1409) being the principal exceptions—the so-called Realists and Nominalists represented two great parties occupied with an internecine struggle At Paris, owing to the overwhelming strength of the theologians, the Nominalists were, indeed, under a kind of ban; but at Heidelberg they had altogether expelled their antagonists. It was much the same at Vienna and at Erfurt. At Basle, under the leadership of the eminent Johannes a Lapide, the Realists with difficulty maintained their ground Freiburg, Tübingen and Ingolstadt, in the hope of diminishing controversy, arrived at a kind of compromise, each party having its own professor, and representing a distinct "nation" At Mainz the au-

thorities adopted a manual of logic which was essentially an embodiment of nominalistic principles.

In Italian universities, it was decided that these controversies were endless and that their effects were pernicious. It was resolved, accordingly, to expel logic, and allow its place to be filled by rhetoric, thereby effecting that important revolution in academic studies which constituted a new era in university learning, and largely helped to pave the way for the Reformation Hence the Italian universities enjoyed a fortunate immunity from dissensions like those which distracted the centres of learning in Germany.

The professorial body in the great Italian universities attained an almost unrivalled reputation throughout Europe. For each subject of importance there were always two, and sometimes three, rival chairs, and a powerful and continuous emulation was thus maintained among the teachers "The call to a Paduan or Pisan chair was deemed the highest of all literary honours. The status of professor was, in Italy, elevated to a dignity which in other countries it has never reached, and not a few of the most illustrious teachers in the Italian seminaries were of the proudest nobility of the land While the universities of other countries had fallen from Christian and cosmopolite to sectarian and local schools, it is the peculiar glory of the Italian that, under the enlightened liberality of their patrons, they still continued to assert their European universality. Creed and country were, in them, no bar—the latter not even a reason of preference Foreigners of every nation are to be found among their professors; and the most learned man in Scotland, Thomas Dempster, sought in a Pisan chair that theatre for his abilities which he could not find at home" (Sir W Hamilton—*Discussions*).

Spain.—To such catholicity of sentiment the Spanish universities of this period offer a complete contrast, their history being strongly modified by political and religious movements Valencia, founded in 1501, and Seville, sanctioned by Julius II in 1505, appear both to have been regarded without mistrust at Rome Julius had approved the foundation of the University of Santiago as early as 1504, but the bull for its creation was not granted by Clement VII until 1526. The design of establishing a university at Granada was deferred until 1531 Little, indeed, is to be learnt respecting the new society until the foundation of the liberally endowed College de Sacro Monte by the archbishop of the province in 1605 Under the direction of the Jesuits the scholastic philosophy, together with a certain attention to Greek and Hebrew, became the dominant study Gregory XIII in 1574 authorized the foundation of the University of Oviedo; but this was not opened until 1608, and then only with a faculty of law After this time the universities in Spain shared in the general decline of the country; and, even after the expulsion of the Jesuits in 1769, no marked improvement is discernible in their schools until the second half of the 19th century.

REFORMATION AND POST-REFORMATION IN ENGLAND

The Renaissance.—The influence of the Renaissance, and the teaching of Erasmus, who resided for some time at both universities, exercised a notable effect alike at Oxford and at Cambridge. The names of Colet, Grocyn and Linacre illustrate this influence at the former centre; those of Bishop Fisher, Sir John Cheke and Sir Thomas Smith at the latter. The labours of Erasmus at Cambridge, as the author of a new Latin version of the New Testament, with the design of placing in the hands of students a text free from the errors of the Vulgate, were productive of important effects, and the university became a centre of Reformation doctrine some years before the writings of Luther became known in England. The foundation of Christ's college (1505) and St. John's college (1511), through the influence of Fisher with the countess of Richmond, also materially aided the general progress of learning at Cambridge. The Royal Injunctions of 1535, embodying the views and designs of Thomas Cromwell, mark the downfall of the old scholastic methods of study at both universities; and the foundation of Trinity college, Cambridge, in 1547 (partly by an amalgamation of two older societies), represents the earliest conception of such an institution in England in complete independence of Roman Catholic traditions. Trinity (1554) and St. John's (1555) at Oxford, on the other hand, founded during the reactionary reign of Mary, serve rather as examples of a transitional period.

Puritanism at Cambridge.—In the reign of Elizabeth, Cambridge became the centre of another great movement—that of the earlier Puritanism, St. John's and Queens' being the strongholds of the party led by Cartwright, Walter Travers and others. The movement continued to gather strength; and Emmanuel college, founded in 1584, owed much of its early prosperity to the fact that it was a known school of Puritan doctrine. Most of the Puritans objected to the discipline enforced by the university and ordinary college statutes—especially the wearing of the cap and the surplice and the conferring of degrees in divinity. The Anglican party, headed by such men as Whitgift and Bancroft, resorted in defence to a repressive policy, of which subscription to the Acts of Supremacy and Uniformity, and the Elizabethan statutes of 1570 (investing the "caput" with larger powers, and thereby creating a more oligarchical form of government), were the most notable results Oxford, although the Puritans were there headed by Leicester, the chancellor, devised at the same time a similar scheme, the rigid discipline of which was further developed in the Laudian or Caroline statutes of 1636 It was under these respective codes—the Elizabethan statutes of 1570 and the Laudian statutes of 1636—that the two universities were governed until the introduction of the new codes of 1858. The fidelity with which both universities adhered to the royal cause in the Civil War caused them to be regarded with suspicion by the Puritan party, and under the Commonwealth both Oxford and Cambridge were, for a brief period, in great danger owing to the distrust, which culminated among the members of the "Nominated Parliament" (July–Dec. 1653), of university education generally, as tending to foster contentiousness with respect to religious belief. It was even proposed by William Dell—himself the master of Caius college—to abolish the two universities altogether, as hopelessly pledged to antiquated and obsolete methods, and to establish in their place schools for the higher instruction throughout the country They were saved, however, by the firmness of Cromwell, at that time chancellor of Oxford, and, although Aristotle and the scholastic philosophy no longer held their ground, a marked improvement was observable both in discipline and morality among the students At Oxford, under the influence and teaching of Dr. Wilkins, Seth Ward and John Wallis, a flourishing school of mathematics was formed.

THE REFORMATION AND LATER FOUNDATIONS

The Reformation represents the great boundary line in the history of European universities. Even in Catholic countries its effects found expression in connection with the Counter-Reformation The influence of the humanists, and the special character which the Reformation assumed in Germany in connection with the labours of scholars like Erasmus, John Reuchlin and Melanchthon, augured well for the future. German university teaching was free from the frivolity, pedantry, and scepticism which characterized so much of the corresponding culture in Italy. It gave promise of resulting at once in a critical and enlightened study of the masterpieces of classical antiquity, and in a reverent and yet rational interpretation of the Scriptures and the Fathers. The bigoted and ceaseless controversies evoked by the promulgation of Lutheran or Calvinistic doctrine dispelled, however, this prospect, and converted the universities into gloomy fortresses of sectarianism For a century after the Reformation the history of Lutheran theology became almost identified with that of the German universities.

Marburg.—The first Protestant university was that of Marburg, founded by Philip the Magnanimous, landgrave of Hesse, May 30, 1527, and was mainly built up out of the confiscation of the property of the religious orders in the Hessian capital. It rapidly became famous, and attracted students from remote countries After 1605, when, by the decree of Count Maurice, its formulary of faith was changed from Lutheran to Calvinistic, its numbers greatly declined. This dictation of the temporal

power now becomes one of the most notable features in academic history in Protestant Germany.

Königsberg.—The Lutheran University of Konigsberg was founded Aug. 17, 1544, by Albert III, margrave of Brandenburg, and the first duke of Prussia, and his wife Dorothea, a Danish princess. King Sigismund of Poland gave the charter (Sept. 29, 1561), and students who graduated as masters in the faculty of philosophy ranked as nobles of the Polish kingdom. When Prussia was raised to the rank of a kingdom (1701) the university was made a royal foundation, and the "collegium Fridericianum," which was then erected, received corresponding privileges Konigsberg will always be remembered as the university of Kant. In 1862 the university buildings were rebuilt, and the number of the students soon after rose to nearly a thousand

Jena.—The Lutheran University of Jena was opened on Feb. 2, 1558. Distinguished for its vehement assertion of Lutheran doctrine, its hostility to the teaching of Wittenberg was hardly less pronounced than that with which both centres regarded Roman Catholicism For a long time it was chiefly noted as a school of medicine, and in the 17th and 18th centuries was in bad repute for the lawlessness of its students, among whom duelling prevailed to a scandalous extent

Helmstedt.—The Lutheran University of Helmstedt, founded by Duke Julius (of the house of Brunswick-Wolfenbuttel) received its charter, May 8, 1575, from the emperor Maximilian II. It was munificently endowed by the founder and by his son; and its "Convictorium," or college for poor students, expended in the course of 30 years no less than 100 000 thalers, an extraordinary expenditure for an institution of such a character in those days Distinguished by its comparatively temperate maintenance of the Lutheran tenets, it attracted a considerable concourse of students, especially from the upper classes Until suppressed in 1809, Helmstedt enjoyed the special and powerful patronage of the dukes of Saxony

Altdorf.—The "Gymnasium Aegidianum" of Nuremberg, founded in 1526, and removed in 1575 to Altdorf, represents the origin of the University of Altdorf Altdorf was about the poorest university in Germany, and long one of the most eminent. Its whole endowment never rose above £800 a year.

Giessen.—The conversion of Marburg into a school of Calvinistic doctrine gave occasion to the foundation of the Universities of Giessen and of Rinteln Giessen, founded by the margrave of Hesse-Darmstadt, Louis V, as a kind of refuge for the Lutheran professors from Marburg, received its charter from the emperor Rudolph II. (May 19, 1607) In 1625 the university was transferred to Marburg; in 1650 it was moved back again to Giessen

Strasbourg.—The University of Strasbourg was founded in 1621 on the basis of an already existing academy which, under the direction of John Sturm attracted students from all parts of Europe, and especially from Portugal, Poland, Denmark, France and England The method of Sturm's teaching became the basis of that of the Jesuits, and, through them, of the public school instruction in England. In 1621 Ferdinand II conferred on this academy full privileges as a university. In 1681 Strasbourg became French. It was refounded by the emperor William I, and before the close of the century numbered over 1,100 students At the end of the 18th century it was distinguished by an intellectual activity with which the name of Goethe is connected, after its reversion to Germany. Since 1918 the university has again become French, and is now enjoying much prosperity.

Russian Universities.—At the beginning of last century Russia possessed but three universities—that of Moscow (1755), founded by the empress Elizabeth, of Vilna (1578), which was Polish; and of Dorpat (to-day Tartu) which was virtually German Alexander I. founded the University of Kharkov (1804) for New Russia, that of Kazan (1804) for the countries about the Volga, but designed also for the populations of Finland and Siberia, and that of St. Petersburg (1819) Each of the foregoing six universities had a definite district assigned to it, and, as a further incentive to the pursuit of academic studies, a *ukaz* promulgated in 1809 proclaimed that in all appointments to official posts throughout the empire the holders of a university degree would receive the first consideration. In 1832 the foundation of the St. Wladimir university of Kiev absorbed the university at Vilna. Odessa, founded in 1865, was designed to represent the university of New Russia. Although at St Petersburg considerable attention was regularly given to the teaching of languages, especially those of Armenia, Georgia, and Tartary, the general status of the Russian universities continued, throughout the greater part of last century, exceptionally low, and in 1884 they were all reconstituted by the promulgation of a "universal code"; with this the statutes of the universities at Dorpat (1632) and Warsaw (1886) were essentially in agreement. The study of the Slavonic languages received a considerable stimulus, especially when, by a decree in May 1887, the use of the Russian language was made obligatory in all places of instruction throughout the Baltic provinces

The University of Tomsk in western Siberia, founded in 1888, depended chiefly on a grant from the State, aided by private liberality After 1860 the general influence of Dorpat rapidly spread far beyond the Baltic provinces, while the number of students, which in 1879 was 1,106, rose to nearly 2,000 in 1882. In 1889 the Russification of the university went far to deprive the university of its claim to be considered German Since the World War it has naturally become an Estonian university, and is now known as Tartu

Helsingfors.—In 1826 the university at Åbo in Finland was removed to Helsingfors, and still preserves the charter whereby, in its original home, it had been constituted a university by Queen Christina and her chancellor, Oxenstierna, in the year 1640.

Prague.—At Prague, where a Czech university had been established on an independent basis, the German university began its separate career in the winter session of 1882–83 The German foundation retained certain revenues accruing from special endowments, but the State subvention was divided between the two It is still in existence, though the country is now Czechoslovakia

THE COUNTER-REFORMATION

Bamberg.—The earliest university whose charter represented the counter-Reformation was that of Bamberg, founded by the prince-bishop and opened Sept 1, 1648. At first, however, it comprised only the faculties of arts and of theology; to these was added, in 1729, that of jurisprudence, and in 1764 that of medicine. The university library contains a collection of manuscripts from some 30 suppressed monasteries, convents, and religious institutions at the time of the "secularization"

Innsbruck.—The University of Innsbruck was founded in 1672 by the emperor Leopold I. In the following century, under the patronage of the empress Maria Theresa, it made considerable progress, and received from her its ancient library and bookshelves in 1745. In 1782 the university was reduced by the emperor Joseph II. from the status of a university to that of a lyceum, although retaining in the theological faculty the right of conferring degrees In 1791 it was restored to its privileges by the emperor Leopold II

Breslau.—The University of Breslau was founded by the emperor Leopold I in 1702. When Frederick the Great conquered Silesia in 1741, he took both the university and the Jesuits in Breslau under his protection, and when, in 1774, the order was suppressed by Clement XIV he established them as priests in the Royal Scholastic institute, at the same time giving new statutes to the university In 1811 the university was considerably augmented by the incorporation of that at Frankfurt-on-the-Oder, and was ultimately reconstituted on lines similar to those of the newly-founded University of Berlin

Jesuit Influence in France.—In no country was the influence of the Jesuits on the universities more marked than in France. The civil wars in that country during the 30 years which preceded the close of the 16th century told with disastrous effects upon the condition of the University of Paris, and with the commencement of the 17th century its collegiate life seemed at an end, and its 40 colleges stood absolutely deserted. To this state of affairs the obstinate conservatism of the academic authorities not

a little contributed. The Jesuits did not fail to profit by this excessive conservatism on the part of the university, and during the second half of the 16th century and the whole of the 17th they had contrived to gain almost a complete monopoly of both the higher and the lower education of provincial France Their schools rose at Toulouse and Bordeaux, at Auch, Agen, Rhodez, Périgueux, Limoges, Le Puy, Aubenas, Béziers, Tournon, in the colleges of Flanders and Lorraine, Douai and Pont-à-Mousson—places beyond the jurisdiction of the parlement of Paris or even of the Crown of France. Their banishment from Paris itself had been by the decree of the parlement alone, and had never been confirmed by the Crown "Lyons," says Pattison, "loudly demanded a Jesuit college, and even the Huguenot Lesdiguières, almost king in Dauphiné, was prepared to erect one at Grenoble The university was rescued from the fate which seemed to threaten it only by the excellent statutes given by Richer in 1598, and by the discerning protection extended by Henry IV.

17TH AND 18TH CENTURY FOUNDATIONS

Halle and Pietism.—But 1693 saw the foundation of the University of Halle, which has been described as "the first real modern university." It originated in a *Ritterschule* for the sons of the nobility Leopold I. granted (Oct 19, 1693) the requisite charter The primary object in founding a university in Halle was to create a centre for the Lutheran party, but its character, under the influence of its two most notable teachers, Christian Thomasius and A. H Francke, soon expanded beyond the limits of this conception. Thomasius and Francke had both been driven from Leipzig on account of their liberal and progressive tendencies Thomasius was the first to set the example, soon after followed by all the universities of Germany, of lecturing in the vernacular instead of in the customary Latin Francke, as the founder of that Pietistic school, exercised great influence Christian Wolf, who followed Thomasius as an assertor of the new culture, was driven from Halle by the accusations of the Pietists In 1740, however, he was recalled by Frederick II, and reinstated Throughout the whole of the 18th century Halle was the leader of academic thought and advanced theology in Protestant Germany, although sharing that leadership, after the middle of the century, with Gottingen.

Göttingen.—The University of Gottingen (named after its founder, "Georgia Augusta"), was endowed with the amplest privileges as a university by George II of England, elector of Hanover, Dec 7, 1736 The university included all the faculties, and two of its first professors—Mosheim, the eminent theologian, from Helmstedt, and G. L. Bohmer, the no less distinguished jurist from Halle—together with Gesner, the man of letters, at once established its reputation Not least among its attractions was also its splendid library, located in an ancient monastery, and now containing over 200,000 vol and 5 000 mss The Gottingen school of history became famous. The labours of the professors at Gottingen especially Putter, Gatterer, Schlözer and Spittler, combined with those of Mascov at Leipzig, did much towards promoting both a more catholic treatment and a wider scope The method of appointment of professors was reformed by the chief curator, Munchhausen, on lines similar to those already instituted in the universities of the Netherlands by Douza (*q v*).

Erlangen.—The University of Erlangen, a Lutheran centre, was founded by Frederick, margrave of Bayreuth. Its charter was granted by the emperor Charles VII in 1743. In 1791, Ansbach and Bayreuth having passed into the possession of Prussia, Erlangen also became subject to the Prussian Government.

THE 19TH CENTURY

Extinction of German Universities During 1798–1815.—The political storms which marked the close of the 18th and the beginning of the 19th century gave the death-blow to not a few of the ancient universities of Germany. Mainz and Cologne ceased to exist in 1798; Bamberg, Dillingen and Duisburg in 1804; Rinteln and Helmstedt in 1809; Salzburg in 1810; Erfurt in 1816. Altdorf was united to Erlangen in 1807, Frankfurt-on-the-Oder to Breslau in 1809, and Wittenberg to Halle in 1815. The University of Ingolstadt was first moved in 1802 to Landshut, and from thence, in 1826, to Munich, where it was united to the academy of sciences which was founded in the Bavarian capital in 1759. Münster, in Prussia, which was constituted a university by Maximilian Frederick (elector and archbishop) in 1771, was abolished in the year 1818, but two faculties, those of theology and philosophy, continued to exist, and in 1843 it received the full privileges of a Prussian university, together with the designation of a royal foundation. Of those of the above centres which altogether ceased to exist, but few were much missed or regretted—that at Mainz, which had numbered some 600 students, being the one notable exception The others had, for the most part, fallen into a perfunctory and lifeless mode of teaching, and, with wasted or diminished revenues and declining numbers, had long ceased worthily to represent the functions of a university Whatever loss may have attended their suppression was more than compensated by the activity and influence of the three great German universities which rose in the last century.

Munich, after having been completely reorganized, soon became a distinguished centre of study in all the faculties; and its numbers, allowing for the two great wars of 1866 and 1870, continuously increased. The eminence of its professoriate, among whom have been Dollinger, Liebig, Schelling, Zeuss and Giesebrecht, attracted students from all parts of Europe.

Berlin.—The University of Berlin, known as the *Royal* Friedrich Wilhelm university, was founded in 1809, when Prussia had been reduced to the level of a third-rate Power. Under Wilhelm von Humboldt, supported by Frederick William III, the principles adopted in connection with the new seat of learning not only raised it to a foremost place among the universities of Europe, but also largely conduced to the regeneration of Germany It not only incorporated the famous "Academy of Sciences," but expressly repudiated all attachment to any particular creed or school of thought It is the largest of the German universities, numbering in 1927 10,426 regular students Berlin with its system of schools for special subjects offers great opportunities to specialist students

Bonn.—The University of Bonn, founded in 1818 and also by Friedrich Wilhelm III, thus became known as the *Rhenish* Friedrich Wilhelm university. The king summoned to his aid the best available talent, including Niebuhr, A W von Schlegel, with C. F Nasse in medicine and G Hermes in theology. In the last-named faculty it combined the opposed schools of theological doctrine of the Evangelical (or Lutheran) and of the Roman Catholic Church

In 1878, a comparison of the numbers of the students in the different faculties in the Prussian universities with those for the year 1867, showed a remarkable diminution in the faculty of theology, amounting in Lutheran centres to more than one-half, and in Catholic centres to nearly three-fourths. In jurisprudence there was an increase of nearly two-fifths, in medicine a decline of a third, and in philosophy an increase of one-fourth

HOLLAND AND BELGIUM

Leyden.—The earliest, that of Leyden, founded in 1575, commemorated the successful resistance of the citizens to the Spanish forces under Requesens. Throughout the 17th century Leyden was distinguished by its learning, the ability of its professors, and the shelter it afforded to the more liberal thought associated at that period with Arminianism. Much of its early success was owing to the wise provisions and the influence of the celebrated Janus Douza Douza, in fact, did for Leyden and the Dutch, what Münchhausen afterwards did for Gottingen and the German universities. The appointment of the professors at Leyden was vested in three (afterwards five) curators, one of whom was selected from the body of the nobles, while the other two were appointed by the States of the province—the office being held for nine years, and eventually for life. With these was associated the mayor of Leyden for the time being. Leyden secured and has maintained a very high reputation for scientific work. Other Dutch universities with a famous history are Franeker (founded 1585), Harderwyk (founded 1600), Groningen (founded 1614),

and Utrecht (founded 1634), the latter being a great resort in the 18th century for English students. Amsterdam is a 19th century foundation dating from 1882.

Ghent and Liége.—The Universities of Franeker and Harderwijk were suppressed, and those of Ghent and Liége created in 1815, while a uniform constitution was given to Dutch and Belgian universities. It was provided that there should be attached to each a board of curators, consisting of five persons, "distinguished by their love of literature and science and by their rank in society," to be nominated by the king When, however, Belgium was created as a separate kingdom, further changes took place in the latter country. At Louvain, the chief Catholic centre, the faculties of law, medicine and philosophy had already, in 1788, been removed to Brussels.

Brussels.—In 1834 Brussels was constituted a free and independent university with a new fourth faculty of natural science, and supported mainly by contributions from the Liberal party Having, however, no charter, it continued incapable by law of possessing property Louvain and Brussels thus came to represent the two chief political parties in the realm, while the Universities of Ghent on the Scheldt and Liége on the Meuse recruited their students mainly from the two chief races—the Flemish and the Walloon For the struggles which arose over the Flemicisation of the University of Ghent in the present century *see* BELGIUM. In Holland, on the other hand, where no such marked racial differences exist, the Universities of Groningen, Leyden and Utrecht have been assimilated (1876) in constitution, each being administered by a consistory of five rectors with a senate composed of the professors in the respective faculties.

UNIVERSITIES OF SWEDEN AND NORWAY

The Royal university of Uppsala, whose foundation as a *studium generale* was sanctioned by Pope Sixtus IV in 1477, was roused to new life in the 17th century by the introduction of the Cartesian philosophy. In the 18th century lectures began to be delivered in Swedish; while the mediaeval division of the students into "nations" continued, as at Lund, until the second quarter of the 19th Gothenburg, on the other hand, with its society of science and literature, dating from 1841, has represented rather a popular institution, existing independently of the State, maintained chiefly by private contributions, and governed by a board called the *Curatorium*. For a long time it was not empowered to hold examinations Stockholm (1878) still remains a gymnasium, but its curriculum is, to a certain extent, supplemented by its connection with Uppsala, from which it is little more than 40 m distant by rail The University of Christiania (now Oslo), in Norway, founded in 1811, and the Swedish universities are strongly Lutheran in character; and all alike are closely associated with the ecclesiastical institutions of the Scandinavian kingdoms. The same observation applies to Copenhagen—where the labours of Rask and Madvig raised the reputation of the university for learning.

The royal university of Kiel was founded in 1665 by Duke Christian Albrecht of Holstein (who himself assumed the office of rector), with faculties of theology, law, medicine and philosophy. After the incorporation of Schleswig-Holstein with the kingdom of Prussia it made a marked advance. In the latter half of the last century it became famous as a school of chemistry, physiology and anatomy, while its library, in 1904, exceeded 250,000 volumes.

FRANCE IN THE 18TH AND 19TH CENTURIES

University of Paris from the 17th Century.—The University of Paris, indeed, was distracted, throughout the 17th century, by theological dissensions—in the first instance owing to the struggle that ensued after the Jesuits had effected a footing at the Collège de Clermont, and subsequently by the strife occasioned by the teaching of the Jansenists. Towards the close of the century a certain revival took place, and a succession of illustrious names—Pourchot, Rollin, Grenan, Coffin, Demontempuys, Crevier, Lebeau—appear on the roll of its teachers. But this improvement was soon interrupted by the controversies excited by the promulgation of the bull Unigenitus in 1713, condemning the tenets of Quesnel At last, in 1762, the parlement of Paris issued a decree (Aug 6) placing the colleges of the Jesuits at the disposal of the university, and this was immediately followed by another for the expulsion of the order from Paris, the university being installed in possession of their vacated premises. Concurrently with this measure, both history and natural science began to be cultivated with a certain success Then came the French Revolution. On Sept 15, 1793, the universities and colleges throughout France, together with the faculties of theology, medicine, jurisprudence and arts, were abolished by a decree of the convention, and the whole system of national education may be said to have remained in abeyance, until, in 1808, Napoleon I. promulgated the scheme of which many of its features still exist. The whole system of education, henceforth called the University of France, and including both secondary and primary, was made subject to the control and direction of the State All France was divided into 17 districts, designated "academies," each administered by its own rector and council, but subject to the supreme authority of the minister of public instruction, and representing certain faculties which varied at different centres, in conformity with the new scheme of distribution for the entire country

Lille, Lyons and Rennes.—While three new "academies"—those of Lille, Lyons and Rennes—date their commencement from 1808, many of the pre-existing centres were completely suppressed In some cases, however, the effacement of an ancient institution was avoided by investing it with new importance, as at Grenoble; in others, the vacated premises were appropriated to new uses connected with the department, as at Avignon, Cahors and Perpignan

Institution of "Free Faculties."—In 1895 the Government was prevailed upon to sanction the institution of certain "free faculties," as they were termed, to be placed under the direction of the bishop, and depending for support upon voluntary contributions, and each including a faculty of theology, the best known being those of Paris and Lille The faculty at Marseille, already mentioned, was now called upon to unite with the Académie of Aix, its faculties being restricted to mathematics and natural science (including a medical school), while faculties of law and philosophy were fixed at Aix, which possesses also the university library properly so termed In the capital itself, the University of Paris and the École Pratique des Hautes Études carried on the work of higher instruction independently of each other—the former with faculties of Protestant theology, law, medicine, science, letters and chemistry, distributed over the Quartier Latin; the latter with schools of mathematics, natural science, history, philology, and history of religions centred at the Sorbonne

In 1896, the higher education of France was decentralized and the existing academies, consisting of isolated faculties, were converted into regional universities, while the Sorbonne, from being the University of France became the University of Paris The total number of universities, including that of Alger, was 16 (since increased to 17 by the recovery of Strasbourg)

Collège de France.—The Collège de France, founded in the 16th century by Francis I, was from the first regarded with hostility by the Sorbonne As a school of gratuitous instruction in Latin, Greek and Hebrew, it not only held its ground, but at the Revolution ultimately survived the universities As reconstituted in 1831 it became chiefly known as an institution for the instruction of adults, and its staff of professors has comprised from time to time the names of not a few of the most distinguished scholars and men of science in the country

Switzerland.—In Switzerland the universities shared in the conflicts handed down from the days when the Helvetic republic had been first created In 1832, Basle having joined the League of the Catholic Cantons, the Confederates divided the canton into two, and agreed to raise the flourishing Hochschule, which already existed at Zurich, to the rank of a university—a measure which may be said to mark a turning-point and a new epoch in the history of the higher education of the republic The gymnasium of Berne, originally established under the teaching of Ulrich Zwingli, developed, in 1834, into a university with all the faculties. As early as 1586 Lausanne had been a noted school for the

education of Protestant ministers, but it was not until 1806 that chairs of philosophy and law were established, to which those of natural science and literature were added in 1836, and, somewhat later, that of medicine. It was not, however, until 1891 that Lausanne was formally constituted a university. At Geneva, the famous academy of the 16th and 17th centuries, long distinguished as a centre of Calvinistic teaching, became merged, in 1876, in a university, where the instruction (given mainly in the French language) was carried on by a staff of 41 professors With this was also incorporated an earlier school of science, in which De Saussure and De Candolle had once been teachers. Fribourg, founded in 1889, began with only two faculties—those of law and philosophy, to which one of theology was added in the following year.

Spain.—In Spain, by the act of 1857, the system was placed under the control of the minister of education, while the kingdom was divided into ten university districts—Madrid, Barcelona, Granada, Oviedo, Salamanca, Santiago, Seville, Valencia, Valladolid and Saragossa—the rector of the universities in each district representing the chief authority. The degrees to be conferred at each were those of bachelor, licentiate and doctor Each university received a rector of its own, selected by the Government from among the professors, and a precise plan of instruction was prescribed in which every hour had its appointed lecturer and subject Philosophy, natural science, law and medicine were to be studied at all these universities, and at the majority a school of chemistry was subsequently instituted But at Salamanca, Valladolid, Seville and Saragossa no school of chemistry was instituted, and at the first three that of medicine ultimately died out No provision was made for instruction in theology, this being relegated to the seminaries in the episcopal cities The University of Manila, in the Philippines, was opened in 1601 as a school for the nobility, and ten years later the famous College of St. Thomas was founded by the Dominican order; but it was not until 1857 that the university, properly speaking, was founded by royal Spanish decree

Austria-Hungary and Vienna.—In pre-war Austria the universities were largely modelled on the same system as those of the German empire. Vienna has long been chiefly distinguished for its school of medicine, which enjoyed, in the last century, a reputation almost unrivalled in Europe The University of Graz, the capital of Styria, was founded in 1586, and has long been one of the most flourishing centres, with nearly 2,000 students, chiefly in law and philosophy The University of Salzburg, founded in 1623, was suppressed in 1810; that of Lemberg (Lwow), founded in 1784 by the emperor Joseph II, was removed, in 1805, to Cracow, and united to that university. In 1816 it was opened on an independent basis In the bombardment of the town in 1848 the university buildings were burnt down, and the site was changed to what was formerly a Jesuit convent. Lwow is now Polish

Budapest, Klausenburg (Cluj) and Agram.—The universities of the Hungarian kingdom before the World War were three in number.—Budapest, originally founded by Tyrnau in 1635, under the auspices of the Jesuits, now possessing four faculties—theology, jurisprudence, medicine and philosophy; Kolozsvar (Klausenburg), once the chief Magyar centre, founded in 1872 and comprising four faculties, but where mathematics and natural science supply the place of theology. It is now known as Cluj, and is in Rumania. Zágráb (Agram), the Slovak university, now in Yugoslavia, originally founded by Maria Theresa in 1776 and reopened in 1874 with three faculties, viz., jurisprudence, theology and philosophy. The chief centre of Protestant education is the college at Debreczen, founded in 1531, which, in past times, was not infrequently subsidized from England. In 1914 it was raised to the dignity of a university.

Japan.—In Japan there are two imperial universities—Tokyo (1868) and Kyoto (1897)—the former representing the union of two pre-existing foundations, on which occasion it was placed under the control of the minister of instruction with yearly grants from the Treasury Kyoto was formed out of four previously existing colleges of law, medicine, science and engineering. The number of universities in the country has since been considerably augmented.

Athens.—The "National University" of Athens (founded May 22, 1837) was modelled on the university systems of northern Germany. It originally included only four faculties, viz., theology, jurisprudence, medicine and philosophy, to which one of applied mathematics was subsequently added

Rumania, Bulgaria and Turkey.—The University of Jassy (1860) in Rumania, was founded by its ruler, Prince Cuza, and together with the newly-founded University of Bucharest, received its completed organization in 1864. Both were constituted State institutions and were represented in the senate, although not receiving any fixed revenues from the Government. Its students are instructed and examined gratuitously The University of Czernowitz (Cernăuti), founded in 1875, is now Rumanian. In the University of Sofia (1888) in Bulgaria, faculties were established, in the course of the ensuing four years, of history, philology, physics, mathematics and jurisprudence, the main object in view being the training of competent teachers of schools and of lawyers, and affording them the means of gaining an intelligent insight into the real wants of the native population. The University of Constantinople (or Stambul) was founded, in 1900, at the jubilee festival in honour of the sultan's succession to the throne. It includes five faculties, with a school of dentistry

South America.—The beginnings of the University of Montevideo go back to 1840. Its importance, however, dates from the foundation of a medical school in 1876. Faculties in law and mathematics were subsequently added, and, still later, one in architecture The National university of La Plata was opened (1905–08) in the city of that name, under the auspices of the University of Philadelphia—university extension being a feature It possesses to-day eight faculties—law, mathematics, medicine, natural science, veterinary science, agriculture and art It contained, in 1825, nearly 2,000 students The Central university of Venezuela goes back to the old Spanish days, having been founded in 1725 For a long time it was little more than a branch of the royal Spanish academy for education in the Spanish language It now consists of four schools in mathematics and science, law, medicine and pharmacy. The largest university in Argentine is the National university at Buenos Aires, founded in 1920. It has six faculties and a large array of professors and over 8,000 students Rio Janeiro university was founded in 1920 out of two existing faculties in medicine and law Lima university has a long and interesting history In 1553 it was a Dominican seminary In 1574 it was separated from the Order and became an independent establishment for students in philosophy and theology. In 1633 medicine was added. To-day it has over 1,000 students. Santiago, in Chile, which dates back to 1743, has five faculties. The Central university of Ecuador, founded towards the end of the 18th century, was reorganized in 1895. It possessed 303 students in 1925. Other South American universities are Cordoba (Argentine) which goes back to 1613, with three faculties, La Paz and Sucre (Bolivia) each with three faculties, Asunción (Paraguay) with two. The Nazional Universidad de Litoral (at Santa Fé, Argentine) founded in 1920, has faculties in law, chemistry and agriculture This list is not exhaustive and it is difficult in some cases to assess the standard of work in some of the universities given above.

Central America and West Indies.—Havana university was created in 1728, but its present activities date from 1900, when it was refounded There are three faculties in letters and science, medicine and pharmacy, and law.

GREAT BRITAIN AND IRELAND. MODERN TIMES

The Cambridge Platonist Movement.—After the Reformation Cambridge had become the centre of a remarkable movement (a reflex of the influence of the Cartesian philosophy), which attracted for a time considerable attention. Its leaders, known as the Cambridge Platonists, among whom Henry More and Cudworth were especially conspicuous, were men of high character and great learning, although too much under the influence of an ill-restrained enthusiasm and purely speculative doctrines. The

spread of the Baconian philosophy, and the example of a succession of eminent scientific thinkers, among whom were Isaac Barrow, master of Trinity (1673–77), the two Lucasian professors, Isaac Newton (prof. 1669–1702) and his successor William Whiston (prof. 1702–11), and Roger Cotes (Plumian prof. 1707–16), began to render the exact sciences more and more an object of study, and the institution of the tripos examinations in the course of the first half of the 18th century established the reputation of Cambridge as a school of mathematical science. At Oxford, where the study had, in turn, declined, and where the statutable requirements with respect to lectures and exercises were suffered to fall into neglect, academic culture declined. But in the 19th century the range of studies was extended both at Oxford and Cambridge; written examinations took the place of the often merely formal *viva voce* ceremonies; at Cambridge the study of the classics was raised, in 1824, to the dignity of a new tripos. The number of the students at both universities increased, the matriculations at each rising to over 400. The recommendations of the Royal Commission of 1830 were not all carried into effect, but the professoriate was considerably increased, reorganized and re-endowed, by means of contributions from colleges. The colleges were emancipated from their mediaeval statutes, were invested with new constitutions, and acquired new legislative powers The fellowships were almost universally thrown open to merit The great mass of vexatious and obsolete oaths were swept away; and, though candidates for the M.A degree and persons elected to fellowships were subjected to a religious test, it was abolished for matriculation and the B A.

In 1869 non-collegiate students were admitted at Cambridge The entire abolition of tests followed After being rejected on several occasions in parliament, it was eventually carried as a Government measure, and passed the House of Lords in 1871

Reforms of 1877.—In 1877 the reports of two new commissions were followed by the diversion of a certain proportion of the revenues of the colleges to the uses of the university, especially with a view to the encouragement of studies in natural science; the enforcement of general and uniform regulations with respect to the salaries, selection and duties of professors, lecturers and examiners; the abolition (with a few exceptions) of all clerical restrictions on headships or fellowships; and the limitation of fellowships to a uniform amount.

A remarkable increase in numbers followed at both universities, especially at Cambridge, where the number of undergraduates, which in 1862 was 1,526, rose in 1887 to 2,979 In the academic year 1862–63 the number of matriculations was 448, and in 1906–07, 1,083. The 22 universities and colleges have since been affiliated to the university, including many institutions throughout the empire. The general effect of the reforms inaugurated in 1877 has been the conversion of the college teaching staff into a permanent profession, and the growth of a resident and working university professoriate. At the same time there has been a gradual growth of "inter-collegiate lectures." At Oxford nearly all honour lectures given by college tutors and lecturers were thrown open to all members of the university: the college tutor was recognized by the university as a teacher in the faculty to which he belonged while boards of faculties were instituted. At Cambridge the system of inter-collegiate lectures has been developed. At both the old English universities the great widening of the courses of study open to senior students (honours men), which began about the middle of the 19th century, has been continued For more recent developments *see* Cambridge University and Oxford University

Durham.—For the University of Durham founded in 1657 by Cromwell *see* Durham In 1871 the corporation of the university, in conjunction with some of the leading landed proprietors in the adjacent counties, founded a college of physical science at Newcastle-upon-Tyne, subsequently designated Armstrong college, and designed to teach scientific principles in their application to engineering, mining, manufactures and agriculture. Students who had passed the required examinations were made admissible as associates in physical science of the university. There is also at Newcastle the College of Medicine.

University of London.—The University of London had its origin in a movement initiated in the year 1825 by Thomas Campbell, the poet, in conjunction with Henry (afterwards Lord) Brougham, Joseph Hume and influential Dissenters. The first council, appointed Dec 1825, comprised names representative of nearly all the religious denominations, including (besides those above mentioned) Zachary Macaulay, George Grote, James Mill, William Tooke, Lord Lansdowne, Lord John Russell and the duke of Norfolk. On Feb. 11, 1826, the deed of settlement was drawn up; and in the course of the year 7 ac., constituting the site of University college, were purchased, the foundation stone of the new buildings being laid by the duke of Sussex on April 30, 1827 In Oct. 1828 the college was opened as the University of London. King's college (incorporated Aug 14, 1829), opened Oct. 8, 1831, was designed to combine with the original plan instruction in "the doctrines and duties of Christianity, as the same are inculcated by the United Church of England and Ireland" In 1836 it was decided to dissociate the University of London from University college as a "teaching body," and to limit its actions simply to the institution of examinations and the conferring of degrees—the college itself receiving a new charter, and being thenceforth designated as University college, London, while the rival institution was also incorporated with the university, and was thenceforth known as King's college, London The charters of the University of London and of University college, London, were signed on the same day, Nov 28, 1836 In 1869 both the colleges gave their adhesion to the movement for the higher education of women which had been initiated elsewhere, and in 1880 women were, for the first time, admitted to degrees

By the University of London Act, 1898, and the statutes of the commissioners named therein (issued in 1900), the University of London was reconstituted For its rapid development since this reorganization *see* the section under London.

The University of Manchester.—The Owens college, Manchester—so called after its original founder—was founded on March 12, 1851 This formed the nucleus of the university, which received its charter on April 20, 1880, as the "Victoria University of Manchester" Since then, Liverpool (*q.v*) (1881) and Leeds (*q v*) (1904), the Mason University college at Birmingham (1900) and the University college at Sheffield (1905) have attained university rank.

Scottish Universities.—In 1747 an act of parliament was obtained for the union of the two colleges of St. Salvator and St. Mary In 1880 the university college at Dundee was instituted as a general school both of arts and sciences in similar connection. Glasgow, in the year 1577, received a new charter, and its history from that date down to the Restoration was one of almost continuous progress The re-establishment of episcopacy, however, involved the alienation of a considerable portion of its revenues, and the consequent suspension of several of its chairs. With the Revolution of 1689 it took a new departure, and several additional chairs were created The act of 1858 made great changes in all the four universities In Aberdeen, King's college and Marischal college, with their independent powers of conferring degrees, were amalgamated In Glasgow, the distribution of the "nations" was modified in order more nearly to equalize their respective numbers

A complete transformation of both the organization and the curriculum of each university was effected by the commission of 1889. The government was transferred from the senatus to the courts, which were further to include representatives from the senatus, the general councils of graduates, and the municipality within which the university is situated. The principal, the lord rector, his assessor, the chancellor's assessor, and the lord provosts of the cities of Aberdeen, Edinburgh and Glasgow, and the provost of St Andrews also have seats in the courts of their respective universities The provost of Dundee occupies a seat in the university court of St. Andrews To the court is entrusted the management of the property and finances, and, in most cases, such patronage as does not belong to the Crown; but, in the case of Edinburgh, the patronage of some of the older chairs is in the hands of a body of curators. Disciplinary powers are retained by the senatus, and the general council remains, as under the act of

1858, a purely advisory body. Another advisory body—the students' representative council—was added by the commission. The curriculum of all the faculties (except divinity) was reorganized; the most important alterations consisted in the abolition of the once sacred six as compulsory subjects in arts (Latin, Greek, mathematics, natural philosophy, logic and moral philosophy). The curriculum was greatly widened, an elaborate scheme of "options" introduced, and a new system of honours degrees was established. The length of residence required was reduced from four years to three, and the courts were empowered to institute summer sessions, and to admit women to lectures and degrees in all faculties.

There has been, since the act of 1858, a great development of university life in Scotland All the four universities of Scotland were aided from time to time in the last century by grants from Government, and in 1905 received a material addition to their resources by the donation of £2,000,000 from Mr. Carnegie.

Trinity College, Dublin.—Trinity college. Dublin, was founded in 1591 A royal charter nominated a provost and a minimum number of three fellows and three scholars as a body corporate. The first five provosts of Trinity college were all Cambridge men, and under the influence of Archbishop Loftus, the first provost, and his successors, the foundation received a strongly Puritan bias, but the policy of Laud and Wentworth was to make the college more distinctly Anglican as regards its tone and belief At the Restoration its condition was found to be that of a well-ordered home of learning and piety, with its estates well secured and its privileges unimpaired Under Bishop Jeremy Taylor, who succeeded to the vice-chancellorship, its progress in learning was considerable, and the statutes underwent a further modification Prior to the year 1873 the provostship, fellowships and foundation scholarships could be held only by members of the Church of Ireland; but all such restrictions were abolished by Act 36 Vict c 21 Other university institutions established in Ireland were the Queen's university (founded 1830), reconstituted in 1880 as the Royal University, and the Queen's colleges at Belfast, Cork and Galway founded in Dec 1845 A scheme for the reorganisation of university education in Ireland put forward by James Bryce in 1907 failed of acceptance Eventually Augustine Birrell carried a measure by which Trinity college was left intact, while two new universities were created, one in Dublin (to-day the National University of Ireland), and one in Belfast, the former involving the erection of another college (towards the expense of which the Government was pledged to contribute) and the incorporation of the Queen's colleges at Cork and Galway, while the college in Belfast was to form the nucleus of the second university The new university in Dublin had a nominated senate of 35 members, of whom the great majority were Roman Catholics; that of Belfast had a similar body, of whom all but one were Protestants In all these new centres there were no religious tests either for professors or students.

Welsh Universities.—The University of Wales, which received the royal charter in 1893, is composed of the university colleges of Aberystwyth, Bangor, Cardiff, and Swansea (added in 1920). St David's college at Lampeter was founded in 1822 for the purpose of educating clergymen in the principles of the established Church of England and Wales, mainly for the supply of the Welsh dioceses, but, although affiliated to both Oxford and Cambridge, retained its independence and also the right of conferring the degrees of bachelor of arts and of divinity. Bangor, in North Wales, on the other hand, which received its charter in 1885, is designed to "provide instruction in all the branches of a liberal education except theology." (J B. Mu ; C. Br)

THE UNITED STATES

History.—The first white settlers who came to North America were typical representatives of those European peoples who had made more progress in civilization than any other in the world. Those settlers, in particular those from England and from Holland, brought with them the most advanced ideas of the time on the subject of education. The conditions of life in the New World emphasized the need of schools and colleges, and among the earliest public acts of the settlers were provisions to establish them. The General Court of Massachusetts in 1636 made the first appropriation for what was to become Harvard college, taking its name in honour of the minister, John Harvard, who died in 1638, leaving his library and one-half of his property, having a value of £800, to the new institution

Through religious zeal or philanthropy colleges were founded as far south as Virginia, and no fewer than ten of these institutions were in operation in 1776 Their present names and the dates of their foundation are: Harvard university (1636); College of William and Mary (1693); Yale university (1701); Princeton university (1746); Washington and Lee university (1749); University of Pennsylvania (1751); Columbia university (1754); Brown university (1764); Rutgers college (1766); and Dartmouth college (1770).

These colonial colleges, though in some cases in receipt of money grants from Governments, had owed their origin to private initiative and were privately controlled. The 19th century was to see the growth of a different group, the State tax-supported universities, destined to become one of the important and characteristic American types. While some of these institutions had their beginning in the 18th century (North Carolina, established 1789, opened 1795), the most notable early example of this type was the University of Virginia which, through the influence of Thomas Jefferson, was established by legislative act in 1819 though not opened until 1825 By 1894 all States south and west of Pennsylvania had established such universities, and in 1917 Rutgers university was designated as the State University of New Jersey The only States not having State tax-supported universities are Massachusetts, Rhode Island, Connecticut, Pennsylvania and New York The distinguishing characteristics of the typical State tax-supported university are: (1) creation and direct support by the State government, (2) absence of any denominational control, (3) the State's share in the selection of trustees, (4) free, or nominal, tuition to students living within the State

Another group of colleges which developed during the 19th century was the Land Grant colleges (*q v*) which owed their existence to the Morrill Act, passed by Congress in 1862 This act gave to the States a large amount of public land, 30,000 ac. for each member of congress from the State, for the establishment of colleges of agriculture and mechanic arts Such colleges were to be started by 1874 but the exact method of their creation was left to the States which met the problem in different ways. In 18 States, the appropriation was added to the endowment of the State universities, in three, Massachusetts, New Jersey and New York, it was turned over to endowed institutions, the Massachusetts Institute of Technology, Rutgers college and Cornell university. The remaining States established new institutions

Meanwhile colleges for women (*see* WOMEN'S COLLEGES) had been growing up since the middle of the second quarter of the century Though women were not entirely excluded from existing colleges—Oberlin was co-educational from its establishment in 1833—the opportunities open to them were so limited that their demand for college training could be met only by the formation of new institutions. The foundation of Mount Holyoke seminary in 1837 was followed by that of Elmira college in 1853. Vassar (incorporated 1861, opened 1865) dates from the Civil War, and after it came Wells (1868), Wellesley (1871, 1875), Smith (1871, 1875), Hunter (1871), Bryn Mawr (1881, 1885), etc, all established as independent colleges. Barnard college (1889, incorporated in the Educational System of Columbia university in 1900) and Radcliffe (1879, affiliated with Harvard in 1892) are examples of a different type, the college for women established in a university parallel to a college for men. Michigan, Illinois, Missouri and California began to admit women in 1870, and now no State-tax-supported university is entirely closed to women, though Virginia admits them to graduate and professional courses only. Of the endowed universities, Cornell admitted women by 1872 and Stanford and Chicago have been co-educational from their beginning. In 1926 the number of women studying in American colleges and universities was 313,163, *i.e.,* 38% of the total number of students. This number included 247,793 undergraduates, 12,341 graduate students, and 5,822 in professional

schools of law, medicine, education, etc.

The last quarter of the 19th century saw the growth of another type of university—that endowed by individual munificence. Cornell university was founded with an original gift from Ezra Cornell of $500,000, later increased through other gifts and profits on the sale of land scrip which Mr. Cornell bought for the university, to $5,381,925. As Cornell receives State aid for three of its colleges and is also a Land Grant college, it is not a typical example of the endowed institution. Johns Hopkins university, opened 1876, was founded by Johns Hopkins, a merchant of Baltimore, who bequeathed $700,000 for the establishment of a university and a hospital Leland Stanford Jr. university was founded by Senator Stanford, of California, with a gift (1885) of 90,000 ac of land in California; this initial gift was later increased by his bequest and by deeds from Mrs Stanford, to a total endowment of more than $25,000,000. An outstanding example is the University of Chicago (incorporated 1890) to which John D. Rockefeller, from 1889 to 1910, has given a total of $34,708,375 A more recent instance of large endowment is Duke university, for which in 1924, Mr. J B Duke made a large gift.

Organization and Work.—The American college, although it is the outgrowth of the English colleges of Oxford and of Cambridge, has developed into an institution which has no counterpart in Europe The college course of study, at first three years in length, was soon extended to four years, and the classes are uniformly known as the freshman, the sophomore, the junior and the senior. The traditional degree which crowns the college course is that of Bachelor of Arts (A B) The studies ordinarily insisted on in the case of candidates for this degree are Latin, Greek, mathematics, English, philosophy, political economy, history, at least one modern European language (French or German), and at least one natural science The degrees of Bachelor of Science (B S), Bachelor of Philosophy (Ph B), and Bachelor of Letters (B L) are conferred by some colleges upon students who have pursued systematic courses of study which do not include Greek or the Latin required for the degree of Bachelor of Arts.

Each college, however small or ill-equipped, exercises a helpful local influence Seventy-five per cent of all college students attend an institution within their own States Few colleges have a national constituency, and even in these cases an overwhelming preponderance of the students come from the immediate neighbourhood This explains, in a measure, the powerful influence which the college has exercised in the life of the nation. While hardly more than one in a hundred of the white male youth of the country has had a college education, yet the college graduates have furnished more than one-half of all the presidents of the United States, most of the justices of the Supreme Court, about one-half of the cabinet officers and United States senators, and nearly one-third of the House of Representatives. Before the Revolution 11 colleges were founded From 1776 to 1800, 12 more were added; from 1800 to 1830, 33, from 1830 to 1865, 180; from 1865 to 1899, 250; from 1900 to 1925, 75. Their standards, efficiency and equipment are very diverse, many of the so-called colleges being less effective than some of the better organized secondary schools

Putting aside tentative attempts to develop genuine university instruction much earlier, it may safely be said that the opening of the Johns Hopkins university at Baltimore in 1876 began the movement to organize carefully advanced study and research, requiring a college education of those who wish to enter upon it. This is university instruction properly so called, and though found elsewhere it is given chiefly at 26 institutions: University of California, Catholic University of America, University of Chicago, Clark university, Columbia university, Cornell university, Harvard university, University of Illinois, Indiana university, State University of Iowa, Johns Hopkins university, University of Kansas, University of Michigan, University of Minnesota, University of Missouri, University of Nebraska, University of North Carolina, Northwestern university, Ohio State university, University of Pennsylvania, Princeton university, Leland Stanford Jr. university, University of Virginia, Washington university, University of Wisconsin and Yale university. All these institutions, except the Catholic University of America, also maintain colleges.

The combination of collegiate and university instruction under one corporation and one executive administration is distinctive of higher education in the United States, and its chief source of strength. The crowning honour of the university student is the degree of Ph D , although that of A M.—obtainable in less time and much easier conditions—is also sought The minimum period of study accepted for the degree of Ph D is two years after obtaining the bachelor's degree; but in practice, three, and even four, years of study are found necessary. In addition to carrying on an investigation in the field of his main subject of study, the candidate for the degree of Ph D. is usually required to pass examinations on one or two subordinate subjects, to possess a reading knowledge of French and German (often of Latin as well), and to submit—usually in printed form—the dissertation which embodies the results of his researches The methods of instruction in the universities are the lecture, discussion and work in laboratory or seminar—the latter transplanted from the German universities. The degree of Master of Arts is conferred upon students who, after one year of university residence and study, pass certain prescribed examinations. This degree, like those of D D., S T D , and LL.D., is often conferred by colleges and universities as a purely honorary distinction. The degree of Ph D. is not so conferred any longer by the best universities.

Not a few of the universities maintain schools of law and medicine. Harvard and Yale universities maintain schools of theology as well The learned publications issued by the universities, or under the direction of university professors, are of great importance, and constitute an imposing body of scientific literature. The National and State Governments make increasing use of university officials for public service requiring special training or expert knowledge. In 1871–72 there were only 198 resident graduate (or university) students in the United States. In 1897 this number had risen to 4,392 and in 1926 to 32,500

ENTRANCE TO ADMINISTRATION BUILDING OF THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL, N C.

Throughout the country, but especially in the West and Middle West, Junior colleges are becoming numerous Some of these institutions are derived from small colleges without support from taxation, some of these colleges, finding themselves financially unable to continue satisfactorily the full four-year course, limit themselves to two years; others more significantly form the upward extension of the vigorous public high schools. Of the 200 Junior colleges in the United States in 1922, 125 were reorganized small colleges. This type not only brings the opportunity for higher education within the reach of many who could not leave the immediate vicinity of their homes, but also reacts favourably on the pupils and teachers of the secondary schools The college remains the most characteristic feature of education in the United States In 1926 there were enrolled 595,458 collegiate students as compared with 174,213 in 1910.

Professional Education.—Schools for professional training have grown rapidly Whereas early in the 19th century professional education comprised little more than preparation for the ministry, it now includes theology, medicine, law, the profession of engineering, education, architecture, journalism, pharmacy, business, library science and two offshoots of medicine—dentistry and veterinary medicine.

The typical organization of the large university provides for a group of professional schools, sometimes in close conjunction with the rest of the university, occasionally scattered but under single university control. Formerly many professional schools

were separate institutions, but the tendency has been to decrease the number of independent schools until in most fields the university professional schools far outnumber the independent organizations. Of the 44 dental schools reported on by the Carnegie Foundation in its survey (1926), 36 are connected with universities Of the 71 medical schools to which the American Medical Association assigns the grade A, 61 are university schools. The Federal Bureau of Education lists 144 law schools, of which 110 are university schools

Medicine.—The medical schools of the United States were slow to adjust themselves to the new conditions brought about by the growth of medical science They followed the model of continental Europe rather than that of Great Britain, in that the teaching was almost exclusively by lectures and imposed no definite requirement as to the preliminary education. There was lacking also, for the most part, stimulating contact with colleges or universities of high academic ideals; and therefore there developed an organization which lent itself readily to commercialism. Later, however, medical teaching was revolutionized, and it now exemplifies the highest standards of professional education The rapid development of physiology and physiological chemistry, bacteriology, pathology and hygiene necessitated the enlargement of the curriculum to include these subjects. Laboratory methods of teaching have been introduced Satisfactory preliminary education is held essential, and all recognized medical schools in 1926 required of candidates for admission the completion of the four-year secondary school course and at least two years of college work, including physics, chemistry and biology

Cornell, Western Reserve and Leland Stanford require three years of college for entrance, Harvard and Columbia a degree from, or two years of high rank in, a college or scientific school; Johns Hopkins and Chicago a bachelor's degree or its equivalent. Most significant of all, the student is again brought into intimate contact with the patient; hospitals and dispensaries are used as laboratories where the prospective physician may acquire skill in examining patients and familiarity with the manifestations of disease. The degree of Doctor of Medicine is conferred on completion of the medical course, which in nearly all schools is four years in length A few institutions require also, before granting the degree, a fifth year, spent as an interne in a hospital Advancing educational requirements, the consequently greater cost of medical training, and the increasing knowledge and interest of the public in matters of public health combined to reduce the number of medical schools from its maximum of 162 in 1906 to 80 in 1927; of medical students from 28,142 in 1904 to 19,532 in 1926–27; of medical graduates from 5,747 in 1904 to more than 4,000 in 1927.

Engineering.—The beginnings of American technological training were made in a group of special schools, independently founded, such as the Massachusetts Institute of Technology, in Boston, and Stevens institute, in Hoboken, N J Later the universities eagerly took up education in engineering, developed elaborate departments and offered the greatest variety of courses. Engineering schools require of applicants for admission the completion of the four-year secondary school course Instruction is largely by means of laboratory courses The degree of Bachelor of Science, with or without specification of the branch studied, is commonly conferred after four years of college work. The degrees of Civil Engineer, Mining Engineer and so forth are awarded for undergraduate work by some schools in place of the B.Sc., by others reserved for more advanced study

Dentistry.—Since 1900 there had been increasing uniformity among dental schools until, in 1921, all recognized schools required for admission at least the completion of a four-year secondary school course, and many of them demanded an additional collegiate year of preliminary training, followed by four full years of professional training. The increasing recognition of the relation of dental pathology to health and disease in the body as a whole tends to make dentistry a branch of the study of medicine, and a leading group of dental schools decided to demand in 1927 the same two years of collegiate preliminary training now required of medical students, followed by four years of dental training.

University Extension Work (*see* UNIVERSITY EXTENSION).

Certain private corporations, not directly engaged in teaching, have influenced education in the United States. The General Education Board, for example, incorporated in 1903, employed the funds at its disposal in assisting institutions of higher learning throughout the country, and in the Southern States it also promoted the development of the secondary schools and the teaching of agriculture. Later it entered the field of medical education. From 1902 to 1926 its total appropriations for universities and colleges were $70,769,821.61, and for medical schools $42,100,-225 94 The Carnegie Foundation for the Advancement of Teaching, incorporated in 1906, starting with a programme of pensions for retiring college professors, has been led into the field of investigations and surveys. (N. M. B.; I. G. M.)

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For German universities. Zarache's *Die Deutschen Universitaten im Mittelalter* (1857), von Sybel's *Die deutschen Universitäten* (2nd ed, 1874), G. Kaufmann's *Geschichte der deutschen Universitäten* (2 vols.), are of first-rate importance

For the modern period down to the end of the 19th century the chief authority is F. Paulsen's *Geschichte des gelehrten Unterrichts auf den deutschen Schulen und Universitäten vom Ausgang des Mittelalters bis zur Gegenwart. Mit besondere Rücksicht auf den Klassichen Unterricht* (2nd ed, 2 vols.); Eng. trans. by Mr. (now Sir) M. E. Sadler (1906).

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For Portugal, the history of Coimbra is largely dealt with in the elaborate history of its theological faculty by Dr. M. E. da Motta Veiga (1872). The *Universidades y Colegios* of Dr. J. V. González (1907) relates the story of university beginnings in Argentina.

For Indian University education the monumental Government *Report on Calcutta University,* edit. by Sir Michael Sadler, in 26 vols.

(1917–19) is indispensable.

For the Colonial universities *see* the short historical notes prefixed to each university in the *Yearbook of the Universities of the Empire* (1929).

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BRITISH DOMINIONS

India.—The foundation of universities in India was the direct outcome of the parliamentary enquiry which preceded the confirmation of the old company's charter by parliament in 1853 London university—as a purely examining university—was taken as a model rather than Oxford and Cambridge, and in 1857 the three oldest universities were founded; Calcutta on Jan 24, Bombay on July 18, and Madras on Sept 5 The framers of the policy did not intend the universities should have no teaching functions, but, in point of fact, the universities for some time were practically only examining bodies In 1882 and 1887, the universities of the Punjab and of Allahabad were established. But since the University Act of 1904 professorships, readerships and lecturerships have been established, but mainly for advanced work, and except in Calcutta, on a very small scale Benares (the Hindu university), Mysore and Patna were established in 1916 and 1917 The Nizam's university, Hyderabad, was established in 1917 and began work in 1919. The whole question of the organization of higher education in India was examined by the Calcutta University commission, 1917–19 In Calcutta little change has since been made, but the recommendations served largely for models in the creation, during 1920–22, of Aligarh, Decca, Delhi, Lucknow and Rangoon, and in the reorganization of Allahabad in 1921 Nagpur was founded in 1923 and Madras reorganized in the same year In 1926 affiliated universities were established at Agra and Begwala. (The Ondhra university instituted for the study, among other things, of Telegu, Ondu and other native languages) In 1925 the Bombay University Reform committee recommended the establishment of a university at Poona The Universities of Calcutta, Bombay and the Punjab are governed by the constitution framed under the act of 1904. There is a senate with an executive called the Syndicate. Into the Punjab university an academic council has been introduced Bombay and Madras have constitutions closely resembling Calcutta. The newer universities follow generally the recommendations of the Calcutta university commission. There is: (1) a court which makes statutes and recommendations on the finance and annual report, (2) an executive council elected by the court and by the academic council with certain ex-officio members, (3) an academic council for all educational purposes.

The outstanding feature of Indian universities is the comparatively adequate provision for higher education compared with the lack of facilities for other branches of education.

Canada.—The universities in Canada fall, roughly, into four groups (the first, which follow the Oxford tradition, such as King's, Halifax; the second, which are modelled on Edinburgh, Dalhousie, McGill, Queen's, in Kingston, Ontario; the third, Laval, the Universities of Montreal and Ottawa, which have copied the French system, while the Universities of Manitoba, Saskatchewan, Alberta and British Columbia rather approximate to the American type.

The McGill university had its beginnings in the McGill College university—instituted by royal charter in 1821 on the foundation of the Honourable James McGill, who died in 1813. With it have since been affiliated, among other institutions, two agricultural colleges and four Protestant colleges in Montreal. Munificent bequests from Sir William Macdonald, the Carnegie Corporation, the Rockefeller Foundation, the Provincial Government and the citizens of Montreal (who gave nearly four and a half million dollars) have augmented its activities. It has good provision for instruction and research in applied science, especially in engineering and has a very flourishing medical school Laval university (Quebec) was originally founded by the seminary of Quebec. It received its charter in 1852 It is under the general supervision of the Catholic archbishop of Quebec Montreal university was founded as a branch of Laval in 1878 Since 1839 it has been practically independent It was incorporated in 1920. It is administered by a senate, commissions of administration and studies, a university council and executive committee. It has now outstripped in size and numbers the parent institution. The University of Toronto was first established under the title of King's college by royal charter in 1827. (*See* TORONTO)

Queen's university, Kingston (Ottawa), was originally a Presbyterian foundation, incorporated in 1841 In 1912 the faculty of theology was separately incorporated as Queen's Theological college, but left in affiliation with the university It is administered by a board of trustees, on which the professors and graduates are represented The University of Western Ontario, at London, originally a Church of England foundation, is now under provincial and municipal control

Acadia university (Nova Scotia) was founded by the N.S. Baptist Educational Society, and incorporated in 1840. The university of Bishops' college, Lennoxville, Quebec, is an Anglican foundation which dates from 1842, and was incorporated in 1853. Dalhousie university (Halifax), founded in 1818, incorporated in 1841, was closed in 1845 Reopened in 1863, it is now, thanks to private benefactors, a flourishing institution. McMaster university (Toronto) incorporated in 1887, has no religious test, but its governing body is elected by the Baptist convention Mount Alison university, New Brunswick, incorporated 1858, is controlled by the Union Church of Canada, but there are no tests for its students The University of New Brunswick at Fredericton is one of the oldest; its original charter as the College of New Brunswick dates from 1800 It received a royal charter in 1828 as King's college, and became the University of New Brunswick in 1857 The University of Ottawa is a Catholic university incorporated in 1889, having started as a college 1849. The University of St Francis Xavier, Antigonist, Nova Scotia, received its first charter in 1866 It is under the direction of the Catholic Church There are, however, no religious tests for entrance or degrees

The four Western provincial universities of Alberta (founded 1906), Saskatchewan (founded 1907), Manitoba (founded 1887) and British Columbia (founded 1915) are all increasing in importance.

Australia.—In Australia the University of Sydney was incorporated by the colonial legislature, which received royal assent in Dec 1857 In 1912 its statutory endowment was doubled and the Senate was altered to include six Government members. The University of Melbourne, founded by the legislature in 1853, is the largest in point of numbers of the Australian universities. Adelaide, established 1874, owes its origin to private beneficence and State grants. The University of West Australia, at Perth, was established in 1911 and opened in 1913 The University of Queensland dates from 1909 The University of Tasmania (Hobart) was founded in 1890 and received a royal charter in 1915.

Two points are noteworthy in Australian universities; one is the large part played by the State in the government of the universities, due to the large grants it makes, and the other the existence in Sydney and Melbourne of university colleges, with an instance also at Adelaide. The colleges date from the act of 1884, since which time colleges representing the Episcopalian, Presbyterian, Roman Catholic and Methodist churches have been founded with, in some cases, halls for women, who, since 1804, have been admitted to degrees. All these colleges are self-governing and receive no financial aid from the universities concerned, who are all undenominational in character

New Zealand.—The University of New Zealand was founded on the London model in 1870, and reconstituted in 1874–75 by royal charter, with power to grant certain degrees To this university, University college at Auckland, Canterbury college at Christchurch, and the University of Otago at Dunedin, and Victoria University college, Wellington, have been successively admitted in connection as affiliated universities, the latter, in 1894, having agreed to hold in abeyance its power of granting degrees. There is a council of 23 members, including four Government nominees. The offices of the university are at Wellington There is an annual grant of £4,000 from the Government A royal commission, in 1925, recommended the establishment of a Federal university, an extension of university teaching and the establishment of special (technical) schools, an increase in college hostels and development of university extension work.

South Africa.—The beginnings of higher education in South Africa date from the foundation of the South African college in 1829. In 1858 a board of examiners in literature and science was founded, which prepared the way for the University of the Cape of Good Hope in 1873. Like its model, London university, it was a purely examining body, its principal candidates coming from the South African college, the College of Stellenbosch (afterwards Victoria college), founded 1874, and St. Andrews college, Grahamstown (founded 1858), which became, in 1904, Rhodes college In the latter year a mining institute was founded at Johannesburg, which later became a college for higher education. In 1908 a university college was founded at Pretoria, and in 1909 a similar one at Pietermaritzburg In 1904 began a movement for instituting a teaching for an examining university In 1908 an inter-colonial conference on university education reported in favour of a federal as against a single college university. In 1918 charters were given to both the South African college and the Victoria college, henceforth styled the Universities of Cape Town and Stellenbosch and the old University of the Cape of Good Hope was reincorporated as a federal university embracing all the other colleges under the name of the University of South Africa. In 1924 the University College of Johannesburg became an independent university. Each of the four universities is governed by a council, senate and convocation A joint committee of the four universities has been established, consisting of the four vice-chancellors, to promote co-ordination in all academic matters.

Other institutions of higher education within the empire and mandated territories are the Imperial Agricultural college in Trinidad, the College of Agriculture in Mauritius, the University of Malta, the Ceylon university college, Colombo, the King Edward VII. College of Medicine at Singapore, the Hongkong university and the Hebrew university at Jerusalem. Mention may also be made of the Shantung Christian university in China, which was founded in 1904 by British and American missionaries, with its headquarters in Toronto (J. B MU.; C. BR.)

MODERN DEVELOPMENTS

Fourteen new universities have been founded in Western Europe since 1910, most of them after the World War. Of these, four are in Italy, three in Germany, two in Portugal and one in England, Holland, Spain and Iceland. In the so-called "new countries" of Central Europe, including the Baltic and Balkan States, 16 new universities have been established, almost all of them since the war, many of the older universities in these countries having been entirely reorganized on passing under a new State. Among such universities are Lublin (1918), Abo-Turku (Swedish university), Bratislava (started as the Hungarian university of Poszonyi, 1914); Brno, Ljubjana, Poznan, Riga, Skoplje (philosophy only), Subotica (law only) and Wilno in 1919; Turku (Finnish university, 1920), Szeged (1921), Kaunas (1922), Pécs, Salonika (1925). In Russia, White Russia and Ukraine several universities were inaugurated during the war, and a great many came into existence after the revolution. Some of the latter were soon closed. Instead of the seven universities which existed in 1910 on the present territory of the Soviet republics, there are now about 20. The general increase in Europe is approximately from 140 to 180. The total number throughout the world is about 450.

This development is not less remarkable on the other continents. Where many universities had come into existence during the 10th century only a few foundations are to be recorded since 1910, some of which were reorganizations of older institutions. In Latin America at least 13 new universities have been created since that year. In South Africa, which had one university only in 1910, there are now four India possessed only five universities in 1910 and has now 20, including two women's universities and the International university founded by Rabindranath Tagore. Two new Imperial universities have been founded in Japan since 1910, so that the number in that country, including the private universities, now reaches 15. In China, where university life is still in formation, we find now about 20 universities. Further foundations in other Asiatic countries, such as Palestine (the Catholic university), Persia, Siam, and even in Hawaii (1920) have also to be recorded

Numbers of Students.—There has been a considerable increase in the number of students in the great majority of the universities except in Germany (*i e.*, Berlin 14,034 in 1909–10 and 11,169 in 1927). This is particularly striking in the United States Columbia university, with 32,244 students in 1927 (6,529 only in 1909–10), has now the largest enrolment of students in the world Other interesting figures are· New York university, in the same city, which had 4,036 students in 1909–10 and 20,383 in 1925–26; for Temple university, Philadelphia, the same figures are 5,033 and 8,579; the University of California in 1906–07 had 3,684 students and 18,969 in 1925–26 Paris, however, is first in regard to whole time students, of whom there were 21,455 in 1925. An extraordinary development is to be noted also in some universities of Central Europe, like Athens (2,800 students in 1909–10, 15,370 in 1925–26), Belgrade (902 students in 1908–09, 5,790 in 1926), Bucharest (3,478 in 1909–10, 13,540 in 1926–27), Warsaw (1,263 in 1909–10, 9,539 in 1926–27)

The extension of the provision of secondary education which resulted from the World War in most countries of Europe and America has been one of the principal causes of the increase in the number of students, particularly in the more strictly professional faculties of law and medicine. In the faculties of art and pure science, the growth is largely due to the increasing number of women who seek to prepare themselves for the wider opportunities of service now opening up for them by courses of academic study The teaching staff has not increased in the same proportion, and must be regarded as inadequate when compared with the number of students.

Institutes.—University institutes, both for teaching and for research, have reached an extremely large number. Many universities possess more than 100 such institutions This development is due to the adoption, in almost all countries, in modified forms, of the so-called "seminar" system, started in Germany during the 19th century, and to developments which found no place in the traditional university organization; so new institutions, either connected with the old faculties or independent of them, were established. In most European countries there existed, since the early years of the 19th century, many specialized institutions for higher education which, while independent of the universities, had obtained university rank They were created mainly for the study of technical sciences, of agriculture, mining and forestry, of commerce, of fine arts and so on. In many cases the schools of education, of political science, of dentistry and veterinary medicine were independent establishments. The number of these institutions has already grown steadily. Since 1910 some 50 or 60 schools of this kind have been founded in Europe. In the more important centres of intellectual life, the number of independent higher schools surrounding the university has become very considerable. Paris attains, undoubtedly, the record with its more than 40 schools. In other countries, mainly in America, but also in Great Britain, the British dominions, and some of the new European countries (*e.g.*, Latvia, where the University of Riga has 11 faculties), all branches of higher education have been included in the curricula of the universities, which therefore possess faculties of engineering, applied science, veterinary medicine, agricul-

ture, commerce, education, fine arts, music, etc. In some universities the number of faculties has doubled since the World War.

Faculty Organization.—In many universities of to-day there are faculties which are entirely different from the traditional ones. These, again, have been divided, owing to the developing needs of life and to the specialization of science. Thus for theology, in some universities two or even three (*e g.*, Warsaw) different theological faculties have been formed, to meet the requirements of various denominations Economic and social sciences have been separated from law and have formed a new faculty (*e.g.*, Geneva). In some countries (*e.g.*, France) a faculty of pharmacy has been created separate from the faculties of medicine, thus following the practice which has prevailed in America for many years. The division of the traditional faculty of philosophy into faculties of letters (arts, humanities) and sciences (natural and physical sciences), which started very early in Western Europe, has strongly influenced the other countries. Since the World War many universities in Central Europe, even in Germany, have adopted this system. In several cases a special faculty of mathematics has been instituted.

New Chairs.—In all faculties, old and new, many new chairs have been established for subjects which, 10 or 20 years ago, either did not appear at all or appeared only exceptionally in university curricula These new chairs and subjects may be divided into three groups In the first place, new branches of science have developed into individual subjects, *e g.*, radiology, or have been recognized as independent sciences, *e g*, sociology, and therefore chairs have been founded for their teaching In the second place, the closer association of universities with practical life has necessitated the establishment of new chairs for various branches of applied sciences, even for subjects like journalism and nursing. Finally, it has been realized that knowledge of foreign nations needs an intensive study, not only of their languages, but of their whole civilization. history, literature, political institutions, economic conditions and so on. Therefore, not only have many new lecturers been appointed for teaching languages, but chairs, and in some cases special institutes, have been founded for the systematic and comprehensive teaching of what in Germany is called "Auslandskunde"

Post-graduate and Research Work.—The measures taken for furthering research work, especially of post-graduates, are mainly of two different kinds. Frequently university "seminars" have been developed into research institutes grouping the students who wish to devote themselves to pure science On the other hand, the system of fellowships which has been developed, especially in the Anglo-Saxon countries, offers to the students and post-graduates certain possibilities of continuing their research work

INTERNATIONAL RELATIONS

Nationalism.—During the whole 19th century, university life, which had been undoubtedly international in the middle ages, and in the times of the Renaissance and the Reformation, became more and more closely connected with national development and national feeling. The World War and its consequences have rather strengthened this connection. In many territories which passed from one State to another the national character of the universities and higher schools changed with the political *régime.* Many nations, especially in Central and Eastern Europe, which before the war, owing to political conditions, had either no universities, or insufficient universities of their own, have profited by their independence, creating universities as living symbols of their liberty and proofs of their intellectual progress or maturity. In all such cases university development has been directed by the national ideal.

National Co-operation.—In countries where the number of universities was large the necessity of promoting co-operation between the national universities began to be recognized more strongly. In 1910 the well known "Office des Universités et écoles françaises" was founded in Paris. In 1912 the numerous universities of the British empire held their first congress and decided to establish a common universities bureau, which started its activities during the war and a few years later organized the second Imperial Universities Congress. Similar offices came into existence in Switzerland, Italy, Belgium, Holland, etc. For the United States a similar *rôle* has been assumed by the various associations of universities, by the Institute of International Education in New York, and by the American University Union in Europe. These national organizations bring the universities of their own country into closer contact, and promote co-operation with the universities of other countries.

International Co-operation.—International university co-operation, which was almost entirely interrupted during the war, plays an extremely important *rôle* in the university life of to-day. Ambitious schemes have been proposed to organize it systematically. The project of an international university has been advanced on various sides Up to now, this idea has been realized in a limited, but perhaps more practical, form, by organizing in various places international courses and summer schools, like those started in Brussels, Vienna, Geneva, The Hague (international law), Williamstown, Mass., etc

Exchanges of Professors and Students.—International exchanges of professors and students have been recently facilitated by means of international conventions General conventions of that kind being still impossible, such agreements have been concluded between one country and another (*e.g*, between France and a great number of other European nations since the war; also between various Latin-American countries) and between one university and another. Lectures or series of lectures given occasionally by travelling professors in foreign universities are more frequent than exchanges of teachers in the proper sense. A practice has grown up in the United States and Canada of professors "visiting" other universities by invitation for the purpose of delivering lectures. Exchanges of students promoted by organizations created for this purpose and, in general, study abroad, have been facilitated by progress towards the international recognition of the equivalence of studies and degrees. While no general conventions have been concluded for this purpose, various countries have published official lists of foreign degrees recognized by their national universities.

Conferences of universities of two different countries (France and Switzerland in 1919, England and Switzerland in 1922) mark progress in that direction. Students who are more and more interested in international affairs have developed international associations. The International Students' Confederation, founded in 1919, is the most representative of these federations. The splendid results achieved by the European Student Relief Fund of the World's Student Christian Federation, and the activity of the International University Federation for the League of Nations should also be mentioned, as well as the International Federation of University Women (post graduates) and the International Secretariat of the Catholic Students Association (called Pax Romana)

The League of Nations.—All these problems have been taken up by the League of Nations, and carefully studied, since 1922, by its committee on intellectual co-operation. The International University Information Office, established by the committee in 1923, was the nucleus of the International Institute of Intellectual Co-operation, offered to the League by the French Government and opened in Paris in Nov. 1925. The institute's special section for inter-university relations publishes a quarterly bulletin containing information on international university development.

(*See* also UNIVERSITY COLLEGES; EDUCATION; SCHOOLS; EXAMINATIONS; ACADEMIES; EDUCATION and INDUSTRY; TECHNICAL EDUCATION; POLYTECHNICS, etc.) (O HA.; A E TW.)

UNIVERSITY ARCHITECTURE. The earliest universities, such as Paris, Bologna, Prague, Salamanca and others were established in towns, and it is with the buildings of the towns that the universities grew and became mingled They were often housed under the protection of religious establishments in monastic and church buildings, and, if under secular control, in old palaces or other structures hired or lent by the civil authorities and not always planned for the purposes of the university

Modern European Universities.—Nearly all modern univer-

sity structures on the Continent of Europe are Renaissance; the remainder are classic in style. Exigencies of the site, such as land values and density of the surroundings, have in many cases imposed a form of building with a closely knit plan entirely occupying a city block. Uninterrupted exterior walls correspond with the street building lines. Within are one or more courts providing light and air. These courts are usually surrounded by a colonnade which gives access to the various rooms. An example of this type is the Sorbonne (Nerot, architect; 1885–1900). Where the site is sufficiently open the U- and H-shaped plans or a combination of these are found. An imposing group of university buildings laid out in modern style is at Strasbourg. Other universities of a modern type are to be found at Vienna (Ferstel, architect; 1885), Uppsala, Munich, Bucharest, Budapest.

Oriental Universities.—The University of Cairo resembles a mosque (*q.v.*). At the imperial University of Peking new buildings influenced by western design are taking the place of the native one or two-storey structures of gray brick, built about small square courts, opening into each other through broad gateways, and said to have been originally palaces. The 50 buildings of the modern University of Tokyo indicate the influence of German universities, and like them provide for education in the sciences.

South American Universities.—University buildings in South America invariably contain one or more courts or patios, from the galleries of which the surrounding rooms are entered. The exteriors are in the Renaissance style as taught at European architectural schools—notably those of France—and found in modern buildings of that country and of Spain. Mansard roofs are much in favour for buildings upon a large and pretentious scale, and abundant ornament characterizes both interiors and exteriors. Of this order are the National University of Mexico at Mexico City, the university buildings at La Plata, Argentina, the University of Montevideo, Uruguay, and the Catholic university at Santiago, Chile.

English Traditional Type.—Oxford and Cambridge typify the English university system, and are so singularly venerable and traditional that, in the English-speaking world, their names are almost synonymous with the word university. The congeries of buildings that grew up at Oxford round the University Church of St. Mary and the Schools, consisted first of halls, which were scarcely more than inns or hostels for the students, that is to say, rows of separate dwellings, each with its entrance on the side away from the street and each independent of its neighbour. Later the colleges were erected, each sufficient unto itself, with its own chapel and antechapel, library, masters' lodge and hall, common room, student lodging, dining hall (commons), kitchen, buttery, bake-house, brew-house, cellars and other offices. Additional rooms were contrived later in the attics, by means of roof and wall dormers, additional storeys and by additional colleges. The early colleges were so constructed as nearly to enclose a quadrangular sequestered space.

These establishments epitomize the history and development of the national styles ranging from the monastic period through the centuries marked by the Perpendicular, Tudor, Elizabethan, Jacobean and Modern styles. In spite of their variations, the oldest of the colleges have in common an architectural character that has been designated the English Collegiate Gothic style. The old English universities dominate the town and yet defer to it in so far as the architectural boundary lines conform to the streets, none of which are rectilinear. Instead of rigidly formal lay-outs or grouping of buildings, there is a happy picturesqueness Modern buildings have, however, made their appearance.

The modern Universities of London, Manchester, Liverpool and Birmingham differ radically from Oxford and Cambridge, and being urban, student lodgings play little or no part in their design.

American Universities.—The influence of both English and Continental university architecture is seen in the building for educational institutions which has taken place on a prodigious scale in America during the past 50 years. The earliest foundations to develop with the towns in which they were situated were Harvard and Yale. The typical American university, however, differs from these in having, often isolated in rural districts, its own separate domain, the heart of which is the campus (*q.v.*) or college yard.

The University of Virginia, designed by Thomas Jefferson and dominated by the classic library, is believed to be the first general scheme realized. After the period of stagnation of the arts, and following the awakening caused by the Centennial at Philadelphia and the work of Richardson and other pioneers (*see* MODERN ARCHITECTURE), the first university to attempt a comprehensively developed plan was that of Stanford, Cal. (C. A. Coolidge, architect; 1886). Developments on a comprehensive pre-arranged plan are at the University of Illinois, Louisiana State university, University of Rochester, Duke university, Johns Hopkins, Washington university (St. Louis), and the University of Minnesota.

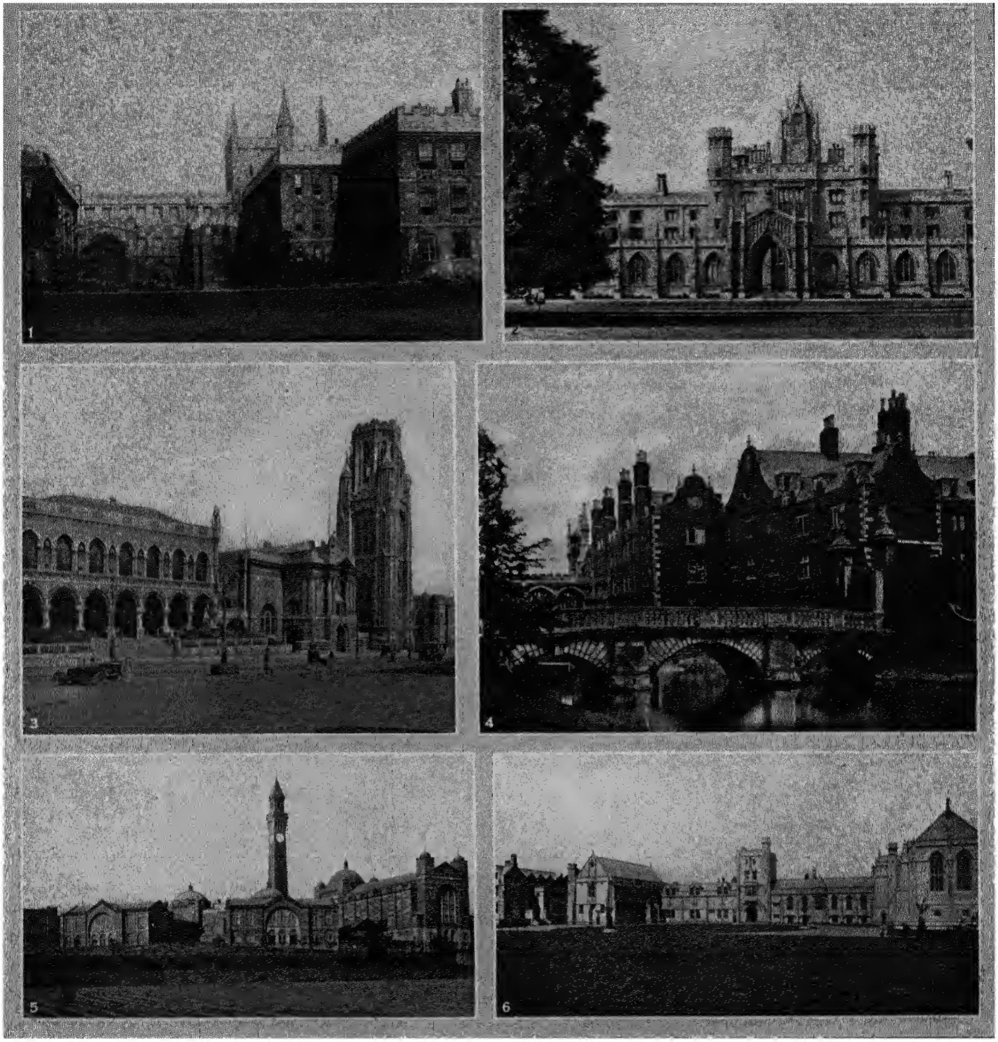
The earliest university buildings were designed in the style brought from England by the colonists. New buildings of this character are also found at Harvard, Franklin and Marshall, Rutgers, Delaware, Johns Hopkins and Brown universities. At the end of the 19th century, however, a counter-current set in. College buildings in English collegiate style having been carried out with measurable success by Cobb at Chicago, Haight at Yale and Cope and Stewardson at the University of Pennsylvania, a predilection for this style arose. Curiously enough, this was more pronounced at the American universities where the Colonial tradition was formerly strong, so at Yale and Princeton, for example, Gothic is seen side by side with the traditional colonial.

Yet another aspect of the development of university architecture in America is the so-called "sky-scraper" type of building such as is now (1928) under construction at the University of Pittsburgh (Klauder, architect). The building is to have 40 storeys, the centre of population being at the fourth floor. It is an interesting solution of the many problems involved in building for colleges and universities Some of these problems are to foresee the demands of teaching and the needs of the community; to make the buildings permanent, harmonious entities yet permitting of expansion and to embody in them all possible known improvements. (C. Z. K)

UNIVERSITY COLLEGES. The so-called university colleges in England owe their rise to the desire, in the 19th century, to bring higher education within the reach of the population of certain regions to whom the existing universities were, for reasons of cost or distance, inaccessible The earliest of such colleges, Owens college, Manchester (opened in 1851), was specifically founded for that purpose, and many of its students were long prepared for the external examinations of London university. Subsequently, in Manchester and elsewhere, the technical side was developed. Other similar foundations were the Yorkshire college, Leeds, the New University college, Liverpool, the Mason college, Birmingham, the Firth college, Sheffield. Later on certain of these colleges became affiliated colleges of a single university (*see* UNIVERSITIES), but such colleges, and even others which did not go through the intermediate stage, have now become independent universities, with the exception of Armstrong college, Newcastle, which is still part of Durham university. In fact, a university college to-day is regarded as a university in the making. The most recent to attain that dignity is Reading, while University college, Nottingham (*see* below) should soon win its charter. (C. BR.)

Exeter.—When the Royal Albert Memorial building was erected in 1865, part of the premises was set aside for educational purposes. Here various extension courses provided by the University of Cambridge were instituted. These were co-ordinated in 1893 and the work placed under the direction of a principal. At the beginning of the present century courses were developed to prepare students for the external degrees of the University of London. In 1922, the institution was incorporated as the University college of the south-west of England, and its status was recognized by grants from the University Grants committee. It is hoped in time to develop this institution as a university of the south-west of England. In June 1927 the prince of Wales laid the foundation stone.

Hull.—The University college of Hull opened for the first time



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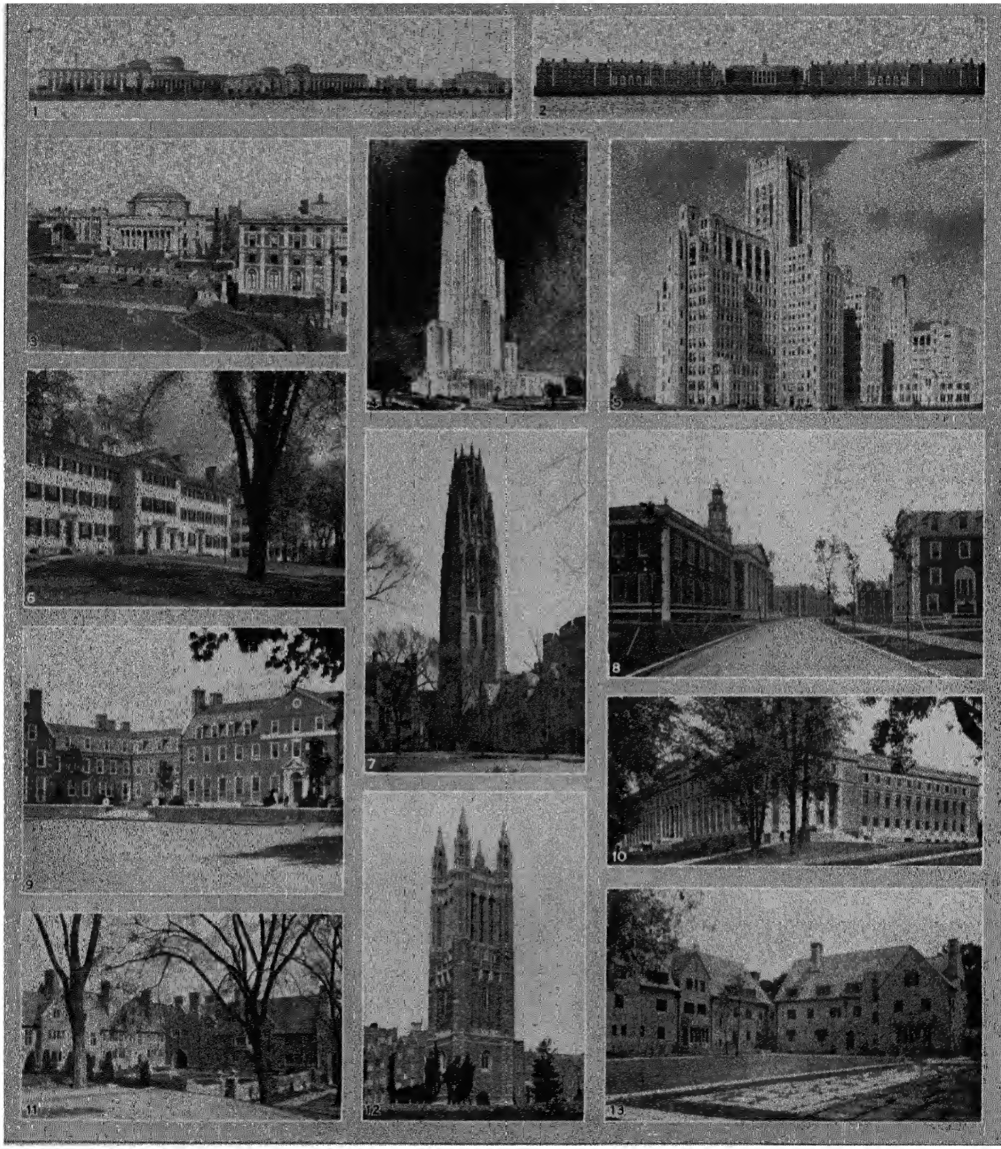
ENGLISH UNIVERSITIES

1. New College, Oxford University, Oxford
2. St. John's College, Cambridge
3. Art Gallery, Museum and University, Bristol
4. St. John's College, showing the river, Cambridge
5. Birmingham University, Birmingham
6. Mansfield College, Oxford

UNIVERSITY ARCHITECTURE



BY COURTESY OF (4) CHARLES Z. KLAUDER, ARCHITECT, (7) JAMES GAMBLE ROGERS, ARCHITECT; PHOTOGRAPHS, (2, 3) EWING GALLOWAY, (5) UNDERWOOD AND UNDERWOOD, (6) PAUL WEBER, (8) FAY C. LINCOLN, (11) ORREN J. TURNER, (12) ROSE

VIEWS OF AMERICAN UNIVERSITIES

1. Massachusetts Institute of Technology, Cambridge, Mass.
2. School of Business Administration, Harvard University, across the Charles river from Cambridge, Mass.
3. Columbia University, New York city
4. Cathedral of Learning at University of Pittsburgh, Pittsburgh, Pa.
5. Buildings on McKinlock campus (Lake Shore Drive, Chicago), Northwestern University, Evanston, Ill.
6. Dartmouth Hall at Dartmouth College, Hanover, N.H.
7. Harkness Memorial Tower, Yale University, New Haven, Conn.
8. School of Business Administration, Harvard University. Detail of fig. 2
9. Alumni Dormitory, Johns Hopkins University, Baltimore, Md.
10. Baker Laboratory of Chemistry, Cornell University, Ithaca, N.Y.
11. Cuyler Hall, Princeton University, Princeton, N.J.
12. Graduate College and Cleveland Memorial Tower, at Princeton, N.J.
13. Sorority House group at Northwestern University, Evanston, Ill.

in Oct. 1928. The college has been established as a result of gifts by the Rt. Hon. T. R. Ferrens, amounting to £272,000. The corporation of Hull has also given £150,000 towards the initial building scheme and has resolved to make an annual maintenance grant of £2,500. The policy of the college is to aim at quality rather than quantity. It has, therefore, been decided to begin as only two faculties, arts and science.

Leicester.—In 1921 an institution was established to prepare students for the examinations of the University of London under the style of the Leicester, Leicestershire and Rutland college In 1926 the name was changed to Leicester University college, when the endowment fund had reached a total of £130,000.

Nottingham.—The University college was first opened in 1881, having developed out of courses conducted by the Extension Board of the University of Cambridge. It was housed till 1928 in buildings in the centre of the town, provided by the municipality. Through the generosity of Sir Jesse Boot, an admirable site and a fine building, opened by the King in the year named, have been provided at a cost of over £500,000. An appeal is now being made for an adequate endowment fund The college prepares its students, both in day and evening classes, for the London university examinations in art, science and law. It has a very active University Extension department.

Southampton.—University college was opened as the Hartley institution by Lord Palmerston in 1862 At the outset the work was mostly evening work, by which students were prepared for the examination of the Science and Art department; the day was rather preparatory to university work than of real academic standard. In 1902, under a scheme of the Board of Education, the institution became the Hartley University college, and received a grant from the Treasury. Just before the World War new buildings had been provided at Highfield, but they were not occupied by the college till 1919

Wales.—*Lampeter* St David's college, Lampeter, was founded in 1827 to provide a liberal education to persons intended for the Church, especially in Wales It was subsequently affiliated to Oxford and Cambridge, where its students have special privileges. Under royal charters it has received the right to confer degrees in arts and theology, the examinations being conducted by examiners appointed by Oxford and Cambridge Residence for a certain number of terms is also essential. (A E. Tw.)

UNIVERSITY COURTS, in the English universities of Oxford and Cambridge, courts of inferior jurisdiction, administering the form and procedure of the canon law

At Oxford the chancellor, in 1244, acquired jurisdiction over actions of debt and actions affecting movables in which one party was a clerk; in 1275 over all personal actions in which either party was a member of the university, and in 1290 over all crimes, except homicide and mayhem The chancellor, vice-chancellor and the vice-chancellor's deputy are justices of the peace for Oxford, Oxfordshire and Berkshire, where scholars are concerned, and so exercise jurisdiction under the Summary Jurisdiction acts. By the Oxford University act 1854, the procedure of the common law was substituted for that of the canon law.

At Cambridge the chancellor enjoyed a jurisdiction similar to that of the Oxford chancellor, but limited to cases arising in the town and suburbs of the university. Previous to 1891, women of light character, who had been convicted of consorting with or soliciting members of the university *in statu pupillari*, were detained in a house of correction called the "spinning house," but in that year a conviction was held bad (*ex parte Hopkins* [1891]), with the result that the clause in Elizabeth's charter of 1561 giving power to imprison women was repealed. *See* H. Rashdall, *Universities of Europe in the Middle Ages* (1895); D. S. Holdsworth, *Hist. Eng. Law* (1921). (H. H. L. B.)

UNIVERSITY EXTENSION, a term applied to the provision of lectures or other teaching by universities for the general public, not members of the university.

Great Britain.—The idea of extending the range of advanced teaching beyond the walls of the universities was not a wholly new one in the 19th century, but it was not taken up with pertinacity till the early '70s. At that time a young Fellow of Trinity, James Stuart, approached his own university of Cambridge for the recognition of extra-mural work. He had been specially impressed with the needs of two classes who had sought his help—the working men of Crewe and an association for the higher education of ladies in the north of England. Cambridge gave its official support in 1873 and Mr. (afterwards Professor) Stuart developed a system, not merely of lectures, but of classes.

Before long Oxford followed suit and a London society was formed which has since been absorbed by the University of London. The old Victoria university (Manchester, Liverpool, Leeds) took its share of the work.

Before the end of the century every large town in England and most small ones had a university extension centre, the subjects studied including history, geography, literature, art, music, science, economics. Since then the older type of extra-mural work, called officially university extension at Oxford and London and university local lectures at Cambridge, has continued to advance Even during the World War a large number of courses were delivered.

The period since the war has shown a remarkable development of university tutorial classes, begun by Oxford in 1908 and soon taken up by other universities. The system, like the older type, provides for lectures, discussion classes and paper work; but the membership is limited to a small number, formerly 32 and now 24, of students pledged to fulfil the conditions for three years In 1910–11 the number of classes was 72 and students 1,829; in 1927–28 these had increased to 591 and 10,778 respectively. In addition there were 83 preparatory classes with 1,709 students. Substantial grants in aid are made by the Board of Education and local authorities

The central joint advisory committee on tutorial classes, formed in 1909, was one of the first bodies to represent all the universities and university colleges in England and Wales. It also has direct representation of the joint committees which manage the work in each case, and which include members nominated by the Workers' Educational Association (*q.v.*). In 1925 a consultative committee was formed, consisting of all the extra-mural officials. It is concerned with all branches of the movement and not only with the tutorial classes. At the congresses of universities of the empire, held in 1912 and 1921, a prominent place was given to teaching work outside the walls. The tutorial class movement has flourished in Australia and New Zealand.

Every university and university college in England and Wales is now conducting tutorial classes. Several have started university extension work of the older type, a development which has been made possible by the issue in Aug. 1924 of new regulations of the Board of Education in providing for grants in aid.

One of the most promising developments is the plan, recommended by the royal commission, of bringing up to the university adult students who have gone through a course of extra-mural instruction. At both Oxford and Cambridge a number of such students are now in residence for at least a year, and experience is already showing that, besides widening their own outlook, they contribute an element of great value to the undergraduate life of the places. All will return to their homes with powers of greater service to the community, and many will become valuable teachers in the adult education movement. (*See* also ADULT EDUCATION.)

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The United States.—To trace the history of university extension in the United States to any definite initial movement is impossible. It grew out of the public demand for the extension of the advantages of the university to the community in general A hint of the desire to broaden the service of higher education may be found in the series of lectures open to the public for a small fee offered by Columbia college at its original site in College Place, New York, in 1830. This was premature and failed to arouse interest. We may refer also to the American National lyceum founded in 1831, the Lowell Institute in Boston (1839), the Peabody Institute in Baltimore (1859), all having features of univer-

sity extension particularly of the lyceum (*see* LYCEUM AND CHAUTAUQUA) or short lecture course type. Then the summer school (*q v*) was organized at *Chautauqua* in 1874 which through its literary and scientific circles developed a form of correspondence study The next incident in the development centred around the public libraries in such cities as Chicago and St Louis, for it was at the meeting of the American Library Association in Sept. 1887, when Prof. Herbert B Adams of Johns Hopkins university spoke on the university extension of England Extension work under the auspices of public libraries was endorsed and earnestly advocated by Melvil Dewey, librarian of Columbia university, before the regents of the University of the State of New York in 1888. In 1890, when Mr. Dewey had become the librarian of the State library of New York, the regents following his suggestion, endorsed by 31 colleges of the State, determined to establish a system of university extension and obtained from the legislature an appropriation of $10,000 for administrative expenses

The University of Chicago and the University of California, 1891–92, were pioneers in the acceptance of extension instruction in their scheme of university study. This naturally led to the gradual disbanding of organizations established outside of the universities. The first 20 years of the 20th century witnessed the organization of extension teaching in at least 30 State universities Only a few institutions which rely largely upon private endowment—as Columbia university (1902 and 1910), New York university (1908), University of Rochester (1916), Syracuse university (1920) and University of Pennsylvania (1913)—have included university extension as part of their public service in education.

Early Forms of University Extension.—As in England so in the United States the early form of university extension was that of the lyceum or short lecture course, not too profound, often illustrated, intended to entertain as well as to instruct Although the short lecture course served a useful purpose, yet the lyceum as a means of education, with its difficulty of maintaining a balance between the serious and the entertaining, proved unsatisfactory. It became necessary to approximate much more closely the form of instruction followed in the established schools and offered to students in regular attendance Those who could not attend classes were given courses by correspondence (*see* CORRESPONDENCE SCHOOLS), which assumed a more or less academic form and exactness, and classes were established at convenient centres and in university buildings. The large universities of the West, *e g*, the University of Chicago and the University of Wisconsin, built up great departments of correspondence although using class instruction in a restricted degree

Credit for Extension Courses.—Certain privately endowed universities and colleges, particularly those in the East, have believed that their special function would be jeopardized if they should supplement their classes by those intended for the irregular student Thus Princeton gives no indication of a desire to enter this field. Yale is cautious in its active interest in adult education. Harvard co-operates with Tufts college, Massachusetts Institute of Technology, Boston university and Wellesley college in offering courses of a collegiate grade to qualified, though not formally matriculated, students Massachusetts has a well organized department of university extension. As to credit toward degrees for extension students the policy varies in different institutions. The State universities in the West generally grant credit for class and correspondence courses. Columbia gives credit for established class instruction but not for home study. Harvard grants credit in co-operation with other institutions toward a special degree of A A., associate in arts

The National Association of University Extension is an organization of universities and colleges which have established departments of extension teaching This was organized in 1914 and publishes annual reports which contain the records of meetings of the association. The American Association for Adult Education held its first annual meeting at the Hotel Drake in Chicago, on March 26, 1926. The latter organization is a most active agent for the study and extension of adult education. In 1926–27, under the auspices of the Carnegie Corporation, four studies covering the field of adult education were published One of these entitled *The University Afield*, by Alfred L. Hall-Quest (1926), is a carefully prepared examination of educational opportunities offered by American universities in university extension.

BIBLIOGRAPHY.—The American Society for the Extension of University Teaching, *University Extension—Its Definition, History, System of Teaching and Organization* (1891); Arthur J. Klein, *Correspondence Studying in Universities and Colleges* (1920); W. H Draper, *University Extension, 1873–1923* (1923), John S Noffsinger, *Correspondence Schools, Lyceums, Chautauquas* (1926); Owen D. Evans, *Educational Opportunities for Young Workers* (1926); N. Peffer, *New Schools for Older Students* (1926); A study by the American Library Association, *Libraries and Adult Education* (1926). (J. C. E.)

UNIVERSITY SETTLEMENT: *see* SOCIAL SETTLEMENTS

UNRUH, FRITZ VON (1885–), German writer, was born in Coblenz, of an aristocratic family He joined the Prussian Guard, and was tutor to a prince. His first plays, *Offiziere* (1912) and *Louis Ferdinand, Prinz von Preussen* (1914) caused consternation. In the World War Unruh served on the staff of the Crown Prince, and in 1916 was requested to write a book to keep up the morale of the troops His *Opfergang* (1916; English tr. 1928, *Way of Sacrifice*) expressed his revolt against militarism with such sardonic force that its author was declared insane. When released, Unruh lived in Switzerland, later in Oranien, Hesse. His trilogy *Ein Geschlecht* (1918–21) was also impressionist The later *Flügel der Nike* (1924), *Heinrich aus Andernach* (1925), and *Bonaparte* (1926, English tr. 1928) were still expressive of revolt but they had lost some of the wildness, and with it some of the force, of *Opfergang*. In 1928 Unruh was elected to the Prussian Academy of Letters.

UNTERMYER, SAMUEL (1858–), American lawyer, was born at Lynchburg (Va), on March 2, 1858. He was educated at the College of the City of New York and at the Columbia law school, and was admitted to the bar in 1879, practising thereafter in New York city. He was counsel in many celebrated cases covering almost every phase of corporate, civil, criminal and international law As counsel for H Clay Pierce he prevented the Standard Oil Co, after its dissolution in 1910, from dominating the Water-Pierce Company. In the same year he effected the merger of the Utah Copper Co with the Boston Consolidated and the Nevada Consolidated Cos, involving more than $100,000,000 In 1903 he undertook the first judicial exposure of "high finance" in connection with the failure of the U S. Shipbuilding Co, organized as a consolidation of the larger shipbuilding companies in America. After this he conducted a number of similar exposures. In 1911 he delivered an address entitled, "Is There a Money Trust?" which led the following year to the so-called Pujo money trust investigation by the committee on banking and currency of the Federal House of Representatives. Mr. Untermyer urged measures like the compulsory regulation of stock exchanges, reform of the criminal laws and the regulation of trusts and combinations He took part in preparing the Federal Reserve Bank law, the Clayton bill, the Federal trade commission bill and other legislation curbing trusts. He was a delegate to Democratic conventions and a strong supporter of President Wilson, who appointed him to serve on the commission which sat at Buenos Aires in 1916 to frame uniform laws for the Pan-American countries

Untermyer acted for Governor Smith in a water-power controversy over the Niagara, St. Lawrence river, Adirondack forest reserve and other hydro-electric power rights, resulting in the defeat of the grant of the water-power rights of the State to private interests He was counsel for Herman Bernstein in the first suit brought against Henry Ford because of attacks on the Jewish people published in the *Dearborn Independent*. In July 1927, Mr. Ford agreed to destroy the publications.

UNTERWALDEN, a canton of Switzerland, consisting of the basins of two streams, both called Aa, flowing into the Lake of Lucerne and divided into Obwalden and Nidwalden. The area of the canton (1923–24) is 296·4 sq.m. Forests cover 84·2 sq.m. and glaciers occupy over 5 sq.m. The highest point is the Titlis—10,627 ft.—south of Engelberg. As Obwalden includes this region, it is generally more mountainous than Nidwalden. The latter in-

cludes much more lake surface than Obwalden. The inhabitants are devoted to pastoral and, in a much less degree, to agricultural pursuits. In 1920 the total population was 17,567 in Obwalden and 13,956 in Nidwalden. The majority of the inhabitants were German-speaking Catholics. Since 1814 the canton has been practically administered by the bishop of Coire; formerly it was a part of the diocese of Constance. The capital of Obwalden is Sarnen (pop. 4,980), and of Nidwalden, Stans (pop. 2,980).

There are no main line railways; a light railway runs from Lucerne to Brünig pass via the Sarner-Aa valley; an electric railway from Stansstad ascends the other main valley as far as Engelberg, and mountain railways give access to the summits of Pilatus, Stanserhorn, Bürgenstock and Seelisberg—all of which overlook the Lake of Lucerne. Each area forms a single administrative district, with its own independent local institutions; in Obwalden there are seven communes and in Nidwalden 11. In each "half" canton the supreme legislative authority is the *Landsgemeinde,* or primitive democratic assembly (meeting in both cases on the last Sunday in April), composed of all male citizens of 20 (Obwalden) or 18 (Nidwalden) years of age. These assemblies have had an uninterrupted existence since 1309

The people have always been deeply religious. In the church of Sachseln, on the Sarnersee, still lie the bones of the holy hermit, Nicholas Lowenbrugger (1417–87), known as Nicholas von der Flüe, or "Bruder Klaus," while at Sarnen, near by, are several convents; the most famous of all the monasteries in the canton is the great and still wealthy Benedictine house of Engelberg (founded about 1120) Another site of historical interest is Stans, the birthplace of Arnold von Winkelried, the real or legendary hero of Sempach (1386) Some of the old and valuable "common lands" are still in the hands of the old gilds, and "communes" consist of natives, not merely residents. In Obwalden, these "burgher communes" contribute to the expenses of the new "political communes" of residents, but in Nidwalden the latter have to raise special taxes. (*See* SWITZERLAND. *Administration*)

History.—Historically, both Obwalden (save a small area in the Aargau) and Nidwalden were included in the Zurichgau. On Aug. 1, 1291, Nidwalden (Obwalden is not named in the text of the document, though it is named on the seal appended to it) formed the "Everlasting League" with Uri and Schwyz (this being the first known case in which its common seal is used). In 1304 the two valleys were joined together under the same local deputy of the count, and in 1309 Henry VII confirmed to them all the liberties granted by his predecessor—though none is known to have been granted. This placed Unterwalden on an equal political footing with Uri and Schwyz, and as such it took part (1315) in Morgarten fight (also driving back an invasion over Brunig pass), in the renewal of the Everlasting League at Brunnen (1315), and at Sempach (1386), and in driving back the Gugler or English freebooters (1375).

In 1798 Unterwalden resisted the Helvetic republic, but, having formed part of the short-lived Tellgau, became a district of the canton of the Waldstatten Obwalden submitted at an early date, but Nidwalden, refusing to accept the oath of fidelity to the constitution, mainly on religious grounds, rose in revolt (Sept. 1798), and was only put down by the arrival of 16,000 armed men and by the storming of Stans. In 1803 its independence as a canton was restored, but in 1815 the refusal of Nidwalden to accept the new constitution resulted in the transfer (1816) to Obwalden of the abbey lands of Engelberg (*See* SWITZERLAND: *History*)

UNYAMWEZI, a region in the Tanganyika Territory. A plateau between the two rift-valleys and 4,000 ft above sea level, it is well watered, fertile and wooded, or covered with long grass. In the west are swamps. From south to north it extends some 200 m. and east to west about 150 m. It includes the town of Tabora (*q.v.*) founded by Arab slave traders from Zanzibar.

The country is named from its inhabitants, the Nyamwezi (in Swahili, Wanyamwegi), and was mentioned by Portuguese chroniclers of the 16th century and by the navigator Antonio Pigafetti as Munemugi "The Land of the Moon," the exact equivalent of the native name Wu-nya-mwezi. The Nyamwezi, a large tribe, or group of tribes—the Sukuma, Sumbwa, Fipa, Winsa, Konongo and Kimbu among others—are both agriculturists and traders. They appear to have come early into contact with the Arabs and Indian merchants established on the coast. Quarrels between them and the natives became common, chiefly over the heavy transit tolls levied by the Nyamwezi on the Arabs. The first Europeans to enter Unyamwezi were Richard Burton and J. H. Speke, who visited Kaze (Tabora) in 1857. About 1858 the Arabs among them Tippoo Tib, a native of Tabora, defeated the Nyamwezi, but in 1871 the Arabs were defeated by a warrior named Mirambo (*c.* 1830–87), who by his military skill made himself master of most of the country. When Unyamwezi fell into the German sphere the Tabora Arabs offered no opposition, and Emin Pasha hoisted the German flag there in Aug. 1890. The Nyamwezi, however, resisted, and it was not until Jan 1893 that the Germans succeeded in storming the *boma* of their chief, Sike by name, who was killed It took the Germans many expeditions before they were fully masters of the country. As a result of the World War, it passed out of German possession

The Nyamwezi numbered (1921) about 500,000 persons. They are Bantu of medium size and negroid features, but with long noses and curly rather than woolly hair. They tattoo, file or extract the upper incisor teeth and load their arms and legs with brass and copper wire rings. They make cloth of cotton in their own looms, smelt and work iron, and grow tobacco extensively.

See the works of Burton, Speke and Stanley, H Brodie, *Tippoo Tib, the Story of his Career in Central Africa* (1907), *Handbook of German East Africa* (1917), a British Admiralty publication. (F. R C)

UNYORO, properly, and now officially, **BUNYORO,** a country of east central Africa lying north-west of Uganda, with which the British protectorate, dating from 1896, is now merged.

It has an area of 5,619 sq m Most is plateau land, 3,200 to 3,800 ft. above sea level, intersected by swamps, deep valleys and hills rising to 4,800 ft During the 19th century the states of Bunyoro and Buganda appear to have been rival overlords of the region between the Bahr-el-Jebel (Mountain Nile) and the great lakes. The Bunyoro number about 100,000. They had a certain civilization and were skilled in iron-work, pottery and wood-work. The ruling class is of Hima stock

The first Europeans to enter the country were J H Speke and J H Grant, who spent part of 1862 there, Kamurasi, the *Mukama,* (king), objecting to their further journey down the Nile. In 1864, Sir Samuel and Lady Baker discovered the Albert Nyanza Ivory and slave traders, nominally Egyptian subjects, penetrated as far south as Unyoro, and (1870–74) Baker, as governor-general of the Equatorial Provinces, placed a garrison at Foweira on the Victoria Nile. He annexed Unyoro to Egypt in 1872. General Gordon, who succeeded Baker, established posts at Masindi and Mruli. With King Kabarega, a son of Kamurasi, the Egyptians had many encounters Egyptian authority ceased with the withdrawal of Emin Pasha in 1888, but Kabarega in 1891 found himself in conflict with Captain (afterwards Lord) Lugard, who entered Unyoro from the south (*see* UGANDA: *History*) In 1889 he was deported first to Kismayu and, in 1901, to the Seychelles. In 1923 he was allowed to return, but died before regaining Unyoro

Another chief had to be deposed for incompetence. The next mukama, Andereya Dukaga, was a man of progressive ideas. He was about the 40th of Kabarega's 250 or so children, could read and write and was a Protestant As the country settled down the powers of the native administration were enlarged. The mukama presides over a *Lukiko* (council or parliament), which has the legal authority. This indirect government worked well and during the World War the Bunyoro gave the British substantial help.

Unyoro has played rather an important rôle in the past (unwritten) history of Equatorial Africa as being the region from which the ancient Gala (Hamitic) aristocracy, coming from Nileland, penetrated the forests of Bantu Africa, bringing with them the Neolithic civilization, the use of metals and the keeping of cattle. In the west and south-west of the country are the primaeval forests of Budonga (160 sq m.) and Bugoma (80 sq m), containing large chimpanzees and a peculiar sub-species of straight-tusked elephants (only found in Unyoro)

See the works of Speke, Grant and Baker; also *Colonel Gordon in Central Africa* (4th ed, 1885); F D. Lugard, *The Rise of Our*

East African Empire (1893); H. H. Johnstone, *Uganda Protectorate* (1902); H. R. Wallis, *Handbook of Uganda* (1920).

UPAS, a Javanese word meaning poison, and specially, the gum of the anchar tree (*Antiaris toxicaria*), of the fig-family (Moraceae), and a native of the Sunda Islands, which was used to envenom the darts of the natives. According to the absurd fable (professedly by one Foersch, who was a surgeon at Samarang in 1773) published in the *London Magazine*, December 1783, and by Erasmus Darwin (*Botanic Garden*, pt. ii), the tree destroys all animal life within a radius of 15 miles. The tree has a straight stem rising without a branch to 60 to 80 feet. It has a whitish bark and yields the juice from which the poison is prepared.

UPDIKE, DANIEL BERKELEY (1860–), American printer, was born in Providence, R.I, on Feb. 24, 1860. In 1893, he began to establish the Merrymount Press. In 1895 he revived the Scotch-cut type produced by Alexander Wilson about 1835. He later acquired the 17th century Dutch fonts of Janson and the matrices of the Mountjoy type, and he has led in the revival of classical typography in America. Special types, among them the Merrymount type, have been designed by Bertram Goodhue and Herbert Horne. He received the degree of A.M at Brown university in 1910. From 1910–17 he was lecturer on printing in Harvard university. He was selected to print the *Standard Book of Prayer* in the revision of 1928. His published works include: *On the Dedication of American Churches* (with Harold Brown; Cambridge, 1891); *Printing Types—Their History, Forms, and Use* (Cambridge, 1921); *In the Day's Work* (Cambridge, 1924). Also he edited. *A Dissertation Upon English Typographical Founders and Foundries*, by Edward Rowe Mores, with appendix by John Nichols (1924).

UPHOLSTERY. In modern usage, an upholsterer is one who supplies coverings, cushions, padding and stuffing for chairs, sofas or beds, or who repairs the same, and more generally one who also provides carpets, curtains and household furniture. The word first appears as "upholder," then as "upholdster" or "upholsterer," that is, a broker who holds goods up to public view.

The earliest example of upholstery consisted in simply stretching a piece of leather across a seat somewhat on the principle of a hammock. Subsequently, springs were added. These springs, at first shallow, developed in height until they were liable to bend over and be "crippled," as it is termed in the trade. This led to a greater amount of lashing or tying of the springs together; and to double springing, that is, one layer of springs of lighter weight superimposed upon a lower layer of heavier gauge.

Later, there has been the hour-glass shaped spring. This allows the use of a wide base and top. On compression, the coils do not "chatter" or rub together when sat upon.

Manufacture.—Across the base of the seat webbing is stretched and tacked to the wood frame To this the springs are sewn with cord, and subsequently lashed or tied together to ensure that they do not get bent over on one side If the chair is to have what is called a spring edge, a piece of cane is bent round at the front of the seat and also lashed to the springs, so as to form a firm edge, and at the same time ensure that the springs work in unison. After this, canvas is stretched over the springs and tacked down to the wooden frame. The chair is then first stuffed with whatever material may be chosen, such as fibre or hair, a light canvas or scrim is placed over the filling, and the edge stitched by hand to form a firm portion which determines the outline and form of the chair. The chair is then second-stuffed with a further layer of hair or some cheaper material. This hair is then covered with a layer of wadding to prevent it from working through the cover. The same treatment is applied to the back and arms, which may also be sprung. The upholstered articles may now be first covered in calico, or the final cover put on.

Spring Frames.—As the web foundation for a chair has sometimes proved unreliable, it is sometimes superseded by the employment of a spring frame. This consists of a series of springs held together by suitable metal links and surrounded by a wire edge bent to the shape of the outline of the seat. Alternatively, other makers have employed lace webbing as a foundation on which to impose the layer of stuffing underneath the cover. The lace webbing resembles wire-woven mattresses.

The principal raw materials employed in upholstery are timber for the framework, webbing, springs, hair, fibre, flock, woodwool, canvas, wadding, tacks, twine and laid cord; various coverings, such as leather, moquettes, velvets, tapestries, silks and damasks. (*See* FURNITURE MANUFACTURE.) (W. H. S.)

UPPER SIND FRONTIER, a district of British India, in the Sind province of Bombay, with administrative headquarters at Jacobabad (*q.v.*). Area, 2,695 sq m.; pop. (1921) 240,619. The land is watered by canals from the Indus, of which the chief are the Begari and Desert canals Principal crops are millets, oil-seeds, pulses, wheat and rice, most of which is sent to the sea-board; the trade from Central Asia into Sind crosses the district, bringing wool and woollen goods, fruits, carpets and horses. The district is crossed by the Quetta branch of the North-Western railway, and from Jacobabad a 2½ ft. gauge line runs to Kashmor

UPPINGHAM, a market town of Rutland, England. Pop. (1921) 2,453. The Church of SS Peter and Paul has Decorated portions in the nave, tower and spire. The pulpit is of the 17th century. Jeremy Taylor was rector here at the outbreak of the Civil War. The principal institution of Uppingham is the school. It is coeval with the grammar school of Oakham (1584), and had the same founder, Robert Johnson, archdeacon of Leicester. During the nineteenth century, the school was developed by Edward Thring into a public school of great educational influence. (See *Life and Letters of Edward Thring* by E. R. Parkin, published 1898)

UPPSALA or **UPSALA,** a city of Sweden, 41 m. N. of Stockholm Pop. (1928), 30,198. The name originally belonged to Old Uppsala, nearly 2 m. N of the present city. This Uppsala, mentioned in the 9th century, was famous for its heathen temple, which gleamed with gold Three huge grave mounds remain here. In the same place the first cathedral of the bishops of Uppsala was erected (*c.* 1100) But on its destruction by fire, convenience caused removal in 1273 of the archiepiscopal see to the present city, then called Ostra Aros, but later Uppsala, which became a kind of ecclesiastical capital Here the kings were crowned, after their election at the Mora Stones, 10 m S E of Uppsala.

In 1567 Eric XIV. murdered in the castle five most eminent men of the kingdom, three of them belonging to the family of Sture In 1593 was held the great synod which marks the final victory of Protestantism in Sweden, in the same year the university was restored by Charles IX In the castle, Christina, daughter of Gustavus Adolphus, resigned her crown to Charles X. in 1654. In 1702 nearly the whole city was burnt down.

Uppsala has water-communication with Stockholm by the river Fyris and the northward arm of Lake Mälar, into which it flows. The older part of the city lies on its sloping west bank.

The university, the chief and oldest in Sweden, was founded in 1477 by Archbishop Jakob Ulfsson The university building, completed in 1887, lies west of the cathedral. The library building was erected in 1819–41. It is on the site of the Academia Carolina, founded by Charles IX., and is known in consequence as *Carolina Rediviva.* Since 1707 the library has had the right of receiving every work printed in Sweden. Among the mss. is the famous *Codex Argenteus* (6th century), a translation of the Gospels in the Gothic of Bishop Ulfilas (4th century). In the old botanic garden, Linnaeus had his residence. The new botanic garden was given by Gustavus III. in 1787. The observatory was founded in 1730. The Victoria museum contains Egyptian antiquities The Royal Society of Sciences, founded in 1710 by Archbishop Erik Benzelius, has a valuable library. Much of the revenue is drawn from the estates granted by Gustavus Adolphus in 1624. Every student must belong to a "nation" (*landskap*), of which there are 13, each representing a particular part of the country and having generally its own club-house and fund. For singing, the students have a high reputation.

The cathedral stands nobly above the town; its tall western towers with their modern copper-sheathed spires are visible for many miles. It is of simple form, and mainly French in style (the first architect was a Frenchman, Étienne de Bonneuil) modified by the use of brick as building material. Ornamentation is

thus slight except at the southern portal. The church was building from 1287 to 1435. It suffered from several fires, and a thorough restoration was completed in 1893. The easternmost chapel is the fine mausoleum of Gustavus Vasa The castle was founded in 1548 by Gustavus I. It was destroyed by fire in 1702, and is still in part ruined. Uppsala is a book-printing centre

UR, a very important Sumerian site and the reputed early home of Abraham (Biblical Ur of the Chaldees). Ur lies about 140 miles south of Babylon, and about 6 miles south of the modern bed of the Euphrates, about two miles from the modern Ur junction on the Baghdad–Basra railway, in 31° N., 46° E. In ancient times the Euphrates ran west of Ur, reaching open water near Eridu The river was diverted so that it passed by Ur in the time of Rimsin. The city also lay near the ancient junction of the Tigris with the Euphrates, when the former flowed along the Shatt al Hai. Ur lies close to the low hills which form the edge of the Arabian desert. It commanded the communications of both rivers. It was close to the sea and at the same time a convenient entrepôt for the commodities of the desert. The gradual change in the coast line and in the course of the rivers has left the ruins in the desert Although most of the ruins of Ur as seen to-day,—and the *ziggurat* is one of the best preserved in Mesopotamia,—belong in their present form to the Neobabylonian period, recent excavations have shown that the site has been occupied from extreme antiquity. Original excavations were undertaken by Taylor in 1854, but a serious examination of the site was not made till after the World War by Hall His work has since been ably continued by Woolley.

Amid the extensive remains of cemeteries, the most recently found graves, which lie south-east of the sacred enclosure, are the most interesting. The graves fall into three periods, and are dated provisionally by Woolley at 3500 B.C., the second series are comparable with Cemetery A at Kish, and are dated by Woolley at about three centuries later, while the third series are some centuries later, but at present are undated

The richest graves of all belong to the earliest period. Their wealth of precious metal shows that there was a very considerable and prosperous civilization, while the settled style of the art shows that this civilization was already an old one. The graves antedate the first dynasty of Ur by 400 years, they come therefore in the period subsequent to "the flood," a period in which Sumerian historians placed two dynasties, those of Kish and Erech For these periods and for the first dynasty of Ur they record only the names of the kings, often exaggerating the length of their reigns to an absurdly great degree The excavations at Ur have, however, produced inscriptions of the first dynasty and these early graves show that the occupation of the lower river valley is extremely ancient, while additional confirmatory evidence of an early date has recently been found at Kish

The great temple area at Ur is both striking and has had many archaeological results The temenos or sacred enclosure as it exists to-day is the work of Nebuchadrezzar. The outer wall appears to have been pierced by six great gateways On the north-east side the more northerly had a corner stone with an inscription of Bur-Sin. The southerly was restored by Cyrus, the son of Cambyses. On the south-western side the gateway opposite the ziggurat had an inscription of Nabonidus.

The ziggurat stands in the north-west corner of the sacred area. It consists of three stories The lowest, which measures 210 × 140 × 20 feet, was built by Ur-Nammu and Dungi and was built so well that further restoration was apparently never needed. The second stage was restored by Nabonidus A small building crowned the third stage. This was the bedchamber of the god and goddess, not a temple as Herodotus supposed The face of the first stage was blackened, the second and third was of red stone, while the shrine on the top was encased in blue brick, the work of Nabonidus. On the north-east side there were three stairways, leading from the platform to the second stage, two ran along the face of the tower from the north and east angles respectively and met in the middle, from which point there was a third stairway, running towards the face of the tower, at right angles to the other two.

East of the ziggurat lay the great temple of E-num-mah. The ruin is of three periods, prehistoric to Neobabylonian, and of the time of Cyrus. The old Sumerian foundation wall was made of unbaked brick built on a foundation of clay which had been beaten hard On this there were two courses of unbaked bricks of Bur-Sin, 8 ft. 9 in. thick and 8 ft. 5 in high, which had been restored at various times. On either side there are a row of rooms. The temple was laid in ruins between the time of Hammurabi and the Kassite dynasty. Nebuchadrezzar II. made a complete restoration. The old temple had no great open court, an obvious need in a great temple, for this Nebuchadrezzar made provision.

South-east of the ziggurat was a much ruined temple of Ningal. The middle cella and the side chapels lie on the north-west side of the court, and the entrance, through a great recessed doorway is on this side On either side there were two rooms connecting with antechamber and chapels and the plan recalls the temple of Ishtar at Babylon. A roadway led from the south-east of the temple of Ningal, ending in a great double gateway which gave access to the court of a great rectangular building east of the temple. There was communication from the south corner of the temple court to this street through a pair of recessed gates. At the other end of the roadway the excavators found a recess with a door opening on to a building of the Kassite period.

Between the temple of Ningal and E-num-mah lay the shrine of Nannar, E-dub-lal-mah. This is mentioned in an old liturgy as a temple of Ur and buildings of this name occur in other cities, such as Adab, Larsa, Lagash and Isin. The town itself was excavated by Woolley It has been shown that the old town of Ur, as it presented itself to Abraham's view, cannot have differed much from the modern mudbrick towns of Mesopotamia.

See, for earlier excavations, *Cambridge Ancient History*, vol. 1, 1923 (bibliography), H R Hall, *Museum Journal*, XV Woolley's reports are appearing annually in the *Antiquaries Journal* (Vol III onwards). A short summary of excavations from 1918 with bibliography in S. Langdon, *Der alte Orient*. 26 (1928) (L. H. D. B.)

URAL-ALTAIC LANGUAGES. The Ural-Altaic languages consist of two groups The first is the Uralian group (Finno-Ugrian languages [*q v.*], and the Samoyedic languages), spoken round the Ural mountains; and the second, the Altaic (Turkish [*q.v*], Mongolian [*q.v*], and Tungus tongues) in derivation from the mountain range of that name.

The Phonetic System.—Almost without exception the Ural-Altaic languages recognize a law of vocalic harmony Exceptions exist but are explained consistently with the general principle: that in any single word only vowels of the same "timbre" may appear, thus, if the radical vowel of a word be *o* or *u*, the vowels in the other syllables must be *o*, *u* or *a*. In other words, vowels in the same word must harmonize in method of articulation. On the other hand, if the root-vowel is *e* or *i*, the vowels of other syllables of the same word must be pre-palatals or anterior-vowels (*i e.*, articulated in the forepart of the mouth like *e* and *i*).

We have thus in Finnish the word *kesi* "hand," *kivi*, "stone," *metsä*, "forest," opposed to *kala*, "fish," *sulka*, "feathers," etc. The same applies to Hungarian, *repul*, "to fly," *lélek*, "soul," *segit*, "to help," presenting vocalic contrast to *három*, "three," *olvad*, "to smelt," *savanyu*, "bitter," etc. Turkish is even more observant of detail. *deri*, "skin," *dudak*, "lip," *bajak*, "leg, thigh," *böjük*, "big, tall," etc. (These examples are from Osmanli)

In actual practice, there are numerous exceptions Nevertheless, in Mongolian, Turkish, Hungarian and Finnish, vocalic harmony, without being general, tends to establish a balance between the divisions and dispositions of words, and is thus an important factor in the phonetic structure of Ural-Altaic languages.

Consonantal Alternation.—In any given word the consonant which ends the root syllable is subject to various mutations according to the nature of the syllable following (open or closed). It is especially characteristic of certain Uralian tongues, like Lapp, Finnish and the Samoyedic languages. In the other languages it has not developed beyond the merest trace. Thus, in Finnish, *kukka*, "flower," but *kukan* (genitive), "of the flower"; *kuto-*, "to weave," but *kudon*, "I weave"; *repo*, "fox," but *revon* (gen.) "of a fox"; *onki*, "fish-hook," but *ongen* (gen.) "of a fish-hook"; *lintu*, "bird," but *linnun* (<*lindun*), "of the bird," etc. In their present form

the consonantal alternations, so numerous and so varied in Finnish and, above all, in Lapp, give no indication of what they once were. In early times, it seems probable that at the end of the root syllable, there was an alternation of degree—a strong one and a weak one, *tt. kk pp.* and *t k p.* There was also an alternation which produced a contrast between *p. t. k.* and *β. δ. γ*; *m. n.* ɔ, and *β. δ. γ.*, etc. This alternation extended to groups of consonants opposing a strong *mt* to a weak *md*, *mp* to *mb*, *ks* to *γz*.

This alternation theory (German *Stufenwechsel*) was formulated by the Finnish linguist, E. N. Setälä, who proposed to extend it to Altaic tongues, where Ramstedt had discovered it in part. It is unlikely that consonantal alternation can be demonstrated in Mongolian, Turkish and Tungus except at a very early stage.

Vocalic Alternation.—There exists also an alternation of vowels by which, according to the suffixes which a word may take, the vowel of the root syllable may be modified or changed. Thus, in Finnish, *pala*, to burn (intrans.), and *polttā*, "to burn" (trans.); in Ostyak, *n'āləm*, "tongue," and *n'ilməm*, "my tongue," etc. These instances are rare in modern Ural-Altaic speech, and the Uralian tongues have best preserved the traces, although examples are also found in Turkish and Mongolian.

The rules which determine the beginning and ending of words are that no word can begin with more than one consonant, and when a foreign word so beginning is borrowed it is simplified accordingly. The Swedish word *stor*, "big," becomes *suuri* in Finnish Elsewhere a vowel is put before the double consonant to facilitate enunciation: the Slav word *stolu* is in Hungarian *asztal* (pron. *ostol*) and the English "steam" is, in Osmanli, *istim*, etc.

The accent varies in position and quality. Finnish and Hungarian stress regularly the first syllable and Turkish the last. In Samoyedic and other idioms such as Ostyak it varies.

Morphology.—In the first place, no language of the group uses prefixes; all the grammatical modifications expressed in English by prepositions (viz, to, on, of, for, etc) are effected by means of suffixes "I enter the house," is, in Hungarian, *belépek a ház-ba* (*ház*, "house"—*ba*, suffix meaning "into"). In a tale written in Kazan Turkish we find: *ber keše urmanγa barγan dej*, "a man went into the forest" (*urman*, "forest"—*γa*, "into") The majority of the grammatical relations affecting words are therefore expressed by suffixes, which differ in form from language to language, but play the same rôle throughout These suffixes are strengthened by post-positions: thus (Hungarian), *egy fa alatt*, "under a tree" (*egy*, "one, a," *fa*, "tree," *alatt*, "below")

The possessive case is formed by suffixes except in Mongolian and Tungus. Hungarian *szem-e-m*, "my eye" (*szem*, "eye" + *m*, "my," with euphonic *e*) *szemed*, "thine eye" (*-d*, "thy, thine"); *szeme*, "his eye" (*-e*, "his"); *szemunk*, "our eye" (*-unk*, "our"), etc. Osmanli Turkish also has this form, *ev-im*, "my house" (*ev* "house," *im*, "my"); *ev-in*, "thy house" (*-in*, "thy"); *ev-i*, "his house" (*i*, "his"); *evimiz*, "our house" (*-imiz*, "our"), etc. This use of the possessive prefix is, however, comparatively modern, since it does not exist in Mongolian and Tungus and, further, since in Hungarian as in Turkish these suffixes are added directly to the root before other suffixes, while in other tongues (Finnish, Lapp, etc.) they follow all other suffixes. Compare Hungarian *a házamban*, "in my house" and Turkish (Osmanli), *evimde* (idem) with Finnish *kodassa-ni* (*-ni*="my").

The Uralian languages, Turkish, Mongolian and Tungus appear to have developed their system of word-building as we know it to-day at a date which, if not recent, was well after the time when the languages were closely related. Only a few suffixes can be restored throughout the family; it may be suggested tentatively that one method of forming the plural was to suffix a *-t* to substantives, as in modern Mongolian, Tungus and Uralian, a process of which Turkish has conserved a few traces. The main characteristic of the Ural-Altaic tongues is the difficulty, even in modern speech, of distinguishing between nouns and verbs by their outward forms. The conjugation of the verb is reminiscent of the possessive-suffix system of the noun and many verbal suffixes are identical in form with those which are used to construct new nouns. The adjective has no proper declension.

Vocabulary.—All words dealing with rudimentary civilization are common to all the languages, such as those expressing relationship (father, mother, uncle, aunt, etc.), certain elements, animals and plants, primitive occupations and simple movement and gesture words. The comparative philology of these languages demonstrates a neolithic civilization of the type of which traces have been found in different parts of the Urals. This primitive vocabulary, the common patrimony of all the tongues, is augmented by words of very diverse origin. Mongolian and Turkish have borrowed much from Chinese and Indian languages. Uralian languages have drawn largely on Indo-European stocks and in modern times many Iranian terms have been admitted. In modern days Hungarian, Wogul, Ostyak, Cheremiss and Wotjak have taken many words from Turkish lexicography. Tungus has a large percentage of Mongolian words; Osmanli Turkish has adopted much from Arabic and Persian. Mongolian and Turkish have lent to, and borrowed from, each other, and Palaeo-Asiatic elements have enriched and varied the vocabularies of the Ural-altaic languages spoken in Asia. In Europe, Finnish, Lapp and Estonian have borrowed much from Germanic, Baltic and Slav languages, Hungarian from Ossetian, Slav tongues and German. The vocabularies of the Finno-Ugrian and Turkish languages spoken on Russian territory are rapidly becoming Russianized

Numerals.—The Ural-Altaic numeral system is decimal throughout. The names of the numbers in the different languages differ widely, because the primitive Ural-Altaic speech had not developed a proper numerical system before the dispersion.

CLASSIFICATION OF URAL-ALTAIC LANGUAGES

A. URALIAN LANGUAGES

Finno-Ugrian Languages (*q v.*) —1. Lapp: Southern Lapp, Ume-Lapp, Swedish-Lapp, Norwegian-Lapp, Enare-Lapp and Kola-Lapp. 2. Finnish: *Suomi* (of Finland), Karelian, Olonetsian, Ingrian, Ludik, Vepse, Wote, Estonian, Livian. 3. Mordvinian, Moksha, Erza. 4. Cheremiss. 5. Permian: Wotjak, Syryene. 6 Ugrian: Wogul, Ostyak, Hungarian (Magyar).

Samoyedic Languages.—Yurak, Tawgy, Yenisseian, Kamass (or Sayan Samoyedic), and Ostyak-Samoyedic.

B. ALTAIC LANGUAGES

Turkish Languages.—1. Turkish of Altai, Uzbeg, Kirghiz, Bashkir. Tatar: Azeri, Turkmen, Osmanli, etc. 2. Yakut. 3. Chuvash

Mongolian Languages.—1. Eastern Mongol (Khalkha, Tsakhar, etc.). 2 Western Mongol (Kalmuck). 3. Northern Mongol (Buriat).

Tungus Languages.—1. Eastern Tungus: Goldic, Olcha, Lamut, Orochene, etc. 2. Southern Tungus: Dahur, Solonic, etc 3 Western Tungus (Tungus of Vershoïansk, Yakutsk and of the Yenissei, etc.), Manchu.

Many sub-dialects are necessarily annulled, and this brief classification does not imply, so far as Altaic languages are concerned, any definite relationship. The relationships of these different tongues are, as yet, far from being elucidated.

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URAL MOUNTAINS, a mountain system which extends north to south, from the Arctic ocean to the Caspian sea and separates Europe from Asia. The Urals have been affected by a series of separate upheavals, some having a north to west strike and some a north to east They reach their maximum altitudes along a zone stretching nearly north and south. The composite nature of the Urals is best seen at the extremities of the system, where the upheavals form a distinct chain of mountains.

The Paē-khoy or coast ridge (Samoyedic "stony ridge") is independent of the Urals proper. It has a distinct north-north-west and north-west trend, and although cut through by the Yugor strait it is continued in Vaigach island and Novaya-Zemlya. Its

dome-shaped summits rise 1,000 ft.

The Obdorsk or Northern Urals begin near the head of Kara bay and extend south-west to the 64th parallel and form a distinct range, stony and craggy, sloping steeply towards the south-east and gently towards the marshes of European Russia Its highest peaks are Khard-yues, 3,715 ft., and Paë-yer, 4,752 ft. Sometimes the main chain has on the west two or three secondary chains, formed by sedimentary rocks, and the highest peaks of the Urals (Sablya, 5,402 ft., and Töll-poz-iz or Muraï-chakhl, 5,537 ft) occur in the south of one of these. Dense forests, chiefly fir, pine and larch, clothe the mountain slopes, but every species, except the larch, gradually disappears in the north, and the upper limit of vegetation (2,400 ft. in the south) rapidly descends to the base of the mountains near the Arctic Circle, and forest vegetation disappears about 65° N (67° in the plains).

The section between 64° and 61° N has again a wholly distinct character. Here the main water-parting is a succession of plateaus stretching in a north-westerly direction It has broad, flat, marshy valleys, whilst here and there are isolated summits, mostly under 3,000 ft (Yang-tump, 62° 43′ N, 4,170 ft). The whole region, except the mountain summits, is densely clothed with coniferous forests. This part of the range is uninhabited.

The Middle Urals, about 80 m. broad, contain rich iron, copper and gold mines (Bogoslovsk, Goroblagodatsk and Ekaterinburg Urals). The Denezhkin Kameñ in the north (4,841 ft) and the Tara-tash in the south (2,800 ft.) mark the limits of this section. Here the orographical structure is more complicated. In the north (61st to 60th parallel) there is a succession of chains with a distinct north-eastern trend South of Kachkanar (2,866 ft) the Urals assume the appearance of broad swellings 1,000 to 2,000 ft in height, deeply trenched by ravines. These low plateaus have been utilized for centuries as the chief highway to Siberia. The water-parting between the Russian and Siberian rivers is here not more than 1,245 ft. above sea-level on the great eastward road, west of Sverdlovsk (Ekaterinburg). The valleys have a decidedly south-eastern direction, as has the railway from Perm to Kurgan. The Middle Urals are densely forested. The valleys and lower slopes have a rich soil and contain large and wealthy villages. The mines also support a considerable population.

The Southern Urals (55° 30′ to 51° N) consist of three parallel chains running north-east and south-west and constitute an independent part of the Ural system. The Urals proper are a low sinuous chain hardly exceeding 2,200 to 2,800 ft. in altitude. Farther west there is a parallel chain which, although pierced by rivers, reaches 5,230 ft.; whilst farther west still is another series of equally high chains. The gentle slopes of the hilly tracts are dotted with woods, mostly of deciduous trees, while the hollows contain rich pasture grounds. The region is being colonized.

Farther south the main range, except when deeply trenched by the rivers, is a plateau which hardly reaches 1,500 feet. It is continued towards the Volga under the name of Obshchiy Syrt.

South of the great bend of the Ural river, quite independent ranges of hills, or flat swellings, appear (*e.g.*, Dzhaman-tau, Mugodzhar hills). A range of heights connects the Mugodzhar hills with the Ust-Urt plateau.

Geology.—The Ural mountains are no more than the western edge of a broad belt of folding of which the greater part is buried beneath the Tertiary deposits of western Siberia. Throughout the greater portion of the chain a broad strip of granites, diorites, peridotites, gneisses and other crystalline rocks rises directly from the Siberian plain, and is covered towards the west by Silurian, Devonian, Carboniferous, Permian and Triassic strata, which are thrown into numerous folds parallel to the length of the chain and usually rise to much greater heights than the crystalline zone. For the mineral wealth of the Urals *see* URALSK AREA.

URALSK, a town of Asiatic Russia, on the Ural river, where the railway crosses it. Pop. (1926) 35,994. Founded in 1775, it is a centre for grain and cattle from the Kirghiz steppe. There are seven flour mills and four leather and gut preparing works with iron and woollen industries; also a model farm, a museum, and branches of the Russian Geographical and of the Fisheries Societies.

URALSK AREA, an administrative division of Russia, lying partly in Europe, and partly in Asia, and which should not be confused with the former Uralsk province of pre-1917 Asiatic Russia, which is now included in the Kazakstan A.S S.R. (*q v*). It stretches southwards from the Arctic Ocean to the Kazakstan A S.S.R on the east, and the Tatar A S S R, Bashkiria and Orenburg province on the west. The Siberian area forms its eastern boundary, and to the west lie the autonomous Komi (Zirian) area, the Vyatka province and the Votyak autonomous area It occupies 1,692,810 sq km. and has a population of 6,791,875 (1926), 91·2% of whom are Russians, the remainder being chiefly Turco-Tatars, Finns, Poles, Jews, Lithuanians and Latvians. Most of the Ural range lies within its borders.

It reveals many aspects of the complex life of Russia, up-to-date electrified industry side by side with peasant mining and metal *artels*, a railway net in the south, trackless wastes in Tobolsk, rich corn-growing lands, meadow cattle pastures, sheep-grazing lands, nomad reindeer breeders, fishing, the hunting life of the coniferous and deciduous forest, and the bleak desert tundra of the Arctic shores. East of the Urals there are the winds from Asia; the rainfall varies between 8 to 16 in. east of the Urals to 20 in. west of them. Summer in the south is as hot as in Odessa, while winter is much more severe. Spring, especially in the south-east is very short. The rivers are frozen from 144 days in the south to 200 in the north. The north lies within the Arctic circle.

The economic life of the Uralsk region centres on the vast mineral wealth of the Urals. A wide zone of the western region of the Urals is covered with Permian deposits rich in copper, salt and salt springs.

Rivers and Lakes.—On the eastern foothills are a series of freshwater lakes formed in natural hollows and quite distinct in type and origin from the salt lakes of the Aralo-Caspian depression. The rivers on the west, the Kama, and its tributaries especially the Kolva, Vyshera, and Chusova, are of great importance, and link the region with the Volga, and by a canal system, with Leningrad. The eastern drainage links with the Ob (*q.v*) and the Arctic, and is therefore less valuable for navigation, especially as the stream beds are often interrupted by rapids; they are, however, sources of potential electric energy. Efforts are being made to establish trade via the Ob river and the north, and a trading expedition in 1928 visited the mouths of the Ob and Yenisei; the transport cost of wheat, fur and asbestos sent this way is less than half of that sent via Leningrad. But the difficulties are great and the season short. Better harbour facilities and a close net of wireless stations along the coast are necessary if the route is to develop. A commission is, however, considering the possibility of shortening the route by cutting a canal from the Ob to Kara bay, thus avoiding the journey round the Yalmal peninsula, and of extending the railway from the Tavda northwards to the Ob, or possibly to the canal itself. The sources of the Ural river (Yaik) and its tributaries the Sakmara, Or and Ilek, and of the Pechora and Usa in the north lie in the area.

Mining.—The beginning of salt, iron and copper exploitation was made in the 16th century by the brothers Stroganov, to whom the land was given by the Moscow government in 1558. Later Peter the Great founded several iron-works and after the discovery of gold in 1745, colonization proceeded rapidly. Until 1861 the work in the mines was carried on by serfs, either belonging to private persons (especially the Stroganovs and Demidovs) or to the Crown. Russia and Sweden, using charcoal, were formerly the chief iron producers, but when coal began to be used, especially in England, the market passed from them The Urals ceased to be the chief mining district in Russia, and the Donetz basin in the south took its place. Even after the revival of the Ural iron industry in 1898, when foreign capital (especially British) redeveloped and improved it, the ratio of iron production as between southern Russia and the Urals was 67:19. In the post-revolution period the region was in the centre of the disturbances and the Czech army and Kolchak's troops both held it temporarily. Much of the plant of the mines and metal works was destroyed, and the bridges, permanent way and rolling stock of the railways were damaged. This, combined with the revolution in the economic

régime brought industrial life almost to a standstill and many branches have not yet fully recovered, especially the copper industry (1928). Important changes have taken place in the industry in the period of re-organization. The freightage costs of fuel are heavy, the good coke of the Kuznetsk district is much better for smelting furnaces than the local coal, but its transport cost raises the price of metal and puts it at a disadvantage in the market. The timber for charcoal in the accessible regions is rapidly diminishing and the power problem became acute after 1921. It has been partly met by electrification, and within the period 1923–28, electric power has been supplied at Chelyabinsk, using brown coal, at Kizelovsk, at Sverdlovsk (Ekaterinburg), using peat fuel, and on the Chusov river, using water power; a further station is under construction at Egorshin, while the capacity of that at Chelyabinsk is being increased Naphtha has also been introduced as fuel and the rôle of timber and charcoal as a source of power compared with other sources diminished in the district from 70 30 in 1922–23 to 52 47 in 1924–25. The industry has also been helped by concentration, the smaller and less profitable undertakings having been closed down. It is still, however, bearing the burden of keeping mines in repair which cannot be opened for lack of capital and of restoring war damages, so that the full effect of the reconstruction is not yet felt.

Iron, chiefly magnetite, is found on the eastern Urals, especially on the Blagodak, Vycok and Magnitnaya hills, the iron ore of the Zlatoust district is of very high quality. The Alapaev mines in the Tagil district in which manganese is worked are productive and developing rapidly. Metal is worked in Nadezhdinsk on a large scale, at Chusovaya and Lysva, near Perm and at Zlatoust. Coal production has reached pre-war level The Kizelovsk mine produces the best quality and supplies the railway; anthracite is mined in Egorshin and along the Troitsk-Orsk railway. Brown coal, with a high calorific value, but much ash, is mined at Chelyabinsk and near Tagil Four of the mines have cheapened cost by using electricity. The coal passes over into graphite towards the north. The vast peat resources of the district are being exploited for electric power, especially at Sverdlovsk and Zlatoust. Copper of good quality is found associated with sulphur pyrites and malachites, and in some cases with gold, silver, zinc, selenium and tellurium. In pre-war times it was exported in quantity; capital, however, is needed for its restoration and at present (1928) the Kyshtym and Kalatinsk mines only are working, while the Pyshminsk-Klyuchev is being kept in repair. In view of its importance in the electrical industry, the copper industry will probably revive.

Gold was formerly an important product and there is a Government gold laboratory in Sverdlovsk. In pre-war times the annual output was 10·9 tons, but it is now declining and the east Siberian goldfields are taking its place on the market. It was mainly a peasant industry centring on Mias, near Zlatoust, Sverdlovsk and Troitsk. The gold obtained from the sands in the south-east is not valuable. Platinum from the Urals formed 90% of the world market supply in pre-war times; it was first exploited in 1824 and is found in the Tagil district. In 1926 the platinum produced was 92,700 troy ounces, as against 157,453 in 1913: the fall was mainly due to lack of dredgers, but these are gradually being replaced The salt works on the upper Kama are very ancient and produce about 18% of all the salt in Russia Rich deposits of potassium salts have recently been discovered extending from Solikamsk in 59° 38′ N., 56° 50′ E, to Usolsk, the terminus of a branch railway from Perm: it is estimated that much will be available for export in addition to that used in local agriculture, and cheap water transport to Rostov-on-Don or Leningrad is available. Superphosphates are produced near Sverdlovsk and the upper Kama, soda at the Beresnikov factory, chromium ore is worked at Shaitansk, and dynamite and nitrite at Kyshtym. Sulphuric acid from the by-product sulphur of the copper is also produced. Asbestos is worked at Alapaev and near Sverdlovsk, and the output of asbestos sheets, asbetite and other products is greater than in pre-war times, partly because the other asbestos mines in the U.S.S.R. are not yet re-started (1928). The Ural precious stones, especially emeralds, are famous and include chrysoberyl, topaz, beryl, tourmaline and amethyst.

Industries.—Of industrial enterprises, smelting and the making of machinery and metal goods occupy the first place. Of special importance is the supply of agricultural machinery to Asiatic Russia, where demand at present far exceeds supply. Sverdlovsk, Perm, Zlatoust, and the Tagil district are centres for heavy industry. Railway repair shops exist here and at other points on the line. There are china, glass, cement, brick and worked stone industries, and aluminium is made from local bauxite. The fine building material is little exploited owing to transport difficulties. Of industries for local needs, leather is prepared in Kungur, Tyumen and Sverdlovsk, and footwear is made at Sarapul; cloth and linen products though greater than in 1913, do not meet the demand Food products include flour, dairy produce, which is organized in about 1,000 co-operative *artels,* brandy, beer and meat preserves. Makhorka tobacco is made and matches in Perm and Tyumen, where there are also saw mills, and cardboard works In the Tagil district there is sawmilling, and a paper and cellulose industry. On the east of the Urals koustar or peasant industries are widely developed, and include small iron ware; every variety of wood product from pitch and tar preparation to furniture making; leather goods; saddlery; flour milling and the polishing of stone and marble

Agriculture.—Much of the Uralsk area consists of the vast tundra of the north and the Yalmal peninsula, and is unsuitable for agriculture Omitting this area, more than half of the remainder is covered with coniferous or deciduous forest. In the valleys of the foothills and on the eastern plain is rich black earth, merging into less favourable, but still fertile, chestnut-coloured soil. In these areas cultivation is densest, wheat, with oats second, forms the main crop in the Troitsk, Chelyabinsk, Shadrinsk, Kurgan and Ishim districts, oats, with wheat second, in Irbit, Sverdlovsk, Tyumen and Zlatoust, while rye is the main crop in Sarapul and Tobolsk, and oats in the Upper Kama, Perm, Tagil and Kungur. Cultivation thins out with height on the Ural plateau, and, in dependence on climate and soil conditions, almost disappears north of the Sverdlovsk-Omsk railway Its northern limit on the east lies roughly along 57° N, and is markedly further south than on the west of the Urals. Isolated patches of potato and vegetable cultivation lie to the north in the alluvial river soil

Camels are bred in the south-east steppe and reindeer north of lat. 52° N. Pigs are reared in the Irbit-Tobol-Tyumen districts Fishing is a supplementary industry in the Urals, but very important in the Ob and its tributaries Even the valuable fisheries of the Lower Ob are feeling the effects of destructive exploitation and there is great need for fishing *artels* and for the building of factories for salting and preserving The catch is mainly perch, ruff, silurus, carp, bream, roach, sturgeon, herring and nelma Hunting is important in the Perm and Upper Kama districts and in Irbit and Tobolsk.

The chief animals hunted are squirrel, hare, elk and deer and heath cock and grouse; others are fox, bear, wolf, marten, ermine, badger, seal, northern deer, and partridge, goose and duck. Hawk hunting is still practised in the steppe regions. Turgut, Obdorsk, Berezov, Tobolsk, Tyumen and Irbit are centres of collection. The latter was noted for its fur fair in February and March, but its importance is diminishing

Communications.—The Perm-Sverdlovsk-Tyumen line, linked from Sverdlovsk with the Tavda river, Chelyabinsk, Troitsk and Kurgan and with some other centres, is the only one. The link with Perm will be very valuable when the plan to link Kotlas with the Murman railway, and thus provide a winter outlet for the Ural products, is carried out. Though this southern net is a contrast to the absence of lines in much of the area, it is inadequate for the needs of an industrial region. Roads are poor and absent in many places, and the improvement of communications, here as elsewhere in Russia, is a problem facing industry. Sverdlovsk (*q.v.*) is the administrative centre, pop. (1926) 136,494; other towns (*q.v.*) are Perm 119,420, Zlatoust, Chelyabinsk and Tyumen, over 47,000, Kurgan, Sarapul, Tobolsk, Troitsk, Kungur, Irbit, Ishim and Shadrinsk.

Population.—Of Finnish tribes the Permyaks of the Kama river are closely related to the Komi (*q.v.*) and speak a language resembling theirs. The Voguls (Maniza) are most numerous in the valley of the Konda, but extend over the Urals and are found in Perm. They are dark, brachycephalic, with broad faces and flat features. Their main occupations are fishing and hunting. The Ugrian Ostyaks are dolichocephalic, short in stature and have some Mongolian features, perhaps due to intermixture with Tatars in the 16th and 17th centuries. Their language is akin to Hungarian. They fish, hunt, and gather cranberries and cedar-nuts. Some have become settled and have built earthen huts, and keep horses and cattle. Their standard of living is higher than that of many tribes, especially amongst the southern Ostyaks. The northern Ostyaks retain more of their ancient customs; they regard the bear with veneration, practice Shamanism and bury their dead in canoes, or leave them in the forest with a covering of skins. In the neighbourhood of Obdorsk are the Yuraks, a branch of the Samoyedes; who are mainly nomad reindeer breeders, with fishing and hunting as supplementary occupations The Samoyedes of the Yalmal peninsula are prosperous, and have large herds of reindeer. (R. M. F.)

See O. A. Konstantinov, *Uralsk Area* (1926), in Russian.

URANIUM (symbol U, atomic number 92, atomic weight 238·2). Pure uranium is a lustrous white metal although it may be obtained as a brown or black powder. The metal is malleable, softer than steel and slightly paramagnetic At 13°C it has a density of 18·685, and although its exact melting point is not known it is stated to be of the order of 1,850°C. Uranium exhibits marked chemical activity. It burns readily in oxygen at 170°C. and reacts vigorously with the halogens With nitrogen at 1,000°C a yellow nitride is formed whilst with carbon it yields a crystalline carbide, UC_2 Uranium is soluble in dilute hydrochloric and sulphuric acids with evolution of hydrogen, whilst with nitric acid a nitrate is formed Aqueous alkalis are apparently without action on the element So far as is known, uranium is the element of highest atomic weight and highest atomic number Its chief use at the present time is in the ceramic industry, the compounds usually employed being the sodium or ammonium diuranates and the green oxide U_3O_8. By varying the composition of the glaze and the firing conditions, colours such as yellow, orange, shades of brown and even dark green may be obtained. In the manufacture of glass, uranium compounds produce an opalescent yellow, green by reflected light. It is claimed that uranium will replace satisfactorily tungsten in high-speed steels. The uranium is added to the steel as an alloy, ferro-uranium, made by heating oxides of uranium and iron with coke in the electric furnace Uranium salts have been used in photography and are useful in the laboratory for volumetric determinations of phosphates and arsenates.

Prior to 1789 varying views were held as to the composition of the mineral pitchblende. In that year Klaproth advanced the opinion that the ore contained a new element definitely distinct from zinc, iron or tungsten, and by reduction of the mineral at a high temperature, isolated a metallic-looking product which he believed to be the new metal To this new substance he gave the name uranium in honour of Herschel's discovery of the planet Uranus in 1781. Not till 1841 was it discovered that the so-called element was in reality an oxide, now written as UO_2. Peligot prepared, in that year, a new chloride (now identified as UCl_4) of which the composition indicated that Klaproth's uranium was not an element, and in the next year, by reduction of the new chloride with potassium, Peligot isolated the element itself. Uranium is not widely distributed in nature but is found in a number of rare minerals. The two principal commercial ores are pitchblende and carnotite. Pitchblende or uranitite is an impure uranium oxide of the formula U_3O_8, in which the uranium may be considered to be present partly as UO_2 and partly as UO_3. The ore may contain 40–90% of U_3O_8 associated with such impurities as silica, thoria, the rare earths, and compounds of lead, iron, calcium, magnesium, manganese, bismuth, etc. Radium and helium are always present. Pitchblende is a dark bluish-black massive mineral, found in igneous rocks, and possessing a pitch-like lustre from which fact its name is derived. The most celebrated deposits are those of St. Joachimsthal in Austria where the mines have been worked since 1517. Other deposits are known in Cornwall, in the United States, Russia, Sweden and Norway. A high-grade uranium ore containing pitchblende is found at Katanga in the Belgian Congo. Carnotite, a canary-yellow mineral of secondary origin, occurs principally in sandstone deposits, especially in the United States. Other deposits are in South Australia and in Portugal Carnotite is essentially a complex vanadate of potassium and uranium of the approximate composition $K_2O{\cdot}2UO_3{\cdot}V_2O_5{\cdot}3H_2O$. Of the less important uranium ores, the yellow autunite, a hydrated phosphate of calcium and uranium, $Ca(UO_2)_2(PO_4)_2{\cdot}8H_2O$, is generally associated with pitchblende. Uranium occupies an important place in the history of scientific discovery. In 1896, Henri Becquerel exposed a photographic plate, wrapped in black paper to the action of the beautiful fluorescent salt, potassium uranyl sulphate, $K_2SO_4,UO_2SO_4,2H_2O$, and made the momentous observation that a distinct impression had been produced on the plate. Further experiments indicated that metallic uranium, all uranium salts and uranium minerals (especially pitchblende) gave rise to the same phenomenon. This epoch-making discovery, which initiated the study of radioactivity, was closely followed by the discovery of radium in pitchblende. Increasing knowledge of radioactive processes clearly showed that uranium was continuously undergoing atomic disintegration whereby products of less atomic weight were produced. Amongst these products was radium, and its presence in all uranium minerals was found to be a direct outcome of the degradation of uranium atoms Moreover, in uranium ores, where the conditions have been such that the radium has not been removed mechanically, it has been found $3{\cdot}4 \times 10^{-7}$ gram of radium is in equilibrium with one gram of uranium So well is this relationship established that in the sale of radium-bearing ores it is the common practice to estimate the radium, not by analysis, but by calculation from the determined uranium content

The value of radium in medicine has centred attention on radium-bearing ores, with the result that pitchblende and carnotite are treated, primarily, for their radium content, whilst the extraction of uranium is of secondary industrial importance. To extract uranium from pitchblende the broken-up ore may be treated with sulphuric acid, to which some nitric acid has been added, the concentrations being so adjusted that whereas the uranium goes completely into solution the radium remains behind quantitatively with the insoluble sulphates of barium, lead, calcium, etc. From the acid filtrate containing uranyl sulphate, UO_2SO_4, the uranium may be obtained as follows. Addition of excess of sodium carbonate solution precipitates iron, aluminium, etc, whilst the uranium forms a double carbonate soluble in the alkali carbonate solution The addition of sodium hydroxide precipitates the uranium as insoluble sodium diuranate $Na_2U_2O_7{\cdot}6H_2O$ in which form uranium comes on to the market and is sold by the trade as yellow oxide of uranium The extraction of uranium from carnotite is based on the same fundamental reactions as outlined above It must be noted, however, that many alternative methods of extraction are available The preparation of the pure element is a matter of difficulty. By reduction of U_3O_8 with carbon in the electric furnace, Moissan obtained a product always containing carbon, but Rideal obtained uranium as a powder containing 99·6% of the element by reduction of the oxide with magnesium From the reaction of uranous chloride, UCl_4, with sodium, potassium or calcium, uranium may be isolated. Electrolysis of an aqueous solution of a uranium salt does not produce uranium; instead, hydrogen is obtained at the cathode, often accompanied by a deposit of hydrated uranium oxides. By using a mercury cathode in an aqueous solution of uranium tetrachloride, uranium amalgam is said to be formed, from which by distillation *in vacuo* the mercury is volatilized, leaving pyrophoric uranium.

Elemental uranium exhibits a valency of either 2, 3, 4, 5, or 6 in its compounds, but the most stable derivatives are those containing sexavalent uranium. The oxide UO_3 exists in yellow and red modifications and has both basic and acidic properties. It dissolves in acids yielding green-yellow solutions from which *uranyl* salts, such as the nitrate, $UO_2(NO_3)_2{\cdot}6H_2O$, chloride,

$UO_2Cl_2 \cdot H_2O$, and sulphate, $UO_2SO_4 \cdot 3H_2O$, can be isolated. The only true normal salt of sexavalent uranium is the fluoride, UF_6. The addition of alkali hydroxides to uranyl salts produces insoluble diuranates such as $Na_2U_2O_7 \cdot 6H_2O$, $K_2U_2O_7 \cdot 3H_2O$. The highest chloride is UCl_6. Uranous compounds corresponding to the basic oxide UO_2 are usually green or blue but their solutions are unstable and revert in the air to the sexavalent state. Solid uranium salts when shaken, crushed, or rubbed, emit light, *i.e.*, they have the property of triboluminescence. This is readily observed in a darkened room. Moreover, uranyl salts in solution exhibit a brilliant greenish-yellow fluorescence, destroyed by ferric or uranous salts. In the presence of organic matter uranyl salts are decomposed by light, undergoing reduction to a lower-valency stage. This latter phenomenon is known as photolysis and has been widely investigated. Photolysis and fluorescence seem to be connected, for substances which destroy fluorescence accelerate photolysis.

(W. Wa.)

URANUS, Heaven, in Greek mythology, the husband of Gē, and father of Cronus (*q.v.*) and other deities (*see* Titans). As such he represents the generative power of the sky, which fructifies the earth with the warmth of the sun and the moisture of rain.

The Roman Caelus is simply a translation of the Greek *Οὐρανός* not the name of a distinct national divinity. In art, Uranus is shown as an old, bearded man holding a robe stretched out over his head in the form of an arch.

URANUS, in astronomy, the seventh major planet in the order of distance from the sun, and denoted by the symbol ♅. It was discovered by Sir William Herschel on March 13, 1781. He saw it as a round nebulous disc, slowly moving among the stars, and at first supposed it to be a comet, and announced it as such to the Royal Society. A few weeks' observation, however, showed it to be moving in a nearly circular orbit at a distance from the sun about nineteen times that of the earth. Its planetary character was thus established, and Herschel named it the Georgium Sidus in honour of his royal patron "The Georgian" was used in the *Nautical Almanac* up to 1850; but it was disliked outside England as was Herschel's name, proposed by Lalande The name Uranus was proposed by Bode

The mean distance of Uranus from the sun is 1,782,800,000 miles, and the time required for a revolution in its orbit just over 84 years. The diameter has been found to be about 30,900 miles, and, since observations of the satellites show its mass to be 14·6 times that of the earth, its density is very low: viz., 0·25 that of the earth, and 1·36 times that of water. The spectrum of the planet contains a number of strong absorption bands of as yet unknown origin, similar to those in the spectra of Jupiter, Saturn and Neptune. They are much more intense than those of Jupiter and Saturn, but less strong than those of Neptune. It is evident that Uranus is in the same physical state as the other planets of the outer group. Despite its distance from the sun Uranus, in consequence of its high albedo, shines as a star slightly brighter than the 6th magnitude. It is therefore, under favourable conditions, within the reach of naked eye vision. Indeed, long before its discovery by Herschel, Flamsteed had taken it for a star. Lemonnier during the opposition of 1768–69 observed it eight times, but did not detect its planetary character.

Its disc, which is of a pale sea-green colour, has a diameter of rather less than 4″, and measurements by several observers have shown it to be definitely elliptical. A white streak has also been recorded crossing the centre and some faint dusky bands or belts have been noted, but it has not been possible to determine the period of its rotation in the usual way by observation of definite surface features Spectroscopic observations, based on the Doppler principle (*see* Light), by the late Professor Lowell and Dr. Slipher in 1912, however, indicated a rotation period of $10^h\ 45^m$, and photometric observations by Leon Campbell at Harvard have revealed variations of brightness, which might well be due to an outbreak of spots combined with axial rotation, in excellent accord with this value.

Satellites of Uranus.—In Jan. 1787 Herschel detected two satellites of Uranus of which the inner one, now known as Titania, had a period of 9 days, the outer, Oberon, of 13½ days. He also on other occasions saw what he supposed to be two additional satellites, but these objects could not have been of this character. In 1851–52 William Lassell at Malta, in conjunction with his assistant A. Marth, observed two satellites yet nearer the planet than those of Herschel. These are now known as Ariel and Umbriel. Their periodic times are about 2½ and 4 days respectively. Lassell's telescopes, which were reflectors, were superior in light-power to others of his time, and these inner satellites were not seen by other astronomers for more than twenty years after their discovery. Indeed, doubts of their reality were only resolved in 1873, when they were observed with the Washington 26-in. telescope.

The most remarkable feature about these satellites is the very high inclination of their orbit planes. This amounts to 98° to the plane of the planet's orbit, and 97·8° to the ecliptic, so that the motion of the satellites is really retrograde. The result of the high inclination is that, as Uranus revolves in its orbit, there are two opposite points at which the planes are presented edgewise to view, and the satellites will be seen to travel nearly north and south in the telescopic field. At intermediate points their orbits will appear circular. The former appearance last occurred in 1924, and the latter will next be seen in 1945

The Satellites of Uranus

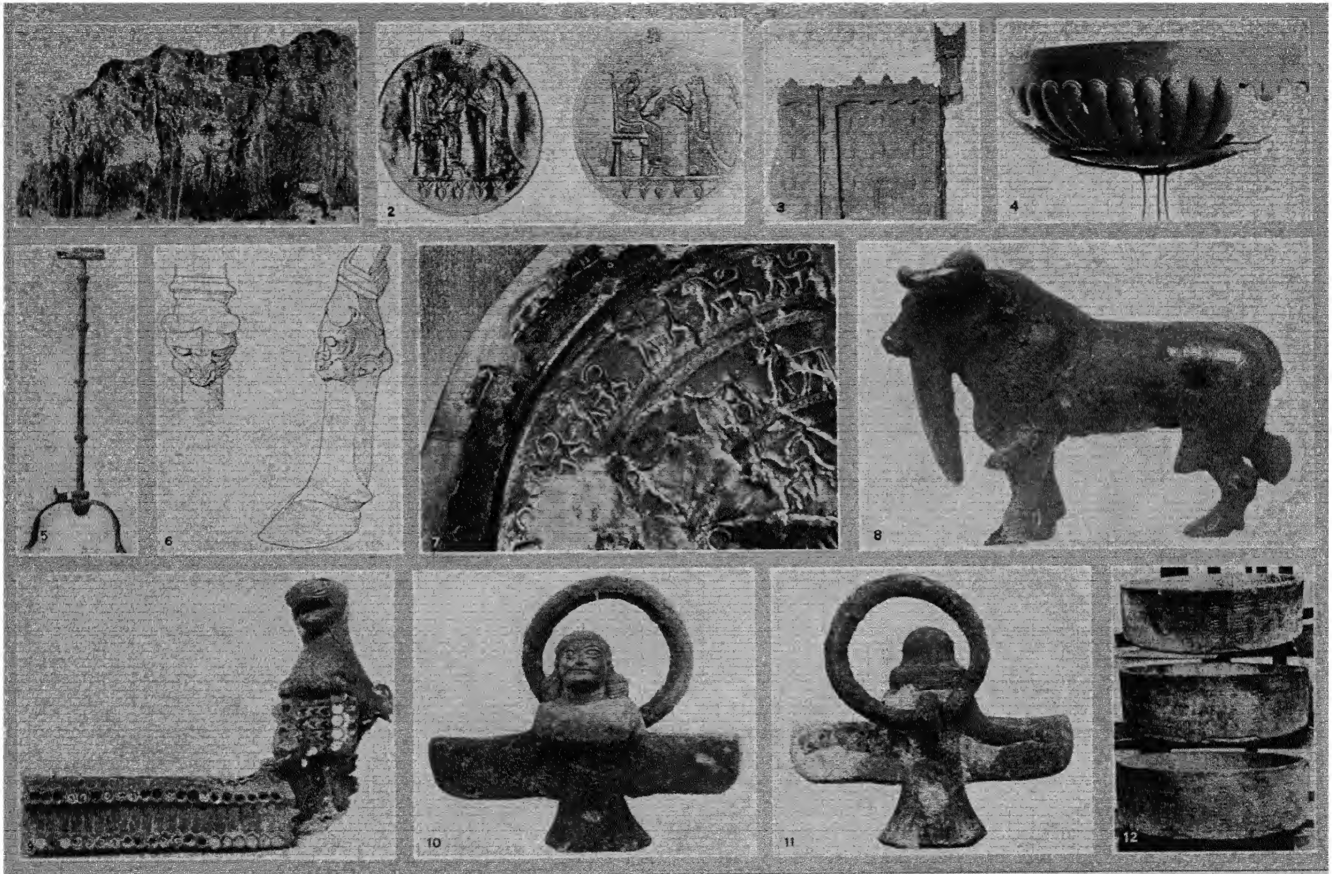
Satellite	Distance from Uranus in miles	Sidereal period	Stellar magnitude
		d. h m. s.	
i Ariel .	119,100	2 12 29 20·8	16
ii Umbriel	165,900	4 3 27 36·7	16–17
iii Titania .	272,200	8 16 56 26·7	14
iv. Oberon . .	364,000	13 11 7 3·5	13

For the irregularity in the motion of Uranus which led to the discovery of Neptune, *see* Neptune.

URARṬU, the Assyrian name for the country called later on Armenia and for its inhabitants. It is identical with the country of Ararat, on one of whose mountains Noah's ark stopped, according to Genesis, the name survives in the Armenian province of Ararat and has been transferred to Mount Ararat south of the river Araxes. Herodotus's Alarodoi are the Urarṭaeans who after the immigration of the Armenians (after 600 B C) retained or formed a distinct nation in the valley of the Araxes. The inhabitants of Urarṭu, however, in their cuneiform inscriptions call themselves *Chaldini* (plural).

The writing of the cuneiform inscriptions of the Urarṭaeans was taken from the Assyrians; but whereas Assyrian is a Semitic language, Urarṭaean is neither Semitic nor Indo-European The Urarṭaeans or Chaldians must have immigrated from the west into what was then to a greater part called Naïri Apparently Sardur I., son of Lutipris, who built a fort to the west of the rock of Van, out of huge stones brought from afar, united the "Naïri-countries" under his rule after a long war against the Assyrians about the time of Assurnaṣirabal II., the father of Shalmaneser III. This kingdom of Naïri was replaced by the kingdom of Urarṭu-Chaldia. Aram, who was the king of Urarṭu, was fought by Shalmaneser III. (859–824 B.C.), and so was his successor Sardur (Seduri II.), father of King Ispuinis who chose the rock of Van for his residence and as the holy seat of the god Chaldis. Ispuinis was the contemporary of Adadnirari IV. of Assyria—son of Shalmaneser III. and husband of Queen Shammuramat, *i.e.*, the historical Semiramis—whom he fought successfully, these successes enabling him to found a Chaldian colony at Muṣaṣir, west of the pass of Kelishina. A bilingual Chaldian and Assyrian inscription was erected by Ispuinis upon this occasion.

Menuas, his son, was the mightiest and most successful of the Chaldian rulers. His greatest work is the aqueduct (the so-called Shamiram-su "river of Semiramis") more than 75 km. in length, irrigating the plain of Van to this day and bringing drinkable water to the eastern borders of Lake Van (whose water is undrinkable), thus enabling him to found a "Menuas-city." Menuas was succeeded by Argistis I., a son, who left records of 14 years of his reign and his successful wars, on the outer walls of the set of chambers hewn into the solid rock of Van. His son Sardur



REMAINS OF URARTU CIVILIZATION

1. Rock of Van Kalah showing dwellings and staircases, the former probably built during the fourteenth year of the reign of Argistis I.
2. Gold medal showing goddess and female worshiper; excavated near Van in 1899 (left, photograph; right, engraving)
3. Bronze model of wall with gate and tower
4. Bronze vessel inscribed with unknown signs
5. Candelabrum excavated in 1899 at Toprak Kalah, near Van
6. Detail of foot, zoomorphic juncture. Bull's foot coming out of lion's mouth
7. Sacred shield adorning wall of Temple at Toprak Kalah with inscription of Rusas III.
8. Bronze bison; one of three chief races of big cattle living in Babylonia in the oldest times
9. Mythical animal (Tiamat); holes partly filled with ornamental glass
10. Bronze vase handle in form of winged disc of the sun with goddess (front side)
11. Reverse side of bronze vase in fig. 10
12. Stone vessel of King Ispuinis, founder of the fortress on the Rock of Van. (Three views)

III., contemporary of Assurnirari (755–745 B.C.) and of Tiglath-pileser III. (745–727) of Assyria, was defeated by the latter, who destroyed the Menuas-city (735 B.C.).

Rusas I. (714 B.C.), son of a Sardur, belonging to a side-line of the dynasty, removed the capital to a hill called Toprakkalah nowadays, after digging an artificial lake, the outflow of which irrigated the side of the hill and the plain where he founded the Rusas-city. All this he recorded in a *stela* set up only a few years after the traditional date of the founding of Rome (754 B.C.). It was taken (1898–99) to the Berlin museum. Rusas I. was a most energetic enemy of Sargon II. of Assyria (722–705 B C.) against whom he summoned a coalition of the states of Western Asia, of which Mardukabaliddin of Babylonia (the Merodach-Baladan of the Bible) probably was one In a bilingual *stela* erected over against the capital of Muṣaṣir, which had developed into a sort of independent buffer-state, Rusas commemorated his feats against Assyria in re-establishing Chaldian sovereignty and the petty king Urzana in Muṣaṣir

But in 714 the Cimmerians, breaking into the north of Urarṭu through the passes of the Caucasus, drove Rusas to suicide Sargon had made a raid into Urarṭu and on his return had conquered Muṣaṣir, robbing its temple and overthrowing and mutilating Rusas I.'s *stela*, which, however was later on re-erected, evidently by Rusas II., the grandson of Rusas I who once more restored the power of Chaldia Rusas II used Cimmerian mercenaries in his combats with Esarhaddon of Assyria (680–668 B C.) and succeeded in getting rid of the bulk of the Cimmerians who went on to the west of Asia Minor Rusas III, son of Erimenas, finished the temple of Chaldis on Toprakkalah Sargon's sculpture of the temple of Muṣaṣir shows its front adorned with ornamented shields, a custom which the Chaldians had in common with the Cretans of Minoan times. Such shields, with inscriptions chiefly of Rusas III., were excavated in Toprakkalah. Their circular friezes are divided into semicircles upon which the animals are going in different directions so as to prevent any one appearing to stand on its head (fig 7), a peculiarity only recurring on Cretan shields of the archaic period The royal residence at Toprakkalah and the temple of Chaldis were evidently destroyed under Rusas III. The Medes must have overrun Urartu before they crossed arms with the Lydians on the Halys (May 28, 585 B.C.).

The pottery excavated at Toprakkalah, apart from other peculiar features, partly shows in red, and sometimes in black, a glazed surface which is practically equal to "bucchero." The gold medal (fig 2) showing a goddess of fertility and her female adorer in beaten work, has peculiarities which have left their mark in archaic Greek, especially Ionic art A candelabrum (fig. 5) and parts of a throne with a baldachin show a wreath of falling leaves the latter in exactly the shape in which it (the forerunner of the *kymation*) appears on the eldest Ionian or pre-Ionian capitals. The legs of the above mentioned candelabrum (fig. 8) and of another one preserved in Erlangen show the "zoomorphic juncture," one member of an animal coming forth out of the mouth of the same or another animal: this feature being entirely restricted to the art of the Chaldians and of the Etruscans. The bronze vessel from Toprakkalah (fig. 2) with vertical rims has innumerable parallels in Etruscan tombs. The way the Chaldians built their walls and towers is illustrated by a model found at Toprakkalah (fig. 3). A very striking likeness of the bison, one of the three chief races of big cattle living in Babylonia in the oldest times, in bronze stressing the beard as its special feature (fig. 6) shows its existence in ancient Armenia in the first millennium B.C. The attaches or handle figures of big bronze vessels in the form of a female divinity in the winged disc of the sun (fig. 10) are a Chaldian speciality, recurring in archaic Greek and in Etruscan art. The bronze snake, probably Tiamat, the animal of the Chaos, shows, as do numerous other pieces, a combination of different materials, the holes, for example, being partly filled with coloured glass.

The Chaldians must have come from more western parts of Asia Minor where they were in touch with elements of Minoan culture; their culture is principally western with only minor traces of Assyrian influence; they influenced archaic Greek art in their turn, and had peculiar relations to the Etruscans which were probably based on a former relatively close proximity. When the Armenians invaded Urarṭu, the Chaldians withdrew into the mountains keeping up their warlike spirit and their metallurgic accomplishments. They were also called Chalybes, probably from the name of the steel which they were the first to produce The region south of Trebizond was one of the last resorts of the Chaldians The Byzantine *thema* of this region was called Chaldia and an archbishopric of the Greek church about Gumushchana is called Chaldia to the present day

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URBAN (Urbanus), the name of eight popes

ST. URBAN, first pope of that name, was bishop of Rome from 222 to 230. Preceded by Calixtus, he was followed by Pontianus

URBAN II. (Odo or Otho or Eudes de Lagary), pope from March 12, 1088, to July 29, 1099, was born near Reims, became archdeacon of Auxerre, and later joined the congregation of Cluny, when he became sub-prior. He was created cardinal-bishop of Ostia in 1078 by Gregory VII., to whom he displayed such loyalty, especially as papal legate in Germany (1084), that he was imprisoned for a time by Henry IV. He was designated by Gregory as one of four men most worthy to succeed him, and, after a vacancy of more than five months following the decease of Victor III, he was elected pope on March 12, 1088, by an assembly of cardinals and others at Terracina Throughout the major part of his pontificate he had to reckon with the presence of the powerful antipope Clement III. (Guibert of Ravenna) in Rome He maintained an alliance with the Norman Duke Roger, Robert Guiscard's son and successor, and united the German with the Italian opposition to the emperor by promoting the marriage of the Countess Matilda with young Welf of Bavaria He aided Prince Conrad in his rebellion against his father and crowned him king of the Romans at Milan in 1093. By excommunicating Philip I. of France for matrimonial infidelity in 1095, Urban opened a struggle which was not terminated until after his death. Invited to Tuscany by the Countess Matilda, he convoked a council at Piacenza in March 1095, attended by so vast a number of prelates and laymen that its sessions were held in the open air, and addressed by ambassadors of Alexis, the Byzantine emperor, who sought aid against the Mussulmans. Urban crossed the Alps in the summer, and remained over a year in France and Burgundy. He held a largely attended council at Clermont in November 1095, where he preached the First Crusade. His sermon is printed in J. R. Watterich, *Pontif. Roman. Vitae* Crusaders on their way through Italy drove the antipope Clement III. finally from Rome in 1097, and established Urban firmly in the papal see With a view to facilitating the crusade, a council was held at Bari in October 1098, at which religious differences were debated and the exiled Anselm of Canterbury combated the Eastern view of the Procession of the Holy Ghost. Urban died suddenly at Rome on July 29, 1099, fourteen days after the capture of Jerusalem, but before the tidings of that event had reached Italy. His successor was Paschal II.

See authorities quoted under PAPACY; also M. F. Stern, *Zur Biographie des Papstes Urbans II* (Berlin, 1883); A. de Brimont, *Un Pape au moyen âge—Urbain II.* (Paris, 1862).

URBAN III. (Uberto Crivelli), pope from Nov. 25, 1185, to Oct. 20, 1187, was a Milanese, and had been made cardinal-priest of St. Lorenzo in Damaso and archbishop of Milan by Lucius III., whom he succeeded. He continued vigorously his predecessor's quarrels with the emperor, including the standing dispute about the territories of the Countess Matilda. His opposition to the pretensions of the Roman senate to govern the Papal States, moreover, compelled him to remain in exile through his pontificate. He suspended the patriarch of Aquileia for crowning the emperor's son, Henry, king of Italy (January 1186), in violation of his own rights as archbishop of Milan, and only the entreaties of

the citizens of Verona, where he was stopping, prevented him from excommunicating Frederick. In 1187 he exhorted the Christian kings to renewed endeavours in the Holy Land, and the fall of Jerusalem (Oct. 2) is said to have caused his death. He died at Ferrara and was succeeded by Gregory VIII. His letters are in J. P Migne, *Patrol Lat*, vol. 202.

URBAN IV. (Jacques Pantaléon), pope from Aug. 29, 1261, to Oct. 2, 1264, was the son of a shoemaker of Troyes. Having received a monastic education, he became archdeacon of Liége and papal legate of Innocent IV to Poland and Prussia; he was consecrated bishop of Verdun in 1253, and two years later was translated to the patriarchate of Jerusalem He was on a visit to Italy when he was elected to succeed Alexander IV. in the Holy See. He spent most of his pontificate at Orvieto Under him began that preponderance of the French in the curia which later led to the papal residence at Avignon, and indirectly to the Great Schism. In 1264 he instituted the festival of Corpus Christi. He favoured the claim of Charles of Anjou to the crown of the Two Sicilies Urban died before the arrival of Charles of Anjou, and was succeeded by Clement IV.

The registers of Urban IV. have been published by L. Dorez and J. Guiraud in the *Bibliothèque des écoles françaises d'Athènes et de Rome* (Paris, 1892)

URBAN V. (Guillaume Grimoard or Grimaud de Beauvoir), pope from Oct 28, 1362, to Dec 19, 1370, was born in 1309 near Lozère in Languedoc, and entered the Benedictine priory of Chiriac. He held many preferments, and was returning from a mission as papal legate to Italy, when he heard that he had been chosen to succeed Innocent VI He was consecrated at Avignon Nov. 6, 1362 Urban witnessed the completion of the work of tranquillizing Italy under the able Cardinal Albornoz, and in 1364, in the interests of peace, made heavy concessions to Bernabo Visconti Moved by Peter of Lusignan, king of Cyprus, and by the celebrated Carmelite Peter Thomas, who had come to Avignon in February 1363, the pope proclaimed another crusade, which found some echo in France and resulted in the temporary occupation of Alexandria (1365) Urban, yielding to the entreaties of the Emperor Charles IV and of Petrarch, left Avignon on April 30, 1367, despite the opposition of the French cardinals, and made his entry into Rome on Oct 16. The following year he was visited by Charles IV, and crowned the Empress Elizabeth (Nov. 1), and in 1369 he received the Greek emperor, John Palaeologus. Urban sanctioned the order of Jesuates and founded the medical school at Montpellier He at length announced his intention of returning to France, avowedly to settle trouble between France and England. He arrived at Avignon on Sept. 24, 1370, died on Dec 19. Urban was serious and humble, opposed to all nepotism, simony and secular pomp He was himself of blameless morality and reformed many abuses in the curia He was honoured as a saint immediately after his death, and beatified by Pius IX in 1870 Urban's successor was Gregory XI

See H J Tomaseth, "Die Register u Secretare Urbans V u. Gregors XI" in *Mitteilungen des Instituts für osterreichische Geschichtsforschung* (1898).

URBAN VI. (Bartolommeo Prignano), pope from April 8, 1378, to Oct. 15, 1389, was born at Naples in 1318 He was made bishop of Acerenza in 1364, and in 1377 was translated to the archiepiscopal see of Bari and placed in charge of the papal chancery. On the death of Gregory XI., who had finally returned to Rome from Avignon, he was elected pope Urban VI. turned his attention at once to the reformation of the higher clergy, and, in spite of the warnings of Catherine of Siena, so angered the cardinals by his harsh and ill-tempered measures that they assembled at Anagni in July 1378, and revoked his election, in which they declared they had acted under fear of violence On Sept. 20, they elected at Fondi the Cardinal Robert of Geneva, who called himself Clement VII and took up his residence at Avignon. Urban, on the other hand, remained at Rome, where he appointed twenty-six new cardinals and excommunicated Clement and his adherents. Thus began the Great Schism which divided the Western Church for about fifty years Urban deposed Joanna of Naples (April 21, 1380) for adhering to France and Savoy in support of the antipope, and gave her kingdom to Charles of Durazzo. Charles was crowned at Rome on June 1, 1381, but three years later quarrelled with the pope and shut him up in Nocera Urban escaped to Genoa, where he put several of his cardinals to death for suspected disloyalty. On the death of Charles he set out with an army apparently to seize Naples for his nephew. To raise funds he proclaimed, by bull of April 11, 1389, a jubilee for every thirty-three years, but before the celebration could be held he died of injuries caused by a fall from his mule.

The chief sources for the life of Urban VI. are in Baluzius, *Vitae Pap. Avenion.* (Paris, 1693); *Theoderici de Nyem De schismate Libri tres*, ed by G. Erler (Leipzig, 1890), Sauerlande, "Actenstücke zur Gesch des Papstes Urban VI," in *Hist Jahrbuch der Görres-Gesellschaft*, xiv (1893); "Acta Urbani VI et Bonifatii IX," ed C Krofta, in *Monumenta vaticana res gestas Bohemicas illustrantia* (Prague, 1905); *Der Liber Cancellariae Apostolicae vom Jahre 1380*, ed. by G. Erler (Leipzig, 1888); *Il Trattato di S. Vincenzo Ferrer intorno al grande schisma d'Occidente*, ed by A Sorbelli (Bologna, 1906). *See* also W St C Baddeley, *Charles III of Naples and Urban VI* (1894); J. B. Christophe, *Histoire de la papauté pendant le XIVe siècle*, vol. 3 (Paris, 1853)

URBAN VII. (Giovanni Battista Castagna), successor of Sixtus V, was born on Aug. 4, 1521 He became governor of Bologna, archbishop of Rossano, and was long nuncio to Spain. Gregory XIII made him a cardinal, 1583; and in 1590 he was elected pope by the Spanish faction, but died twelve days later, on Sept. 27, 1590. and was succeeded by Gregory XIV

See Ciaconius, *Vitae et res gestae summorum Pontiff Rom.* (Rome, 1601–02), Cicarella, continuator of Platina, *De vitis Pontiff Rom.* (both contemporary; the latter prolix and tedious); Arrigho, *Vita Urbani VII* (Bologna, 1614); and Ranke, *Popes* (Eng. trans, Austin), ii 227.

URBAN VIII (Maffeo Barberini), pope from 1623 to 1644, was born in 1568, of a wealthy Florentine family He early entered the prelacy, became prefect of Spoleto, twice nuncio to France, cardinal (1606), and finally, on Aug. 6, 1623, succeeded Gregory XV. as pope. Urban accepted the papacy chiefly as a temporal principality, and made it his first care to provide for its defence and to render it formidable He built Castelfranco on the northern frontier; fortified the port of Civita Vecchia; and strengthened the Castel Sant' Angelo, equipping it with cannon made from the bronze of the Pantheon, an act of vandalism which the Romans punished by the epigram, "Quod non fecerunt barbari, fecerunt Barberini" He also established an arsenal and a factory of arms But the only territory gained during Urban's pontificate, the duchy of Urbino, the last addition to the papal states, was acquired by reversion (1631); and in his one war, with the duke of Parma, for the district of Castro, he met defeat and humiliation (1644) The Thirty Years' War Urban professed to regard as waged for political, not for religious, ends He therefore threw in his lot with France, supported the duke of Nevers in the Mantuan Succession, and, under stress of fear of Habsburg supremacy, suffered himself to be drawn into closer relations with the Protestants than beseemed his office.

Urban was the last pope to practise nepotism on a grand scale. He failed to found a princely house; but he enriched his family to an extent that astonished even the Romans. Urban bore a hand in the condemnation of Galileo. He acknowledged the genius of the astronomer, and had not approved of the action of the Inquisition in 1616; but subsequently, believing himself to have been caricatured in the *Dialogo*, he permitted the Inquisition to have its way and to compel an abjuration (1633). Urban also denounced the doctrines of Jansen, 1644. (*See* JANSENISM.) He promulgated the famous bull *In Coena Domini* in its final form, 1627; published the latest revision of the Breviary, 1631; founded the College of the Propaganda for the education of missionaries, 1627; and accorded the title of "eminence" to the cardinals, 1630. Urban did much to embellish the city. Conspicuous among his works are the Barberini Palace, the College of the Propaganda, the Fountain of the Triton, and the baldachin of St. Peter's. His hymns and poems, which have frequently been published, are evidence of his literary taste and ability. Urban died on July 29, 1644, and was succeeded by Innocent X.

For contemporary accounts of Urban *see:* Tommasucci, in Platina, *De vitis Pontiff. Rom.;* Oldoin, continuator of Ciaconius, *Vitae et res gestae summorum Pontiff. Rom.;* and Simonin, *Gesta Urbani* (Antwerp,

TABLE I. *Population of the United States in Urban and Rural Groups 1900–20*

Class of places	1920 Number of places	1920 Population	1910 Number of places	1910 Population	1900 Number of places	1900 Population	Percentage of total population 1920	1910	1900
Total Population of the United States		105,710,620		91,972,266		75,994,575	100.0	100.0	100.0
Urban territory	2,787	54,304,603	2,313	42,166,120	1,801	30,380,433	51.4	45.8	40.0
1,000,000 or more inhabitants	3	10,145,532	3	8,501,174	3	6,429,474	9.6	9.2	8.5
500,000 to 1,000,000 inhabitants	9	6,223,769	5	3,010,667	3	1,645,087	5.9	3.3	2.2
250,000 to 500,000 ,,	13	4,540,838	11	3,949,839	9	2,861,296	4.3	4.3	3.8
100,000 to 250,000 ,,	43	6,519,187	31	4,840,458	23	3,272,490	6.2	5.3	4.3
50,000 to 100,000 ,,	76	5,265,747	59	4,178,915	40	2,709,338	5.0	4.5	3.6
25,000 to 50,000 ,,	143	5,075,041	119	4,026,045	82	2,800,627	4.8	4.4	3.7
10,000 to 25,000 ,,	459	6,942,742	367	5,524,434	280	4,338,250	6.6	6.0	5.7
5,000 to 10,000 ,,	721	4,997,794	612	4,254,856	468	3,220,766	4.7	4.6	4.2
2,500 to 5,000 ,,	1,320	4,593,953	1,106	3,879,732	893	3,103,105	4.3	4.2	4.0
Rural territory		51,406,017		49,806,146		45,614,142	48.6	54.2	60.0
Incorporated places of less than 2,500 inhabitants	12,905	8,969,241	11,832	8,169,149	8,930	6,301,533	8.5	8.9	8.3
Other rural territory		42,436,776		41,636,997		39,312,609	40.1	45.3	51.7

1637). A rich collection of materials was made by Andrea Niccoletti, *Della vita di Papa Urbano VIII e storia del suo pontificato*, never published, but extensively used by Ranke and others *See* also Gregorovius, *Urban VIII im Widerspruch zu Spanien u dem Kaiser* (Stuttgart, 1879), and Weech, *Urban VIII* (London, 1905).

URBANA, a city of eastern Illinois, U S A Population 10,244 in 1920 (94% native white) Urbana and the adjoining city of Champaign (*q v*) are separately incorporated, but otherwise form practically one community. Urbana is the seat of the University of Illinois (*q v*)

URBANA, a city of Ohio, U S A, the county seat of Champaign county. Pop (1920) 7,621 (87% native white); 1928 local estimate 8,500 It is the seat of Urbana university (Swedenborgian), a junior college founded in 1850

Urbana was founded in 1797 by Col William Ward, of Greenbriar, Virginia, who owned the land and gave many lots to the county on condition that the proceeds from their sale should be used for public improvements The village was incorporated in 1805 and was chartered as a city in 1867

URBANIZATION. The growth of cities has characterized the increase in the population of all countries. This urban tendency which has affected the whole social order of the modern world, continued almost unbroken until the World War Since then, in the inevitable redistribution of population consequent upon a slowing down of industry, there has been a suggestion of a decrease in the movement both in Europe and America

Distribution of Population.—The extraordinary changes in population resulting from economic conditions have been statistically measured in the United States (*see* Table I), but in Europe enumerations have been detailed and systematic only in Great Britain and France. According to the most recent (available) censuses covering Europe (ranging from 1912–25) there were in that continent, exclusive of Russia (U S S R), 449 cities having more than 50,000 inhabitants, representing approximately 23% of the total population. In the United States the corresponding percentage was 31.

Most of the principal countries have taken a census of population since 1920, but the methods followed in determining the size of the places to be considered as urban communities were not uniform. The population reported for the urban places was that residing within the city limits, but in some cases the city limits give only an inadequate idea of the population grouped about the urban centre. In large cities there are suburban districts outside the city limits, which, from many standpoints, form part of the city. Many of the residents have their business or employment in the city and, to some extent, persons living in the city are employed in the suburbs

The population of the world in 1926 was placed at 1,800 millions, this figure including estimates for the considerable portion of the total who live in countries not taking censuses. The countries which distinguish between urban and rural areas had an aggregate population of 782,319,328 and included under the urban classification 248,426,233 persons, or 31 8% of the total The data for these countries are presented in Table II These figures omit many cities of Asiatic countries, of southern Europe and Russia, for which statistics are not available

United States.—As defined by the census, urban territory includes all incorporated places of 2 500 inhabitants or more, and in three New England States, all towns (townships) of that size; all other territory is classed as rural The urbanization of the population has been notable for the increase in the large cities. There are four cities in the United States, including Detroit, that have a population of more than a million. China, Germany, Great Britain, Japan, India and Russia, each, have two cities of this class, and Argentina, Austria, Brazil, France and Turkey, each, have one city with more than a million inhabitants In the United States there were only six cities in 1790 that had 8,000 or more inhabitants, and their population amounted to 131,472, forming 3 3% of the total population At the census of 1920 there were 924 cities in this class, and they had 46 307,640 inhabitants, or 43 8% of the total The census of 1920 was the first to show that more than half (51·4%) of the inhabitants resided in places having a population of 2,500 or more, the proportion having increased from 28 6% in 1880

In many instances the population of the cities has been increased by the annexation of territory and the extension of the municipal boundaries so as to include suburbs (W M St)

URBINO, a city of the Marches (*Urvinum Metaurense*), Italy. Pop (1921) 6,212, town, 19,932, commune It is picturesquely situated on an abrupt hill 1,480 ft. above sea-level; its streets are narrow and crooked, and the town has a mediaeval aspect It is dominated by the ducal palace erected by Luciano di Laurana, a Dalmatian architect, in 1465–82, for Federigo Montefeltro (well represented in a picture by Justus of Ghent in the gallery), and regarded by the contemporaries of the founder as the ideal of a princely residence The monumental staircase, sculptured doorways, chimneys and friezes of the interior are especially fine Some are by Domenico Rosselli of Florence. The rich intarsia work of the Duke's study is by Baccio Pontelli.

In the cathedral there is a Pietà in marble by Giovanni da Bologna Opposite the palace is the church of S Domenico, a Gothic building with a good early Renaissance portal and a relief in the lunette by Luca della Robbia (1449) S Francesco has a fine 14th century portico and campanile, and a handsome portal of a chapel in the interior by Constantino Trappola (15th century). S. Bernardino, outside the town, is a plain early Renaissance structure. On the walls of the chapel of San Giovanni Battista are frescoes by Lorenzo and Giacomo Salimbeni da San Severino (1416). The modest house where Raphael was born and spent his boyhood forms a museum of engravings and other records of Raphael's works. A monument was erected to him in the piazza in 1897. The theatre, decorated by Girolamo Genga, is one of the earliest in Italy; in it was performed the first Italian

TABLE II. *Total and Urban Population of Selected Countries*
(This list comprises only countries which at recent censuses have classified their populations as urban and rural)

Country	Census date	Population			Basis of urban classification
		Aggregate	Urban		
			Number	Per cent	
Europe					
United Kingdom					
England and Wales	1921	37,886,699	30,035,417	79·3	1,154 urban districts
Scotland	1921	4,882,497	3,771,762	77·3	Places having 1,000 inhabitants or more
Ireland	1911	4,390,219	1,470,595	33·5	Civic areas having 2,000 inhabitants or more.
Belgium	1920	7,402,276*	4,224,225	57·1	Places having 5,000 inhabitants or more
Czechoslovakia	1921	13,595,816	5,884,576	43·3	Places having 2,000 inhabitants or more.
Denmark	1921	3,267,813	1,418,551	43·4	Cities and villages.
Finland	1920	3,364,807	543,046	16·1	Towns.
France	1921	39,209,518	18,205,492	46·4	Places having 2,000 inhabitants or more.
Germany	1925	62,410,619†	40,191,588	64·4	Places having 2,000 inhabitants or more.
Netherlands, The	1920	6,865,314	6,327,928	92·2	Places having 2,000 inhabitants or more (not defined as urban).
Norway	1920	2,649,775	785,404	29·6	Towns.
Portugal	1920	6,032,991	1,050,500	17·4	Cities having 2,000 inhabitants or more (not defined as urban).
Yugoslavia	1921	12,017,323	7,804,506	64·9	Places having 2,000 inhabitants or more (not defined as urban)
Sweden	1920	5,904,489	1,813,422	30·7	Thickly populated area, not absolutely defined
Ukraine	1923	29,020,304**	5,087,595	19·9	Only places having 500 inhabitants or more enumerated.
America					
Continental United States	1920	105,710,620	54,304,603	51·4	Incorporated places having 2,500 inhabitants or more.
Alaska	1920	55,036	3,058	5·6	Incorporated places having 2,500 inhabitants or more
Hawaii	1920	255,912	93,758	36·6	Incorporated places having 2,500 inhabitants or more
Porto Rico	1920	1,299,809	283,934	21·8	Incorporated places having 2,500 inhabitants or more
Canada	1921	8,788,483	4,352,112	49·5	Population residing in all cities, towns and incorporated villages
Cuba	1919	2,889,004	1,200,955	41·7	Cities having 1,000 inhabitants or more.
Argentina	1914	7,885,237	4,525,500	57·4	Classified by local board
Chile	1920	3,754,723	1,749,562	46·6	Cities, towns and villages having 1,000 inhabitants or more.
Guiana, British	1921	297,691	67,987	[illegible]	Towns
Honduras, British	1921	45,317	22,524	49·7	The district town and other towns of the Colony.
Asia					
Ceylon	1921	4,504,549	580,953	12·9	Towns having special regulations regarding deaths
Hongkong	1921	625,166	542,003	86·7	Approximately all population massed around Hongkong harbour
India	1921	318,942,480	32,418,776	10·2	All towns
Japan	1918	58,087,277	10,842,857	18·7	All large cities (smallest 23,996), not defined as urban
Malays, British	1921	3,358,054	932,170	27·8	Towns having 1,000 inhabitants or more.
Africa					
Egypt	1917	12,718,255	1,854,100	14·6	Towns, not defined as urban (smallest 11,022).
Uganda Protectorate	1921	3,071,608	65,156	2·1	Towns having 500 inhabitants or more.
Union of South Africa, British	1921	6,928,580	1,735,685	25·1	Any localities possessing some form of urban local authority
All others					
Australia	1921	5,436,794	3,370,316	62·0	Metropolitan areas and urban provincial districts.
Dominican Republic	1920	894,665	148,894	16·6	Not defined.
New Zealand	1921	1,284,873	626,633	48·8	Cities, boroughs or town districts having 1,000 inhabitants or more.
Total		782,319,328	248,426,233	31·8	

*Does not include population (60,213) of Eupen and Malmedy. †Does not include population of Saar Basin, estimated to be 770,000 in 1925.
**Population from 1929 *Statesman's Year Book.*

comedy, the *Calandria* of Cardinal Bibbiena, the friend of Leo X. and Raphael The magnificent library formed by the Montefeltro and Della Rovere dukes was incorporated in the Vatican library in 1657. There is a free university founded in 1506

The ancient town of *Urvinum Metaurense* takes its name from the river Metaurus The walls can be traced. It was important in the Gothic wars, and is mentioned by Procopius. About the end of the 12th century Urbino came under the rule of the family of Montefeltro, and especially of Federigo da Montefeltro, lord of Urbino from 1444 to 1482, who was an unusually enthusiastic patron of art and literature.

Federigo da Montefeltro much strengthened his position by his own marriage with Battista Sforza, and by marrying his daughter to Giovanni della Rovere, the favourite nephew of Pope Sixtus IV., who conferred upon Federigo the title of duke. Federigo's only son Guidobaldo, who succeeded his father, married in 1489 the gifted Elizabeth Gonzaga, of Mantua. Guidobaldo in 1508 bequeathed his coronet to Francesco Maria della Rovere, nephew of Julius II. In 1626 the last descendant of Francesco, Francesco Maria II., abdicated in favour of Pope Urban VIII, and Urbino, with its subject towns, which included Pesaro, Fano, Fossombrone, Gubbio, Castel Durante and Cagli together with outlying small villages, about 300 in number, became incorporated in the domain of the Papal States.

During the reigns of Federigo and Guidobaldo, Urbino was one of the foremost centres of activity in art and literature in

Italy. Here Piero della Francesca wrote his celebrated work on the science of perspective, Francesco di Giorgio Martini his *Trattato d' architettura* and Giovanni Santi his poetical account of the chief artists of his time.

Throughout the 16th century the state of Urbino manufactured majolica, especially at Gubbio and Castel Durante Most of the finest pieces were made for the dukes Famous citizens include the Ferrarese painter and friend of Raphael, Timoteo della Vite, and Bramante (*q v.*) This city was also the birthplace of Pope Clement XI, of several cardinals of the Albani family, and of Raffaelle Fabretti, and other scholars.

See E. Calzini, *Urbino e i suoi monumenti* (1897); G. Lipparini, *Urbino* (Bergamo, 1903).

URDU, the name of that variety of Hindustani which borrows a great part of its vocabulary from Persian and Arabic, as contrasted with "Hindi," the variety which eschews such words, but borrows from Sanskrit instead It is spoken by Muslims and those Hindus who have come under Muslim influence, and has a considerable literature *See* HINDUSTANI and HINDUSTANI LITERATURE

UREA or **CARBAMIDE,** a colourless crystalline substance known for about 150 years as a constituent of urine. It results from the oxidation of certain nitrogenous materials—proteins (*q v*)—in the animal organism and is not only present in the urine of higher animals (mammals) but also in their blood, bile, milk, perspiration and other body fluids. Moreover, it has been recognised in many lower forms of animal life—coelenterates, echinoderms, insects, worms, crustaceans, molluscs and fish, and has been identified in certain plants and in fungi and moulds, in the leaves of endive, potato, spinach, carrot and turnip, and in the seedlings of cereals and leguminates Human urine contains 2 to 5% of urea which is excreted by an adult man to the extent of about 30 grams (one ounce) daily.

In 1773 H M Rouelle obtained, by alcoholic extraction of the solid residue from evaporated urine, an alkaline nitrogenous substance which on bacterial fermentation yielded carbonic acid and ammonia Subsequently A F Fourcroy and Vauquelin (1798) prepared urea nitrate from urine and the isolation of pure urea from this liquid was first accomplished by M Proust in 1821. F. Wohler in 1828 announced his famous discovery of the artificial formation of urea from ammonia and cyanic acid Potassium cyanate, obtained by fusing potassium ferrocyanide with red lead or manganese dioxide, was mixed with ammonium sulphate, and the solution evaporated to dryness, when an alcoholic extract of the residue yielded urea

The isolation of urea from urine is most conveniently effected through its nitrate or oxalate, which are two of its most characteristic salts. Urea crystallises in long rhombic needles or prisms having a cooling taste It is readily soluble in water or alcohol but not in ether It melts at 132° C and may be vaporised *in vacuo*, but when more strongly heated it yields ammonia, biuret, ammelide and cyanuric acid.

Commercial Synthesis of Urea and its Derivatives.—Urea contains 46% of combined nitrogen in a form which is easily converted into ammonia in the soil, and it is therefore a much more concentrated nitrogenous fertiliser than either ammonium sulphate or sodium nitrate. It is, moreover, easy to handle and stable under ordinary factory and farm conditions, so that it possesses advantages over calcium cyanamide and calcium nitrate Hence it is now manufactured on an extensive scale for use as an artificial manure (*See* AGRICULTURAL FERTILISERS)

A century ago the synthetic production of an ounce of urea was a noteworthy scientific achievement, at present a daily output of 100 tons is the routine practice of a modern fertiliser plant. The following processes are available: (1) The regulated acidic hydrolysis of cyanamide (made from calcium cyanamide) in presence of an iron oxide as catalyst, $CN\cdot NH_2+H_2O=O:C(NH_2)_2$. (2) The heating under pressures of 33–53 atmospheres of ammonium carbonate obtained from carbon dioxide and ammonia, $NH_2\cdot CO_2\cdot NH_4 \rightleftharpoons H_2O+NH_2\cdot CO\cdot NH_2$: equilibrium is reached at 130–150° C with yields of 30–45% of urea. (3) Dry ammonia is passed into phenyl carbonate obtained from carbonyl chloride and phenol in presence of alkali,

$$2NH_3+CO(OC_6H_5)_2=CO(NH_2)_2+2C_6H_5\cdot OH:$$

the phenol is recovered and utilised again. (4) The process of treating carbonyl chloride with ammonia is more practicable for urea derivatives than for urea itself Thus, carbonyl chloride and ethyl aniline give diphenyldiethylcarbamide,

$$C_6H_5(C_2H_5)N\cdot CO\cdot N(C_2H_5)\cdot C_6H_5,$$

a crystalline substance known as "Centralite" and employed as a stabiliser in smokeless gunpowders

By heating together urea and *p*-aminoacetanilide a diacetylcarbamide is produced which on hydrolysis yields *pp*-diaminodiphenylcarbamide,

$$CO(NH\cdot C_6H_4\cdot NH_2)_2,$$

a diamine giving rise to important azo-dyes such as benzo fast yellow. (*See* DYES, SYNTHETIC)

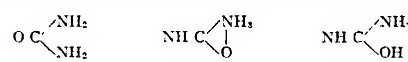
Applications of Urea and its Derivatives.—For use as a fertiliser, urea is frequently employed in combination with calcium hydrogen phosphate (superphosphate), the product being known as "Phosphazote" Its complex salt with calcium nitrate is also recommended for agricultural purposes

Urea gives a remarkable condensation product with formaldehyde known as "Pollopas," a transparent, colourless, lustrous solid resembling flint glass in appearance and refractive index, but differing from glass in that it is non-splintering and can be worked on a lathe (*See* RESINS, SYNTHETIC.)

With hydrogen peroxide urea forms a crystalline additive compound, $CO(NH_2)_2.H_2O_2$, employed as a disinfectant and as an oxidising agent. Urea finds employment as a stabiliser in nitrocellulose explosives and has many medicinal uses such as an antipyretic and a diuretic Urea salicylate (ursal) is recommended in gout and rheumatism Urea acetylsalicylate and urea quinate (urol or uracol) have similar uses, and urea calcium bromide, $CaBr_2.4CO(NH_2)_2$, known as ureabromin, is prescribed in epilepsy and neurasthenia.

Urea is the starting point in the manufacture of many important synthetic drugs Veronal (*q.v.*) or diethylmalonyl urea, is the condensation product of urea and diethylmalonyl chloride, its sodium salt is medicinal. Proponal is dipropylmalonyl urea and bromural is α-bromo*iso*valeryl urea

Chemical Constitution of Urea.—Urea has long been regarded as the diamide of carbonic acid (carbamide) with formula I, but E A Werner has brought together considerable evidence in favour of the cyclic formula II, and he visualises also the transient existence of an active tautomeric enol form (formula III) which has been stabilised in certain *iso*urea derivatives



(I) (II.) (III)

When heated slightly above its melting point, urea dissociates into ammonia and the keto-form, NH:CO, of cyanic acid This acid acting on unchanged urea produces biuret,

$$NH_2\cdot CO\cdot NH\cdot CO\cdot NH_2.$$

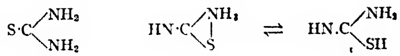
At 195° C biuret decomposes into ammonia, cyanic acid, which polymerises to cyanuric acid, $C_3N_3(OH)_3$, and ammelide, $\underline{HN\cdot CO\cdot NH\cdot C(NH)\cdot NH\cdot CO}$. The transformation of ammonium cyanate to urea in boiling aqueous solution is a bimolecular reversible reaction, and equilibrium is reached in a decinormal solution with 95% of urea and 5% of cyanate At 80° C dry ammonium cyanate passes rapidly into urea, which is also produced by hydrolysis of lead cyanate (A C Cumming, 1903), and together with biuret by heating under pressure a solution of carbon monoxide in ammoniacal cuprous chloride (Jouve, 1899).

Thiourea, the sulphur analogue of urea, is now prepared on a manufacturing scale for employment in photography, synthetic resins, the treatment of weighted silk fabrics and as a starting material in the production of important azo-dyes and sulphur colours. It may be prepared (1) by heating ammonium thiocyanate at 160–170° C, when a reversible reaction takes place proceeding to equilibrium with 25% of thiourea; (2) by the action

of hydrogen sulphide on cyanamide.

Thiourea crystallises from water or alcohol in colourless, six-sided prisms or silky needles melting at 172–7° C. When condensed with formaldehyde, thiourea forms insoluble products which form the basis of important synthetic resins (*q.v.*). These resins are used in making moulding powders and moulded articles including vases, bowls and tea services, which admit of decorative treatment in mottled colourings.

Isomerism among thiourea derivatives is more noticeable than with those of urea Derivatives corresponding with formula I are the true thiocarbamides, their isomerides (termed isothioureas) are derived from the active thiol form (III) which is regarded by Werner as existing in equilibrium with the cyclic modification (II.)



(I) (II.) (III.)

In most of its reactions thiourea behaves as a thiol, with diazomethane it yields methyl isothiourea, $NH\ C(SCH_3)\ NH_2$, and with chloracetic acid it gives rise to a complex thiolacetic acid, $NH.C(NH_2)\ S\ CH_2\ CO_2H$ Moreover, thiourea reacts in the thiol form with chloroacetaldehyde to furnish aminothioazole. (*See* THIAZOLE)

Both urea and thiourea are monacidic bases, a characteristic which is in accordance with Werner's view of their constitution. Urea nitrate is $NH\ C(OH){\cdot}NH_3{\cdot}NO_3$ and thiourea hydrochloride is $NH{\cdot}C(SH){\cdot}NH_3Cl$

BIBLIOGRAPHY—E A Werner, *The Chemistry of Urea* (1923); T. E. Thorpe, *Dictionary of Applied Chemistry*, vol. vii (1927).

(G. T. M.)

URETHANE is synthesized from ammonia and ethyl chlorocarbonate or diethyl carbonate, by digestion of urea with alcohol under pressure, or by the action of warm alcohol on urea nitrate with addition of sodium nitrite. Urethane, ethyl carbamate, $NO_2{\cdot}CO_2C_2H_5$, crystallizes in large plates, readily soluble in water and melting at 49–50° and boiling at 184° C. When heated with ammonia to 180° C, it gives urea. Cold alcoholic potash decomposes it into potassium cyanate and alcohol. When treated with very concentrated nitric acid it yields nitro-urethane, $NO_2{\cdot}NH{\cdot}CO\ OC_2H_5$, from which nitramide $NO_2{\cdot}NH_2$ was isolated. Physiologically, urethane has a rapid hypnotic action, producing a calm sleep and having no depressant effect on the circulation. It is especially suitable for children and is much used as an anaesthetic for animals. Di-urethane, $NH(CO_2C_2H_5)_2$, and hedonal, $NH_2CO_2CH(CH_3){\cdot}(C_3H_7)$, are also narcotics, the latter being, in addition, a powerful diuretic.

URFÉ, HONORÉ D', MARQUIS DE VALBROMEY, COMTE DE CHÂTEAUNEUF (1568–1625), French novelist and miscellaneous writer, was born at Marseilles on Feb 11, 1568, and was educated at the Collège de Tsarnon. A partisan of the League, he was taken prisoner in 1595, and, though soon set at liberty, he was again captured and imprisoned. During his imprisonment he read Ronsard, Petrarch and above all the *Diana enamorada* of George de Montemayor and Tasso's *Aminta* Here, too, he wrote the *Epîtres morales* (1598). Honoré's brother Anne, comte D'Urfé, had married in 1571 the beautiful Diane de Châteaumorand, but the marriage was annulled in 1598 by Clement VIII Anne D'Urfé was ordained to the priesthood in 1603, and died in 1621 dean of Montbrison. Diane had a great fortune, and to avoid the alienation of the money from the D'Urfé family, Honoré married her in 1600. This marriage also proved unhappy; D'Urfé spent most of his time separated from his wife at the court of Savoy

In Savoy he conceived the plan of his novel *Astrée*, the scene of which is laid on the banks of the Lignon in his native province of Forez. It is a leisurely romance in which the loves of Céladon and Astrée are told with digressions. Some episodes suggest the adventures of Henry IV The shepherds and shepherdesses of the story are of the conventional type usual to the pastoral, and they discourse of love with a casuistry and elaborate delicacy that are by no means rustic. The two first parts of *Astrée* appeared in 1610, the third in 1619, and in 1627 the fourth part was edited and a fifth added by D'Urfé's secretary Balthazar Baro. *Astrée* set the fashion temporarily in the drama as in romance, and no tragedy was complete without elaborate discussions on love in the manner of Céladon and Astrée. D'Urfé also wrote two poems, *La Sireine* (1611) and *Sylvanire* (1625). He died from injuries received by a fall from his horse at Villafranca on June 1, 1625, during a campaign against the Spaniards.

E. Rostand, *Deux Romanciers de Provence, H. d'Urfé et E. Zola* (1921), p. 73.

URGA (the Russian form of the Mongol Orgo = palace of a high official), a city of Mongolia, on an affluent of the Tola river It is the holy city of the Mongols and the residence of the "living Buddha," metropolitan of the Kalka tribes, who ranks third in degree of veneration among the dignitaries of the Lamaist Church. The lama acts as the spiritual colleague of the Chinese amban, who controls all temporal matters.

Hurae, as the Mongols call Urga (Chinese name K'ulun) stands on the high road from Peking to Kyakhta (Kiachta), about 700 m. N.W. of Peking and 165 m S of Kyakhta. There are three distinct quarters: the *kuren* or monastery, the residence of the "living Buddha", the Mongol city proper (in which live some 13,000 monks), and the Chinese town, 2 or 3 m from the Mongol quarter. Besides the monks, the inhabitants number about 25,000. Within living memory bricks of tea formed the only circulating medium for the retail trade at Urga, but Chinese brass cash then became current. There is a considerable trade in cattle, camels, horses, sheep, piece-goods and milk

URI, an ancient canton, south of central Switzerland The name is popularly derived from Urochs and Auerochs (wild bull), two bull's horns, the cantonal symbol still being borne aloft at the head of the annual *Landsgemeinde* processions. (*See* below) The total area (1923–24 determinations) is 414 7 sq m., of which only 52·7% (the lowest figure in the confederation) are reckoned as "productive" (forests covering 48 sq m.), while 7½ sq m are occupied by a part of the Lake of Lucerne and more than 22% of the unproductive area is covered with glaciers. The highest summit in the Uri is the Dammastock (11,929 ft.), north of the Furka pass; the lowest commune is Fluelen (1,437 ft.) on the Lake of Lucerne. Little of the land is capable of further cultivation, for Uri is composed of the torrent section of the Upper Reuss, draining, with its tributaries, steep-sided valleys. The chief, and practically the only, railway is the main St. Gotthard line. Near Wassen are the very remarkable looped and spiral tunnels. An electric railway connects Göschenen with Andermatt, and another one connects Altdorf with its port, Flüelen Communication is largely by the excellently planned roads which lead to the mountain passes; these give access to the cantons lying east and south, *e g.*, Glarus (the Klausen pass, 6,404 ft.), the Grisons (Oberalp pass, 6,733 ft.), Ticino (St. Gotthard pass, 6,935 ft.), the Valais (Furka pass, 7,992 ft.).

In 1920 the aggregate population was 23,973 (only 58 to 1 sq m —the Grisons, the least densely populated, had 43), of whom 22,403 were German-speaking, 1,382 Italian-speaking, and 87 French-speaking, while 22,036 were Catholics, 1,853 Protestants, and five were Jews. Since 1814 Uri has been administered by the bishop of Coire, previous to this date all the canton except Andermatt (Urseren) was in the diocese of Constance. The capital and largest town is Altdorf (pop. 4,160), indissolubly connected with the legend of William Tell (*q.v.*).

Uri forms an administrative district and contains 20 communes. The legislature of the canton is a primitive democratic assembly (*Landsgemeinde*) composed of all male citizens of 20 years of age. This assembly has met, uninterruptedly, since 1309, usually once annually, near Altdorf, on the first Sunday in May, but (1928) it has been abandoned. The procedure was controlled by many antique ceremonies. Uri is entitled to but one member in the Federal *Nationalrat;* he is elected by a popular vote. (*See* SWITZERLAND: *Administration*)

History.—Uri is first mentioned in 732 as the place of banishment of Eto, the abbot of Reichenau, by the duke of Alamannia. In 853 it was given by Louis the German to the nunnery (*Frauenmünster*) at Zürich which he had just founded,

and of which his daughter, Hildegard, was the first abbess. As early as 1243 Uri had a common seal, and in the confirmation of its privileges (1274) granted by Rudolf of Habsburg mention is made of its "head-man" (*Amman*) and of the "commune" (*universitas*). It took part, with Schwyz and Unterwalden, in founding the "Everlasting League" (*q.v.*) on Aug. 1, 1291, defending its liberty in the fight of Morgarten (1315) and renewing the League of the Three at Brunnen (1315). It took part in the victory of Sempach (1386), and (1512) the conquest of Lugano. At the Reformation Uri clung to the old faith. In 1798, on the formation of the Helvetic republic Uri became part of the huge canton of the Waldstätten and lost all its Italian possessions. In 1803 Uri became an independent canton again, with Ursern, but without the Val Leventina It tried hard to bring back the old state of things in 1814–15, and opposed all attempts at reform, joining the League of Sarnen in 1832 to maintain the pact of 1815, opposing the proposed revision of the pact, and being one of the members of the Sonderbund in 1845 (*See* SWITZERLAND: *History.*)

URIC ACID, in organic chemistry, an acid which is one of the penultimate products of the tissue waste in the human body. (*See* PURINES.) While the bulk of the nitrogen of the albuminoids is excreted by kidneys and bladder as urea, a small portion of it stops at the uric acid stage. Human urine contains only a fraction of a per cent of the acid, chiefly as sodium salt; abundance of uric acid is met with in the excrement of serpents and birds, in which it is the principal nitrogenous product of tissue waste Pure uric acid, $C_5H_4N_4O_3$, forms a snow-white microcrystalline powder, devoid of smell or taste, soluble in 1,800 parts of boiling and in 14,000 parts of cold water. For its detection in urine, excess of hydrochloric acid is added when uric acid separates, generally coloured red by impurities The precipitate is dissolved in a few drops of nitric acid and after evaporation to dryness the residue on addition of ammonia assumes the intense purple colour of murexide (*q v*)

URICONIUM (more correctly *Viroconium* or *Vriconium*), *chef-lieu,* as proved by an inscription, of the Cornovii, now Wroxeter on the Severn, 5 m E. of Shrewsbury At first perhaps (47–65) a Roman legionary fortress, held by Legiones XIV. and XX against the Welsh hill tribes When the garrison was removed, it became a flourishing town with public baths (excavated 1859–61), town hall, and market (excavated 1924–27)

Bibliography—*See* J P Bushe-Foxe, *Excavations at Wroxeter in 1912, 1913, 1914* (*Soc Antiq Research Reports,* i , ii and iv.) ; G F. Hill, *Numis Chron* (1925), 336, *Report of Excavations* by D Atkinson (*Birmingham Arch Soc*), *in the Press*

See Journ of R Studies, 1923–27, xii. 252, xiv. 226, xv 228, xvi. 224, xvii *Classical Review* (1924), p. 146 *seq* and (1928), p. 10 *seq.*

URIM and **THUMMIM,** in the Bible. These descriptive terms are applied to one of the methods of divination employed by the ancient Hebrews, which, it is now generally agreed, consisted in a species of sacred lot Together with "dreams" and the prophetic oracle it formed the recognized channel by which divine communications were given (*cf* I Sam. xxviii 6). That some method of casting lots is denoted by the terms is evident from I. Sam xiv 41, *f*

From this illuminating passage it is clear (*a*) that by means of the Urim and Thummim the guilt or innocence of the suspected parties was determined; (*b*) that this was effected by a series of categorical questions implying the simple alternative of "yes" or "no," or something positive or negative A further inference (*c*) from a comparison of I Sam xiv. 41, *f.* with ver. 36 (Greek text) is that this method of casting the sacred lot was closely connected with divination by the Ephod (*q.v.*), and was the prerogative of the priests For this last point the "Blessing of Moses" (Deut. xxxiii.), where the opening words of the Benediction on Levi run thus (text as emended by Ball, following LXX ; *Proc. of Soc. of Bibl. Arch.* 1896): "Give to Levi Thy Thummim, and Thy Urim to the man of Thy favour " For a similar Arabic custom, *cf.* G. F. Moore *Ency. Bib.* IV., col. 5236.

In the post-exilic Priestly Code the Urim and Thummim figure as part of the equipment of the High Priest (*cf.* Ex. xxviii. 30; Lev. viii. 8; Num. xxvii. 21). Here it is stated that they are kept in a square pouch which is worn upon the high priest's breast ("the breastplate of judgment"), and attached to the ephod. Thus the association of the Urim and Thummim with the ephod, is retained

That Urim and Thummim were not then in use is shown by Neh. vii. 65 (Ezra ii. 63, I. Esdras v 40). Later references (Ecclus. xiv. 10; in Josephus and the Talmud) prove that no real tradition survived on the subject As vocalized in the Massoretic Hebrew text the names= 'Lights and perfections " But the Greek translators read the former *orim* and connected it with *torah,* "decision"; it would thus mean "doctrine", so Symmachus (*cf.* I. Esd v 40)

BIBLIOGRAPHY—For the older views, *see* Spencer, *De leg Hebr rit Diss* VII , and a useful summary by Plumptre in Smith's *Bib Dict* For modern discussions, *see* the articles "Urim and Thummim" in the Bible Dictionaries, the relevant sections in the treatises on archaeology, and W. Muss-Arnolt, "The Urim and Thummim" (*Amer Journ of Semitic Lang.,* 1900) (G H. B)

URINARY SYSTEM. The urinary system in the fully developed human being consists of (1) the kidneys, (2) the ureters, (3) the urinary bladder, and (4) the urethra

The Kidneys.—The *kidneys* are two firm, reddish brown organs about 4½in long, placed obliquely behind the other abdominal viscera—one on each side of the last thoracic and three upper lumbar vertebrae Each is imperfectly covered on its ventral surface by peritoneum Around them there is usually much fat and

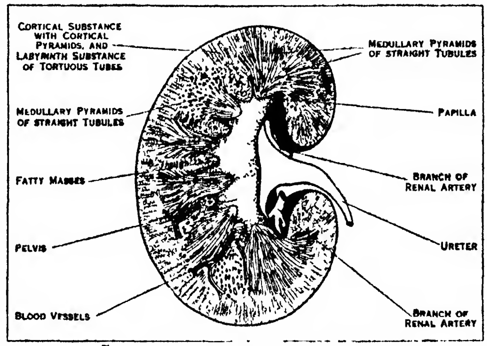
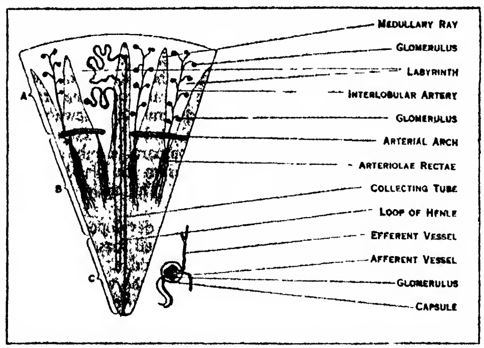


FIG 1 —VERTICAL SECTION OF THE KIDNEY



FROM A F DIXON IN CUNNINGHAM, 'TEXT BOOK OF ANATOMY' (OXFORD MEDICAL PUBLICATIONS)

FIG 2 —DIAGRAMMATIC REPRESENTATION OF THE STRUCTURES FORMING A KIDNEY LOBE

areolar tissue. The degree to which the kidney is fixed in position varies somewhat In so-called moveable or floating kidney the mobility may give rise to symptoms. The kidney in the foetus is lobulated, but becomes smooth in later years of childhood. Each organ has a firm, fibrous capsule, easily stripped off when the kidney is healthy. The inner and ventral margin of each kidney is concave

(*hilum*) and contains the renal artery and vein and the ureter which is always behind and below the blood vessels. Longitudinally divided from hilum to outer edge, the cut surface is seen to consist of two parts—an outer layer, the cortex, and an inner part, the medulla (fig 1). The latter consists of a series of eight to sixteen pyramids, whose bases and sides are invested with cortical matter, and whose apices or papillae project into the pelvis of the

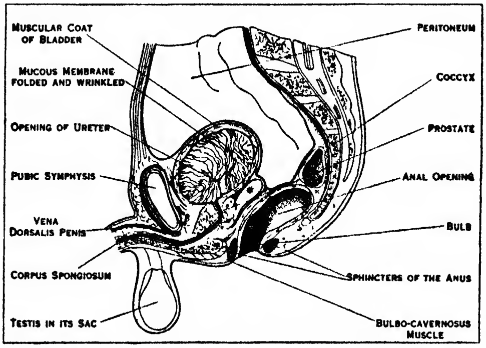


FIG 3.—VERTICAL SECTION THROUGH PELVIS, SHOWING THE URINARY BLADDER AND RECTUM IN SITU

kidney, where they are severally surrounded by membranous tubes (calices), which by their union make up the ureter In minute structure the kidney is the most complex gland in the body.

Ureter, Bladder and Urethra.—The *ureter* or duct of the kidney begins at the hilum and descends on the back wall of the abdominal cavity to open into the bladder. It is usually about 12in. in length and as thick as a goose quill At its termination it passes obliquely through the coats of the bladder, so that when the bladder is distended the lumen of its end is closed The *urinary bladder* is a membranous bag lying in the pelvic cavity directly behind and above the dorsal surface of the pubes In the foetus and infant, however, the bladder lies in the abdomen, not in the pelvis. During life it is seldom distended so as to hold more than about 10oz. When distended it rises and is applied closely against the back of the ventral abdominal wall. The bladder has a strong wall of unstriped muscle in several layers, which are innervated by branches from the sacral nerves. It has a peculiar epithelial lining of several strata, the superficial cells of which are cubical when the sac is collapsed, but flattened and scale-like when it is distended. At the lower part of the bladder is a triangular space known as the trigone, the angles of which are formed by the openings of the two ureters and the urethra In this space the mucous membrane is smooth and firmly bound to the subjacent muscle; elsewhere it is thrown into numerous folds when the bladder is empty. The female urethra is 1½in in length and is comparable only with that part of the male urethra which extends from the bladder to the openings of the seminal ducts (fig 3) The male urethra is described under REPRODUCTIVE SYSTEM

Embryology.—The excretory organs are developed as a series of small tubes situated in the intermediate cell mass, the ventral part of which projects to form the Wolffian ridge. Three sets of these tubes appear in succession and occupy the whole length of the body from the cervical to the lumbar region The most anterior—*pronephros* or *head kidney*—is represented in man by only two or three small tubules on each side which appear as ingrowths from the neighbouring coelom (fig. 4). It is probable that these are only mere vestiges Although the pronephros is rudimentary, the duct which in lower types carries away its excretion is well developed. This is the *Wolffian duct,* which appears in man before the pronephric tubes are formed, and runs longitudinally back in each intermediate cell mass to open into the cloaca (fig. 4). In certain parts of its course it is, at an early date, close to the skin on the dorsal side of the intermediate cell mass, and many embryologists hold that it is originally ectodermal and has sunk into the mesoderm secondarily. Morphologically, this view seems likely.

When the pronephric tubules disappear, which they do early in the embryo's development, the Wolffian duct persists as the drain for another and more important series of tubules (the *mesonephros* or *middle kidney*), formed in the intermediate cell mass behind the pronephros (fig 4) There is some doubt whether these tubes are strictly homologous and in series with those of the pronephros; they are of later development.

By about the sixth week of intra-uterine life these tubules reach their maximum development and form the *Wolffian body,* which projects into the coelom as the now very definite *Wolffian ridge* and acts as the functional excretory organ of the embryo When the permanent kidney is formed this organ degenerates; for its ultimate fate *see* REPRODUCTIVE SYSTEM.

The *metanephros* or *hind kidney* begins as a diverticulum from the dorsal side of the Wolffian duct close to its opening into the cloaca (*see* fig 4); this organ occurs about the fourth week of intra-uterine life, and the diverticulum grows forward (cephalad), dorsal to the hind end of the Wolffian body. In doing this it forms a duct—the *metanephric duct* or *ureter*—the cephalic end of which enlarges and divides to form the calices of the kidney. From the calices numerous smaller ducts grow into the mesoderm of the hind (caudal) end of the intermediate cell mass and become the collecting tubes of the kidney. While this is going on another set of tubules, probably in series with the mesonephric tubules, develops independently in the intermediate cell mass and forms the rest of the tubular system of the kidney. Toward these tubules, at one point, branches from the aorta push their way and invaginate each tube, thus forming the Malpighian corpuscles.

By the eighth week the kidney is definitely formed and takes over the excretory work of the mesonephros, which now atrophies.

At first, as has been stated, the ureters open into the Wolffian ducts, but later on each gains a separate opening into the cloaca, and eventually these shift ventrally until they reach their permanent connection with the allantoic bladder.

The *bladder* is developed from that part of the allantois which is nearest the cloaca. At first it is tubular, but after the second month becomes pyriform, the stalk of the pear corresponding to the fibrous *urachus* which reaches the umbilicus.

The *Müllerian ducts* (fig. 4) are formed after the Wolf-

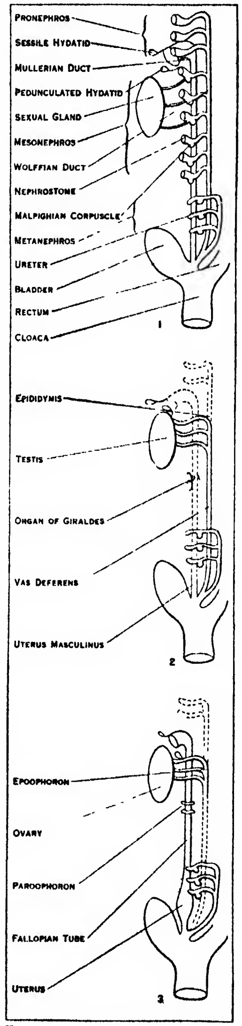


FIG. 4.—DIAGRAM OF THE FORMATION OF THE GENITO-URINARY APPARATUS

The first figure is the generalised type, the second the male, and the third the female specialised arrangements. The suppressed parts are dotted

fian ducts are fully developed. A ridge appears in the intermediate cell mass ventral to the Wolffian duct, and into the anterior (cephalic) end of this a tubular process of the coelom forces its way backward (caudad). Before reaching the cloaca the two Mullerian ducts coalesce and open between the orifices of the two Wolffian ducts These ducts form the oviducts, uterus and at least part of the vagina.

Comparative Anatomy.—In the Acrania (Amphioxus) the nephridial tubules are segmental and are only found in the pharyngeal region; each opens into the coelom by several ciliated funnels (nephrostomes) and also into the atrium, which is the exterior of the animal, by an opening called the nephridiopore

Among the Cyclostomata (lampreys and hags) the pronephros persists throughout life in Bdellostoma and probably in the hag (Myxine), but a Wolffian (archinephric) duct has been evolved so that the tubules no longer open on the surface by nephridiopores. In the Teleostomi (bony and ganoid fish) the pronephros is aborted and the mesonephros is the functional kidney.

In the Elasmobranchii (sharks and rays) the pronephros is more completely and more early aborted than in the last subclass, and the mesonephros is divided into an anterior or genital part (which receives the vasa efferentia in the male from the testis and thus is the first appearance phylogenetically of an epididymis) and a posterior or renal part The Wolffian duct therefore acts both as a vas deferens for the sperm and a ureter for the urine, though in the female it is merely a ureter

The Dipnoi or mudfish are remarkable for having a cloacal caecum which probably functions as an urinary bladder

In the Amphibia the snake-like forms (Gymnophiona) show a very primitive arrangement of the kidney tubules, each having its nephrostome, Malpighian capsule and short convoluted part leading to the Wolffian duct which acts both as ureter and vas deferens

In Reptilia the hind kidney or metanephros is developed and takes over all the excretory work; it is usually lobulated, its nephridia are never provided with nephrostomes and its duct (the ureter) opens into the Wolffian duct or vas deferens before reaching the cloaca Birds resemble reptiles very closely in their urinary system except that there is no bladder and that the ureters and vasa deferentia open independently into the cloaca

In the Mammalia the bean shape of the kidney is fairly characteristic. In foetal life the organ is always lobulated, and this often persists in the adult as in the ox, bear, seal and whale

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URMIA, a town in the province of Azerbaijan in Persia, on a plain at an elevation of 4,400 ft, in 37° 34′ N., and 45° 4′ E., 78 m from Tabriz The population before the war was roughly estimated at 45,000, being mainly Turkish, with Armenian and Nestorian minorities The town has a wall beyond which extend many houses in gardens and orchards. It is clean with broader and less oriental-looking streets than in most Persian towns Special features are the Citadel with its arsenal and barracks; and the bazaars, a maze of domed and brick-vaulted corridors. The plain of Urmia is fertile. By means of irrigation, cultivation especially of fruits and tobacco (*tutun*), reached a high standard

Then came the World War There was a wholesale exodus of Christians—said to have reached 59,000 souls—in July 1918, in the Turkish advance after the Russian debâcle; and, in the same year, there were massacres by the Turks and Kurds of two-thirds of those who remained. In 1919, the remnant of 600 Christians was transferred to Tabriz Some survivors have been repatriated by the Persian Government, and by loans for the repair of buildings and the purchase of seed, oxen and implements, some agriculture has been restored. Relief was given by the British in 'Iraq.

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URMIA, LAKE OF, in north-western Persia, between 37° 10′ and 38° 20′ N. and between 45° 10′ and 46° E, which takes its name (Pers *Deryacheh i Urmia,* Turk *Urmi gol*) from the town of Urmia, situated near its western shore, but is also known as the Deryacheh i Shahi and Shahi gol The limits of the lake vary much, the length (north to south) from 80 to 90 m, the width (east to west) from 30 to 45, being greater in the season of high water in spring when the snows melt

The mean depth of the lake is 15 to 16 ft, and its greatest depth probably does not exceed 50 feet. The lake has in recent years exhibited extraordinary changes of level, either due to a movement of the earth's crust or merely to an increase of rainfall as compared with evaporation De Morgan gives an area of 4,000 and 6,000 sq km. (1,544 and 2,317 sq m) for low and high water respectively. In the south is a cluster of about 50 rocky islands, the largest of which, Koyun daghi, *i e.,* "Sheep-mountain," is 3 to 4 m long and has a spring of sweet water near which a few people graze their goats and sheep. All the other islands are uninhabited The lake is about three-fifths as salt as the Dead sea—far too salt to permit of any life, except of lower organisms

By the U S S R treaty with Persia, of 1921, the railway from Tabriz to Julfa and branch line from Sofian to Lake Urmia and all the properties pertaining to navigation on the lake—formerly a Russian concession—were gratuitously transferred to Persia From the port of Sharaf-Khaneh on the eastern shore of the lake a fleet of motor boats of 20–160 h p. is operated in conjunction with the railway. The service is weekly. The lake is also navigated by clumsy craft with round bows and flat sterns carrying enormous sails (*See* Urmia)

URODELA, the name for that division of the Amphibia (*q v*) which includes the newts and salamanders (*qq v*) and is characterized by the possession of a tail throughout life and by the aquatic larval stage in their life history, which last feature, however, they share with the Anura (*q v*).

UROLOGY. The branch of medicine—chiefly surgical—that deals with diseases of the genito-urinary organs Recent progress in urology has been due largely to improvements in the cystoscope, advances in radiology, use of diathermy and close co-operation between urologists, bacteriologists, and bio-chemists Endovesical instruments are now available from the simplest cystoscope, consisting of a telescope within an irrigating sheath, to complicated instruments with which lesions can be treated surgically under direct vision instead of by an open operation.

Similarly, advances in radiology have led to the detection of calculi hitherto regarded as transparent to the rays, and to stereoscopic radiograms indispensable for locating a suspicious shadow in the neighbourhood of the kidney or ureter Pyelography also gives information concerning the size and shape of the renal pelvis and calices A skiagram is taken after a fluid opaque to the X-rays (*e g*, sodium iodide or lipiodol) has been introduced into the renal pelvis by means of a ureteric catheter It is of great value in diagnosing early dilation of the kidney, silent hydronephrosis, polycystic kidney, malformation of the pelvis and renal tumours encroaching on the pelvis; in localising shadows in the renal area such as calcified mesenteric glands and gall stones, and in differentiating between abdominal and renal tumours By similar means, silhouettes of the bladder or male urethra can be obtained, though in the latter instance they are not indispensable, for the canal can be examined easily and thoroughly with a urethroscope.

Perirenal inflation with CO_2 was introduced by Carelli of Buenos Aires and in radiographs shows clearly alterations in shape, size and density, therefore being useful in such conditions as early hydronephrosis, polycystic kidneys, tuberculosis, tumours and stones not dense enough to show by ordinary radiography; but its greatest value lies in giving a clear and distinct radiogram of the suprarenal capsule.

Diathermy.—Diathermy (*see* Electro-Therapy) acts by virtue of the heat generated in the tissues by the resistance they offer to the passage of an electric current. For this purpose a very strong current must be used, deprived of its stimulating and electrolytic properties by alternations of not less than 500,000 per second

The only sensation produced by a current of such high frequency is one of heat ranging, according to the strength of the current, from a pleasing warmth to a temperature high enough to char the tissues for a distance of about 1 cm. from the electrode. All degrees of diathermy are used for diseases of the genito-urinary system, the lower temperatures for testicular neuralgia and epididymo-orchitis, chronic urethritis and prostatitis, and benign enlargement of the prostate when a radical operation is inadvisable Destructive diathermy is now the method of choice in the treatment of certain forms of papilloma of the bladder and urethra, and in the median bar type of prostatic obstruction. It has been used with moderate success for carcinoma of the prostate

Use of Radium.—Radium (*q.v.*) has been used extensively for carcinoma of the prostate and bladder. It is applied in the form of needles and emanation tubes or seeds implanted directly into the growth, but has not yet emerged from the experimental stage. Caution is required in its use, for large doses produce great irritation and may be followed by excessive infiltrations of the bladder neck. Again, emanation tubes placed too close to the pouch of Douglas have caused peritonitis and death. In view of these disadvantages and the discouraging results they have encountered many urologists are now averse to using it at all.

Urinary Antiseptics.—Both mercurochrome and hexyl-resorcinol are powerful antiseptics, and though not "ideal" are valuable additions to the comparatively few powerful bactericides which can be administered with safety. Mercurochrome can be used either locally or intravenously. In cases of chronic cystitis, usually due to the colon bacillus, instillation of a watery solution (0·2–1·0%) sometimes has a remarkable effect. In pyogenic coccal infections the results are not so striking In pyelitis, irrigation with mercurochrome is not so irritating as with silver nitrate Instillations appear to be particularly valuable for chronic posterior urethritis, especially when complicated by prostatitis and vesiculitis When given intravenously in doses of from 1 to 5 mg. per kg. of body weight results have been most encouraging, especially in acute coccal and bacillary infections of the genito-urinary tract associated with pyrexia Chronic afebrile colon bacilluria, on the other hand, does not always respond so readily to this treatment. In rare cases, pronounced febrile and gastro-intestinal reactions follow the injection but these usually subside in 24 hours. The danger to the kidneys of such a powerful mercurial compound must never be overlooked, but Young (Baltimore) considers it may be used intravenously without fear of injury.

Hexyl-resorcinol [$C_6H_3(OH)_2C_6H_{13}$] is a synthetic compound first described by Leonard. Possessing forty-five times the germicidal power of phenol, it conforms experimentally to the qualifications necessary for an ideal urinary antiseptic in that it is chemically stable, non-toxic, non-irritating to the urinary tract, has an antiseptic and bactericidal action in high dilution in urine of any reaction, and is eliminated in high percentage by the kidneys. On the other hand, it can only exert its germicidal properties on tissues with which the urine comes in contact, and therefore infections of the renal parenchyma and submucous tissues of the urinary tract are not affected by it. If taken on an empty stomach the drug may cause griping or catharsis. Infections due to pyogenic cocci appear to yield to the drug with remarkable rapidity. *B. coli* infections of the urinary mucosa with a low bacterial count can be cured with hexyl-resorcinol, but when the count is high and the sub-mucous tissues are infected, prolonged treatment combined with appropriate local treatment is necessary. When administered prophylactically two days before, and daily after operations on the bladder, the wounds remain healthy and healing is accelerated.

Tests of Renal Function.—Tests for estimating the function of one or both kidneys are now employed regularly. Though not conclusive, they are capable of giving a warning which should be heeded, particularly in operations on the urinary tract. Thus in prostatectomy they serve to determine a one- or two-stage operation, and since they have been adopted as a routine the mortality from uraemia has become almost negligible. The chief tests in use in England are: (1) The urea concentration test (Maclean and de Wesselow), (2) estimation of blood urea; (3) colour tests. The technique of applying these tests can be found in text-books

The range of normality of the blood urea is so great that this test alone is of little value unless the urea retention is above 50 mg per 100 cu.cm. of blood, but when combined with the urea concentration test it gives an excellent indication of the renal efficiency. In some clinics on the Continent great reliance is placed on the elimination of creatinin and chlorides as tests of renal efficiency. The dyes chiefly employed for colour tests are indigo-carmine and phenolsulphonaphthalein. Indigo-carmine can be employed during a cystoscopy and gives a good indication of the function of one kidney without the use of a ureteric catheter (chromocystoscopy). A 0·4% solution injected either intravenously (5 c.c) or intramuscularly (20 c.c) should tinge the urine of a healthy kidney in five minutes. Phenolsulphonaphthalein is excreted solely by the kidneys and so differs from indigo-carmine, which is only partly excreted by the kidneys In America it is used almost exclusively, but in England it has not been popular owing to the somewhat elaborate technique required and to the difficulty, since the War, of obtaining a reliable preparation of the dye. The test is very reliable provided the pure compound is used

The capacity or otherwise of a patient to resist the spread of sepsis to the upper urinary tract after an operation, such as prostatectomy, is a factor which may upset the calculations of both surgeon and bio-chemist MacAdam and Shiskin have found that the *cholesterol content* of the blood gives a fair indication of the power of resistance. The average in a series of healthy adults under 50 years of age was found to be 0·16%. Above 50 years it ranges between 0·13% and 0·19%. Practical experience led these workers to conclude that in prostatic obstruction a blood-cholesterol below 0·13% indicates such a lowered resistance to the spread of sepsis as to constitute a bad operative risk Cases with a high blood-urea and a normal blood-cholesterol all recovered from a two-stage prostatectomy, but out of eight cases with a high blood-urea and a low blood-cholesterol all died save one.

The Kidney.—Dudgeon and others have pointed out that the combination of pus cells and a pure culture of staphylococcus albus in the urine of one kidney is almost pathognomonic of a stone in that kidney. With certain reservations all cases of renal calculus are now subjected to operation, for the stone, whether causing symptoms or not, slowly but surely injures the kidney and often determines a serious bacterial infection. Small stones are more dangerous than large ones, for they may lodge in the ureter and cause hydronephrosis, anuria and so on.

The problem of bilateral lithiasis is a difficult one, but on the whole urologists advocate operation on the healthiest kidney first, as there is always the possibility that nephrectomy may be necessary on the side which is more grossly affected. Pyelolithotomy is now performed in preference to nephrolithotomy whenever possible.

Decapsulation of the kidney for nephritis has been performed on many occasions with varying success, but is viewed with increasing favour. The benefit obtained is probably due to the mechanical relief of renal tension, and this certainly explains the immediate improvement following unilateral decapsulation in eclamptic uraemia. The indications for this operation are uraemia, anuria, oedema, excessive albuminuria and obstinate haematuria. Contra-indications are age, heart diseases and extensive cardiovascular changes.

Renal Tuberculosis.—Investigations by Braasch in the Mayo clinic have disproved the common opinion that renal tuberculosis is usually primarily unilateral. In seven out of 22 apparently unilateral cases, the urine from the supposed healthy kidney was proved to contain tubercle bacilli by animal inoculation, a fact which goes far to explain the comparatively heavy mortality in the first few years after nephrectomy. Continental writers estimate

that in life the infection is bilateral in about 15% of cases, whereas in the post-mortem room it is as high as 65%. This fully bears out the experience that spontaneous cure is extremely rare and that the only rational treatment of unilateral tuberculosis is early nephrectomy. In bilateral infections, Ekehorn advocates and practises removal of that kidney which is found by inspection to be the most diseased, or is thought to be the cause of pyrexia and distressing bladder symptoms. In 20 cases reported by him the results were good enough to justify the operation. The treatment of the tuberculous ureter is still under discussion, most workers considering that it heals naturally after the diseased kidney has been removed, while others advocate a primary nephro-ureterectomy to prevent infection of the lower urinary tract by the diseased ureter. All are now in favour of a post-operative course of tuberculin.

Movable Kidney.—Operations for nephroptosis are decreasing in number year by year, for surgeons have now realised that the condition is commonly associated with Glenard's disease and with such general symptoms as headache, gastric discomfort, neurasthenia and ptoses of various kinds, for which fixation of the kidney gives no relief whatever. Nephropexy is now reserved chiefly for cases of intermittent hydronephrosis, haematuria, casts and albuminuria, and for uncomplicated renal pain relieved absolutely by rest in the horizontal position.

Ureteral Calculus.—In the case of small stones impacted in the ureter most urologists favour removal by manipulative and other methods rather than by ureterolithotomy. The chief methods employed are: (i.) dilation of the ureter combined with instillation of sterile liquid paraffin, subcutaneous injection of atropine, and forced diuresis with Contrexéville water; (ii.) intra-ureteral instillation of 5 cu.cm of a 2% solution of papaverine sulphate, selected for its analgesic and antispasmodic properties; (iii.) dilation of the ureter by diathermy, and (iv.) division of the ureteric meatus with scissors through a cystoscope.

Severe reactions after cystoscopic manipulations, and irregular stones greater than 1 cm. in diameter are indications for ureterolithotomy. The pelvic portion of the ureter is now always exposed extraperitoneally, either through a paramedian subumbilical incision or by Kidd's inguinal operation.

Bladder.—The ureter may be implanted into another part of the bladder, either for stricture of its extramural portion or after partial cystectomy for growths involving the ureteric orifice. For inoperable bladder growths and for extrophy of the bladder, Coffey has devised a method of simultaneous transplantation of both ureters into the pelvic colon, which does not obstruct the ureters or disturb kidney function.

The bacteriology of cystitis and pyelocystitis has received much attention from bacteriologists. The most important recent communications on this subject are by Dudgeon, Wordley and Bawtree. These workers have isolated from different cases —

(1) A special group of haemolytic bacilli, strongly resembling but not identical with the paratyphoid bacillus; (2) the colon bacillus; (3) Proteus.

Improvements in the cystoscope have led to earlier recognition of diverticula. Swift Joly reviews the whole subject and discusses the relative value of the different operations. He also points out that accompanying prostatic or urethral obstruction should be treated at the same time whenever possible.

Papilloma.—These tumours are now treated by fulguration through a cystoscope whenever possible, and in many instances can be destroyed completely at one sitting and under local anaesthesia. When the papilloma is sessile and diathermy can only be applied to the surface nearest the cystoscope, several treatments at intervals of a week or ten days may be required, a portion of the growth being destroyed at each sitting. Subsequently a cystoscopic examination should be made at intervals of three to six months for at least three years, so that fresh growths can be kept in check. Open operation by the suprapubic route is reserved for large growths, especially if sessile and for those involving the ureteric orifice. In some cases the tumour can be destroyed by diathermy with a large electrode, in others a partial cystectomy, with or without transplantation of the ureter, is necessary. Attention has been called to the danger of "graft-recurrences" in the abdominal wall after removal of papillomata by the suprapubic route, and Maybury and Dyke have reported a case in which three successive implants grew in the abdominal wall. The primary vesical growth was benign but the recurrent implants became progressively malignant. Carcinoma should be excised whenever possible, for as yet the results of treatment with imbedded radium is disappointing and uncertain. In the flat ulcerating form of carcinoma, peculiar to the aged, a fair measure of comfort and relief can be obtained from deep X-ray therapy.

The Prostate.—For chronic inflammatory lesions of the prostate and seminal vesicles diathermy is valuable and acts, not only on the gland itself, but also on the arthritic and other complications so frequently associated with gonorrheal prostatitis and vesiculitis. In cases of enlarged prostate where operation is impossible owing to age, cardiovascular changes, advanced renal disease, etc., a fair measure of relief can be obtained by medical diathermy or by deep X-ray therapy. In all other cases prostatectomy is undoubtedly the correct procedure. The type of enlargement most suitable for operation is that due to chronic lobular prostatitis with pronounced adenomata; the second type, chronic interstitial prostatitis or fibrous prostate, presents many difficulties to the operator but should be removed whenever possible, as it causes a severer degree of obstruction and consequent impairment of the renal function than the adenomatous variety. Before deciding on an operation the chemical tests of renal efficiency should be carried out, for the type of operation selected will depend almost entirely on these tests. Careful preliminary treatment, often lasting several weeks, is nearly as important as the operation itself.

After much discussion, the majority of urologists have decided in favour of the suprapubic operation in one or two stages. The two-stage operation has reduced the mortality from uraemia to a negligible quantity and is indicated in all cases with renal deficiency, severe cystitis, retention, or four or more ounces of residual urine. The Thomson-Walker operation is undoubtedly an improvement on the somewhat crude but remarkably effective operation practised by Freyer. It takes longer but eliminates the risk of post-operative stricture. The perineal operation, performed almost exclusively by Young of Baltimore, is in England reserved for carcinoma and for the fibrous type of prostate. Here the advantages of control of haemorrhage and perfect drainage are outweighed by the dangers of pelvic cellulitis, perineal fistula and incontinence of urine.

In about 25% of patients with symptoms of prostatic obstruction but without palpable enlargement of the prostate, a careful cystoscopic examination reveals the presence of a ridge of hypertrophied tissue, either on the posterior lip of the prostate overhanging the internal meatus, or projecting upwards from the floor of the prostatic urethra and constituting the so-called median bar. For the relief of this type of obstruction H. Young invented his well-known punch, later improved by Kenneth Walker, by adapting it for diathermy. (*See* ELECTRO-THERAPY.)

Hitherto, treatment of prostatic carcinoma by radium has been so unsatisfactory that many surgeons have ceased to use it. Diathermy has been more or less successful in conferring relief, but the results can hardly be described as brilliant. Whenever possible, Young's perineal resection appears to be the most satisfactory procedure; failing this, excellent results have been sometimes obtained from deep X-ray therapy.

The Testis.—Steinach of Vienna performed vasoligation in *senile* rats with a view to increasing the internal secretion of their testes and thereby stimulating their failing energies. For two to four weeks after bilateral division of the vas between ligatures no appreciable change was noticeable. The rats then began to show a return of sexual excitement and vigour, in some instances equalling that of young males. This was followed in rapid succession by a return of pugnacity, increase in muscular energy and a copious growth of fur. The change lasted for about six months, when the animal gradually lost his youthful appearance and powers and became senile again, eventually dying within a few weeks of the onset of the change. Steinach found that the operation induced degeneration of the seminal epithelium (later followed by regeneration) and an increase in the interstitial tissue. In man the operation has been attended by very variable results. The

greatest successes appear to have occurred in cases of premature old age; when performed for impotence alone it is not so satisfactory, and is quite useless if the testis be already atrophied. Some cases of arteriosclerosis have been greatly benefited by it.

Testicular Grafts (*see* REJUVENATION).—Grafts from lower animals have been employed for many years with more or less similar results, viz., improvement shortly after implantation, followed by atrophy and absorption of the graft, and a return on the part of the patient to the original condition. Voronoff in 1920 used testes of anthropoid apes and found that they survived for three years or longer, and that the initial improvement in the patient's condition was maintained. Kenneth Walker has on several occasions employed a healthy human ectopic testis. He concludes that the life of a hetero-graft is not longer than two years, that absorption of the graft does not necessarily imply a return of the patient to his former condition, and that permanent improvement is probably due to increased growth in other endocrine tissues stimulated into activity by the graft.

Tuberculous Epididymitis.—When this disease is advanced castration is indicated, but when it is localised to the globus major or minor epididymectomy is now regarded as the correct procedure. The full extent of the disease must always be determined with care.

The Urethra.—The great improvement in urethroscopes has simplified the diagnosis and treatment of urethral conditions. With the Joly type of posterior urethroscope, diathermy can be applied where formerly a serious cutting operation was necessary. There is now an increasing tendency to revert to former methods and to treat stricture of the urethra by gradual dilatation with metal sounds or gum elastic bougies, urethrotomy being reserved for resilient and cartilaginous strictures and those complicated by fistulae. If contraction recurs after internal urethrotomy many surgeons advocate excision of the stricture and axial anastomosis. When a large amount of cicatricial tissue has been excised, the gap has been successfully bridged in one case by implantation of the patient's appendix, and in another by a child's prepuce fashioned into a canal around a catheter.

(*See* also BLADDER AND PROSTATE DISEASES.)

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(C. A. R. N.)

UROTROPIN, known also as uritone, a chemical substance (hexamethylenetetramine) formed by the action of ammonia on formaldehyde, used in medicine. It consists of colourless granular crystals freely soluble in water and having an alkaline reaction. Urotropin is among the most powerful of urinary antiseptics. It is used to render the urine acid in cases where it is alkaline, loaded with phosphates or purulent, as in cystitis. It is slightly diuretic. Experimentally it has been shown to have a solvent action on uric acid, but its action in this direction in the body requires confirmation. Urotropin is valuable in sterilizing the urine of "typhoid carriers" (*See* CARRIERS.) Analogous preparations are cystamine, helmitol and hetralin. Chinotropin is urotropin quinate, and borovertin is urotropin triborate.

URQUHART, DAVID (1805–1877), British diplomatist, was born at Braelangwell, Cromarty. He was educated in France, Switzerland and Spain, and at St. John's college, Oxford. He served (1827–28) in the Greek navy in the War of Independence, being severely wounded. In 1830 his reports on the new Greek frontier, as determined by the protocol of March 22, 1829, were of great service to the British Government. In Nov. 1831 he was appointed attaché to Sir Stratford Canning (Lord Stratford de Redclyffe, *q.v.*) on his mission to the sultan for the final delimitation of the frontiers of Turkey and Greece. In 1833 he went on a secret mission to Turkey in the interests of British trade, but he was recalled by Palmerston on account of his indiscreet advocacy of British intervention on behalf of the sultan against Mehemet Ali. In 1835 he founded the *Portfolio*, printing in the first issue a series of Russian State papers, which made a profound impression. As M.P. for Stafford (1847–52) he vigorously opposed Palmerston's foreign policy. He protested against the action of England in the Crimean War, advocating Turkish autonomy. He organized "foreign affairs committees" (known as "Urquhartite") throughout the country, in opposition to the Government, and in 1855 founded the *Free Press* (renamed in 1866 the *Diplomatic Review*) to which Karl Marx was a contributor. His health obliged him to retire to Montreux in 1864, and he died in Naples on May 16, 1877.

He published *Turkey and its Resources* (1833); and *England, France, Russia and Turkey* (1833), both violently anti-Russian; and *The Lebanon* (1860).

URQUHART or URCHARD, **SIR THOMAS** (1611–1660), Scottish translator of Rabelais, was the son of Sir Thomas Urquhart of Cromarty, and of Christian, daughter of the fourth Lord Elphinstone. After part of his estate had been alienated he received a "letter of protection" from his creditors from Charles I in 1637. He took part in the "Trot of Turriff" in 1639, and was knighted in 1641. He then published his *Epigrams*. In 1645, he produced a tract called *Trissotetras*, a treatise on logarithms, adjusted to a kind of memoria technica, like that of the scholastic logic. In 1649 he was proclaimed a traitor for taking part in the rising at Inverness. At Worcester, he was wounded and taken prisoner. His mss. were almost wholly destroyed. Urquhart was released by Cromwell's orders in 1651. He published during 1652 and 1653 three tracts with quaint titles and quainter contents, the last being on a universal language.

The *Translation of Rabelais* (Books I. and II.), which Urquhart produced in 1653, is a masterpiece of translation. Though not a close rendering, it reproduces the spirit of the original. The translation was reprinted in 1664; and in 1693 that of the Third Book was added. It is said the Urquhart sought refuge during the Commonwealth, like other cavaliers, on the continent, and died (1660) of a fit of laughing, brought on by joy over Restoration.

URSA MAJOR ("The Great Bear"), in astronomy, a constellation of the northern hemisphere, supposed to be referred to in the Old Testament (Job ix. 9, xxxviii. 22), and mentioned by Homer, Ἄρκτος θ', ἣν καὶ ἄμαξαν ἐπίκλησιν καλέονται (*Il.* 18. 487). The Greeks identified this constellation with the nymph Callisto (*q.v.*) placed in the heavens by Zeus in the form of a bear together with her son Arcas as "bear-warder," or Arcturus (*q.v.*); they named it Arctos, the she-bear, Helice, from its turning round the pole-star. The Romans knew the constellation as *Arctos* or *Ursa*; the Arabians termed the quadrilateral formed by the four stars α, β, γ, δ, *Na'sh*, a bier, whence it is sometimes known as *Feretrum majus*. The Arabic name should probably be identified with the Hebrew name *'Ash* and *'Ayish* in the book of Job (*see* G. Schiaparelli, *Astronomy in the Old Testament*, 1905). Ptolemy catalogues eight stars. Of these, the seven brightest (α of the 1st magnitude, β, γ, ϵ, ζ, η of the 2nd magnitude, and δ of the third magnitude) constitute one of the most characteristic figures in the northern sky; they have received various names—Septentriones, the wagon, plough, dipper and Charles's wain (a corruption of "churl's wain," or peasant's cart). With the Hindus these seven stars represented the seven Rishis. The stars α and β are called the "pointers," since they point to the pole-star. Five stars of the Plough form an associated group with common proper motion; but α (the upper pointer) and η (the last star of the tail) have no connection with the others. Stars in other parts of the sky have been found to belong to the same cluster; in particular Sirius is a stray member of it.

URSA MINOR ("The Little Bear"), in astronomy, a constellation of the northern hemisphere, mentioned by Thales (7th century B.C.). By the Greeks it was sometimes named *Cynosura* (Gr. *κυνός*, dog's; *οὐρά* tail), alleging this to be one of the dogs of

Callisto, who became *Ursa major*. The Phoenicians named it Phoenice, or the Phoenician constellation, possibly in allusion to the fact that the brightest star, Polaris, being situated very close to the north pole, is of incalculable service to navigators. Polaris, a second magnitude star, is at present distant 1° 9′ from the celestial pole. It is a Cepheid variable with very small light-range.

URSINS, MARIE ANNE DE LA TRÉMOILLE, Princess des (1642–1722), lady of the Spanish court, daughter of the duke of Noirmontier and Renée Julie Aubri. After the death of her second husband, Flavio Orsini, duke of Bracciano, she assumed the title of Princess des Ursins, a corruption of Orsini, and for her unofficial services in securing Neapolitans and Spaniards of rank at Rome as French partisans in view of the approaching death of Charles II of Spain, she was rewarded in 1699 by a pension. When Philip, duke of Anjou, grandson of the French king was declared heir by the will of Charles II the princess took an active part in arranging his marriage with a daughter of the duke of Savoy. Appointed *Camarera Mayor* by quiet diplomacy and the help of Madame de Maintenon, she accompanied the young queen to Spain in 1701. Till 1714 she was the most powerful person in the country. She was expected to look after French interests in the palace, and to manage the Spanish nobles. But she wisely held that the young king should rely on his Spanish subjects and was in frequent conflict with the French ambassadors. Recalled in 1704, she still had the support of Madame de Maintenon, and her own tact placated Louis XIV. In 1705 she returned to Spain, with practically the power to name her own ministry During the war of the Spanish Succession she was the real head of the Bourbon party. She was so far from offending the nation, that when Louis XIV. threatened in 1709 to desert his grandson, she dismissed all Frenchmen from the court On the death of the queen, acting by advice of Alberoni, she arranged a marriage for the king with Elizabeth Farnese of Parma She was rudely disillusioned in her hopes of governing the new queen as she had done the old. Driven from Elizabeth's presence with insult, at Quadraque, whither she had gone to meet her, she was sent out of Spain without being allowed to change her court dress. After a short stay in France, Madame des Ursins went to Rome, where she died Dec 5, 1722.

See F. Combes, *La Princesse des Ursins* (1858), *Lettres inédites de Mme. de Maintenon et de . . . la Princesse des Ursins* (1826; Eng trans, 1827); *Lettres inédites de la princesse des Ursins* (1859), C Hill, *Story of the Princess des Ursins in Spain* (1905)

URSULA, ST., and her companions, virgins and martyrs, are commemorated on Oct. 21. The *Breviary* gives no legend; but in current works, such as Butler's *Lives of the Saints*, it is to the effect that "these holy martyrs seem . . . to have met a glorious death in defence of their virginity from the army of the Huns. . . . They came originally from Britain, and Ursula was the conductor and encourager of the holy troop" The scene of the martyrdom is placed near the lower Rhine

The date has been assigned by different writers to 238, *c* 283 and *c.* 451. The story, however, is unknown both to Jerome and to Gregory of Tours—and this though the latter gives a somewhat detailed description of the Cologne church dedicated to that Theban legion with which the tradition of the martyred virgins was very early associated. The story of their fate is not entered under Oct. 21, in the martyrology of Bede (*ob. c.* 735), of Ado (*c* 858), of Usuard (*ante* 877), Notker Balbulus (896) or Hrabanus Maurus (845); but a 9th-century life of St Cunibert (*ob.* 663) associates a prominent incident in the life of this saint with the basilica of the sacred virgins at Cologne (Surius vi 275, ed 1575). Not only does Archbishop Wichfrid attest a grant to the church of the sacred virgins outside the walls of Cologne (in 927), but he was a large donor in his own person. Still earlier a Cologne martyrology, written, as Binterim (who edited it in 1824) argues, between 889 and 891, has the following entry under October 21. "xi. virg. Ursule Sencie Gregorie Pinose Marthe Saule Britule Satnine Rabacie Saturie Paladie." Much shorter entries are found in two of the old martyrologies printed in Migne (cxxxviii 1207, 1275). A more definite allusion to the legend may be found (*c.* 850) in Wandelbert of Prüm's metrical martyrology (Oct. 21):

Tunc numerosa simul Rheni per littora fulgent
Christo virgines erecta tropaea maniplis
Agrippinae urbi, quarum furor impius olim
Millia mactavit ductricibus inclyta sanctis.

The full legend first makes its appearance in a festival discourse (*sermo*) for Oct. 21, written, as internal evidence seems to show, between 731 and 839 This *sermo* does not mention St. Ursula, but makes Pinnosa or Vinnosa the leader of these spiritual "amazons," who, to avoid Maximian's persecution, left their island home of Britain, following their bridegroom Christ towards that East whence their faith had come a hundred years before. The concurrent traditions of Britain, Batavia, *i e*, the Netherlands (where many chapels still preserved their memory), and Cologne are called in evidence to prove the same origin. The legend was already very old and the festival "nobis omni tempore celeberrima"; but, as all written documents had disappeared since the burning of the early church erected over the sacred bones, the preacher could only appeal to the continuous and careful memory of the society to which he belonged (*nostrates*).

Two or three centuries later the *Passio XI MM. SS. Virginum*, based apparently on the revelations made to Helentrude, a nun of Heerse near Paderborn, gives a wonderful increase of detail. The narrative in its present form may date somewhere between 900 and 1100, while Helentrude apparently flourished before 1050. According to her account, the son of a powerful pagan king demands in marriage Ursula, the beautiful daughter of Deonotus, a king "in partibus Britanniae" Ursula is warned by a dream to demand a respite of three years, during which time her companions are to be 11,000 virgins collected from both kingdoms. After vigorous exercise in all kinds of manly sports, to the admiration of the populace, they are carried off by a sudden breeze in eleven triremes to Thiel on the Waal in Gelderland Thence they sail up the Rhine by way of Cologne to Basel, at which place they make fast their vessels and proceed on foot to Rome Returning, they re-enter their ships at Basel, but are slaughtered by the Huns when they reach Cologne Their relics are then collected and buried "sicut hodie illic est cernere," in a spot where "to this day" no meaner sepulture is permitted

The legend of Cologne grew to further dimensions with the revelations of St. Elizabeth of Schonau in the 12th century, motived apparently by the opening up of an old Roman burial ground in Cologne It advanced still further with Hermann Joseph, a Praemonstratensian canon of Steinfeld in 1183, who explained the presence of the bones of little children among those of the sacred virgins

See H Crombach, *Vita et Martyrium S Ursulae* (Cologne, 1647), and the Bollandist *Acta Sanctorum*, 21st October, where the story fills 230 folio pages The rationalization of the story is to be found in Oscar Schade, *Die Sage von der heiligen Ursula* (Hanover, 1854), of which there is a short *résumé* in S Baring-Gould's *Lives of the Saints* See also S Baring-Gould, *Popular Myths of the Middle Ages;* A G Stein, *Die Heilige Ursula* (Cologne, 1879) The credibility of some of the details was doubted as early as the 13th century by Jacobus de Voragine in the *Legenda aurea.* (T. A. A; A. J. G.)

URSULINES, a religious order founded at Brescia by Angela Merici (1470–1540) in November 1535, primarily for the education of girls and the care of the sick and needy. It was approved in 1544 by Paul III, and in 1572 Gregory XIII. declared it a religious order under the rule of St Augustine In the following century it was encouraged by St Francis of Sales and the Ursulines in Canada did valuable work among the French, the Indians and half-breeds About 1700, the order embraced some 20 congregations, with 350 convents and from 15,000 to 20,000 nuns

URTICACEAE (nettle family), in botany, a family of flowering plants belonging to the order Urticales, which includes also Ulmaceae (elm family), Moraceae (mulberry, fig, etc) and Cannabaceae (hemp and hop) It contains 41 genera, with about 480 species, mainly tropical, though several species such as the common stinging nettle (*Urtica dioica*) are widely distributed and occur in large numbers in temperate climates. Two genera are represented in the British Isles, *Urtica* (*see* Nettle) and *Parietaria* (pellitory, *q.v.*). In addition to *Urtica* and *Parietaria*, four other genera,—*Boehmeria, Hesperocnide, Laportea* and *Pilea,* are represented in North America, with some 15 native species.

The plants are generally herbs or somewhat shrubby, rarely, as in some tropical genera, forming a bush or tree The simple, often serrated, leaves have sometimes an alternate sometimes an opposite arrangement and are usually stipulate—exstipulate in *Parietaria*. Stinging hairs often occur on the stem and leaves The bast-fibres of the stem are generally long and firmly attached end to end, and hence of great value for textile use. Thus in ramie (q.v., *Boehmeria nivea*) a single fibre may reach nearly 9 in in length, and in stinging nettle as much as 3 in. *Maoutia* and *Urtica* have also been used as sources of fibre. The small inconspicuous regular flowers are arranged in definite (cymose) inflorescences often crowded into head-like clusters. They are unisexual and monoecious or dioecious The four or five green perianth leaves (or sepals) are free or more or less united; the male flowers contain as many stamens, opposite the sepals. The flowers are adapted for wind-pollination The female flower contains one carpel bearing one style with a brush-like stigma and containing a single erect ovule The fruit is dry and one-seeded, it is often enclosed within the persistent perianth The family is divided, according to Engler, into two main classes. (1) the *Urereae* with stinging hairs, including the genera *Urtica, Urera, Laportea,* and (2) others, which are without stinging hairs.

COMMON NETTLE. (URTICA DIOICA)

URTICARIA, popularly known as nettlerash, is characterised by the appearance on the skin of slightly raised red or white patches, varying in shape and size, termed wheals, which develop suddenly, persist for a few hours, and then fade spontaneously and completely. The eruption is invariably accompanied by sensations of itching or burning which may be very pronounced. It is customary to distinguish between an acute and a chronic variety of urticaria The former is marked by its abrupt onset, the profuse and extensive character of the eruption, and in many cases by the general symptoms which accompany the rash, such as fever, diarrhoea and vomiting. Acute urticaria is often caused by tainted food, and the whole attack is usually limited to a few hours or a few days. In chronic urticaria the eruption is either continuously present over periods of months or years, or is developed in bouts with intervals of comparative or absolute freedom The onset as a rule is insidious, and the general health is little disturbed unless the degree of itching is sufficient to interfere with sleep or repose

Nettlerash is now generally held to represent a symptom rather than a genuine disease, for it may be provoked by a great many and very different agents acting externally (nettles, jellyfish), or internally. The theory of sensitisation has a special application in urticaria. For example different kinds of foods are capable of causing urticaria under special conditions A certain individual suddenly becomes unduly "sensitive" to some article of diet which has, up to this point, been eaten without harm, while a second individual develops "hypersensitiveness" to a completely different type of food, a third to something different again, and so on. This acquired condition is specific, that is to say the individual who is "sensitised" only reacts to what is now his own harmful substance (*see* ANAPHYLAXIS).

The human tissues can also become "sensitised" to many other agents besides food, such as the poisons liberated from collections of germs in the teeth, tonsils, bowel and other regions of the body (focal infection) In other cases a second injection of horse-serum (diphtheria or tetanus anti-toxin), if given at a sufficient interval of time after the first will sometimes cause urticaria and anaphylactic shock. The mechanism of the reaction is similar in all these cases and the same degree of specificity is observed. The theory of sensitisation does not cover every case as, for example, where the eruption is related to an emotional crisis.

(H. MacC.)

URUGUAY (officially the Oriental Republic of the Uruguay, and still locally called the *Banda Oriental,* the "eastern shore" of the Uruguay river), the smallest independent State in South America. It lies between Brazil on the north and the estuary of the Río de la Plata on the south, extending from the Uruguay river to the Atlantic coast It has a sea-board of some 120 miles, a shore-line on the Plata of 235 miles and one of 270 miles along the Uruguay. The southern part of the country is mostly undulating plains, an extension eastward of the Argentine Pampas The coast-line is fringed with tidal lakes and sand dunes; the banks of the two bordering rivers are low, unbroken stretches of level land The northern section of the republic presents greater variety of relief, with occasional ridges and low ranges, alternating with broad valleys, a true southward extension of southern Brazil None of the sierras or mountains of Uruguay exceed 2,000 ft in elevation.

There are no large rivers within the territory of Uruguay. The Río Negro, which crosses the country from north-east to south-west, is the largest stream Throughout most of its length it is not navigable, its one river port being the town of Mercedes, 20 m. from its junction with the Uruguay. No other streams are navigable except for vessels of light draught. The Santa Lucía, the Queguay and the Cebollati are the principal water courses. These, as well as the Uruguay, are fed by numerous smaller streams (*arroyos*), affording an intricate network of drainage. The Uruguay river offers navigable waters along the border for steamers of 14 ft. draught from the island of Martín García at its mouth to Paysandú, and above that point for smaller vessels to the falls at Salto, 200 m in all. Beyond here navigation is interrupted by rapids (C L C, G M. McB.)

Geology.—The eastern and southern half of Uruguay is a low, rolling prairie, whose subsoil consists of weathered ancient schist and granite, through which protrude some low ridges composed of less weathered rocks. In central and north-central Uruguay a basement of ancient schist is overlain by nearly horizontal Permian beds, which form a low plateau The north-western part of Uruguay is occupied by a southward extension of the Parana plateau of southern Brazil. This plateau is formed of horizontal beds of Triassic red sandstone of continental origin, which are in places faulted and capped by sheets of Triassic basalt The plains of Uruguay are covered with Pleistocene deposits of sand and clay like those found on the pampas of Argentina and with alluvial beds. (G. McL. Wo.)

Climate.—Uruguay enjoys the reputation of possessing an excellent climate from the viewpoint of human health and comfort. The latitude ensures a fair uniformity of temperature throughout the year, the average for the summer months of January and February being 71° F and that of the coldest month, July, being 50°; frost is almost unknown Moreover, the climate of both summer and winter is marked by great variability from day to day, due to the passing of cyclonic storm centres. Brusque windshifts are common, the hot northerly *zonda* sometimes being followed immediately by the chill *pampero* from the south-west and bringing a sudden drop in temperature. These changes, while less extreme than in the pampas of the Argentine, give a middle latitude character to the climate of Uruguay. There are no decided rainy and dry seasons. A rainfall maximum is reached in the autumn (April and May), not in the winter months as is often supposed even by the residents of the country. Winter rains are most frequent but autumn rains are heaviest. The mean annual precipitation is about 35 in., decreasing with distance from the sea, but everywhere well distributed throughout the year. Many of the summer-time *tormentas* are thunderstorms, convectional and purely local in character. These do not always bring rain and are seldom accompanied by hail. Fogs are frequent from May to October, but seldom last all day on land. There are well developed land and sea breezes, especially in the summer season, when their influence is welcome.

Flora.—Uruguay is primarily a grass-producing country, a true

continuation eastward, in this respect also, of the Argentine pampa. There are more trees, however, both native and introduced, than on the pampas, but these are found chiefly in narrow ribbons along the bottom lands of the water-courses. The principal species are the ombú, alder, aloe, poplar, acacia, willow and eucalyptus. The *montes,* by which are understood plantations as well as native thickets, produce, among other useful wood, the *algarrobo,* the *guayabo,* the *quebracho* and the *urunday.* Indigenous palms grow in the valleys of the Sierra de San José Ignacio, as also to some extent in the departments of Minas, Maldonado and Paysandú. The myrtle, rosemary, mimosa and the scarlet-flowered ceibo are common. The valleys within the hills are fragrant with aromatic shrubs. The prairies are gay with the scarlet and white verbenas and other brilliant wild flowers

Fauna.—As in most of the inhabited parts of the world, the wild animals have largely disappeared. Even the rhea (the American ostrich) is now seldom seen, except in a semi-domesticated state. Pumas and jaguars are found on the wooded islets and banks of the larger rivers and along the northern frontier The fox, deer, wild cat, the *carpincho* or water hog, and a few small rodents nearly complete the list of native quadrupeds A little armadillo, the *mulita,* is the living representative of the extinct giants, mylodon and megatherium, whose fossils are found over the pampa There are a few specimens of the vulture, a native crow (lean, tall and ruffed) and many partridges and quails Parakeets are plentiful in the *montes* and the lagoons swarm with water-fowl. The most esteemed is the *pato real,* a large duck A characteristic sight on the prairies is that of the tiny burrowing owl, sitting on top of every little eminence Large flocks of the lapwing, *teru-teru,* are common, with their habit of warning other game of the approach of danger Of birds of bright plumage the humming bird and cardinal—the scarlet, the yellow and the white—are the most attractive, while white herons are frequently seen in swampy lands. The scorpion is rare, but large and venomous spiders are common The principal reptiles are a lizard, a tortoise, the *vivora de la cruz* (a dangerous viper, so called from marks like a cross on its head) and the rattle-snake in Maldonado and the stony lands of Minas. Along the upper waters of the Uruguay river the *caimán* (alligator) is not uncommon. Seals are found on small islands off the south-east coast, particularly Lobos island, which so gets its name

Area and Population.—The area of the republic is estimated at 72,210 sq m and it has a population of 1,042,668 according to the census of 1908, the estimate of 1925 giving 1,758,334 The country is divided into 19 departments, the area and population of which, according to the census of 1908, were as follows.

Departments	Area square miles	Population
Artigas	4,392	26,298
Canelones	1,833	87,931
Cerro Largo	5,753	44,806
Colonia	2,192	54,679
Durazno	5,525	42,313
Flores	1,744	16,158
Florida	4,763	45,393
Maldonado	1,584	28,804
Minas	4,844	51,170
Montevideo	256	309,231
Paysandú	5,115	38,528
Río Negro	3,269	10,909
Rivera	3,790	35,653
Rocha	4,280	34,110
Salto	4,863	46,304
San José	2,687	46,267
Soriano	3,560	30,431
Tacuarembó	8,074	46,027
Treinta-y-Tres	3,686	28,756
Totals	72,210	1,042,668

The average density of population on the above figures is 12·9 per square mile, ranging (exclusive of Montevideo) from 47·9 in Canelones to 5·8 in Tacuarembó and 6 in Artigas. In 1925 this average density had increased to 24·4 per square mile, showing Uruguay to be the most densely populated of the South American countries. There is a large number of foreign born inhabitants, the majority of these being Italians or Spaniards, with lesser numbers, in descending scale of Brazilian, Argentine and French birth. British, Swiss and Germans are comparatively few The number of immigrants varies greatly from year to year In 1907 there were 26,105 Italians arriving, 21,927 Spaniards, 2,355 British, 2,315 French and 1,823 Germans In 1924 the principal groups arriving at Montevideo were distributed as follows· Argentina, 33,361; Spain, 9,978; Italy, 7,514; Germany, 3,671, Brazil, 2,648; England, 1,902; France, 1,564 In the north there is a strong Brazilian element The average annual birth-rate is about 35 per thousand, and the death-rate about 15 5. About 26% of the births are illegitimate. The principal towns are Montevideo, the capital, with an estimated population (June 30, 1925) of 381,228, Paysandú, at the head of deep water navigation on the Uruguay river, with some 21,000 people; Salto, farther up the same river, with about 20,000 inhabitants, and Mercedes, an agricultural and live stock centre on the lower Río Negro, with a population of 16,000.

Agriculture.—In 1885 Uruguay imported most of her breadstuffs; now not only is wheat grown in sufficient quantities to meet the local demand, but a small surplus is annually available for export However, only 5% of the land is under cultivation Land for farming purposes is expensive, and wages are high, leaving small profit, unless it happens that a man, with his family to assist him, works his own land The farmers are chiefly Italians, Canary islanders and Frenchmen The principal crops in addition to wheat are oats, barley, maize, linseed and bird seed Since 1890 the cultivation of the grape and the manufacture of wine have considerably extended, especially in the departments of Salto, Montevideo, Canelones and Colonia.

Cattle-breeding and sheep-farming, however, are the principal industries Nearly 80% of the land is devoted to grazing, and the stock census of 1924 showed an existence of 8,425,196 head of cattle and 14 514,060 sheep The cattle are destined chiefly for the great packing houses which, since the development of refrigeration, consume most of the meat produced There are modern meat-packing establishments in Uruguay where beef and mutton are chilled or frozen for export Large quantities of liquid extract of beef are also prepared for the European trade A smaller amount of meat each year is being sent to the *saladero* establishments for the preparation of *tasajo,* or jerked beef, for the Brazilian and Cuban markets In the south, where the farmers are European, the breed of cattle is improved by breeding

Sheep farming flourishes chiefly in Durazno and Soriano Uruguayan wool is favourably regarded in foreign markets, on account of the clean state in which it is shipped, this being largely due to the natural conditions of the land and climate

Mining.—Mining is of slight importance in Uruguay Minerals are known to exist in the northern section of the republic, and gold-mining is carried on to a small extent Expert opinions have been advanced that gold-mining in Uruguay is capable of development into an important industry The other minerals found are silver, lead, copper, talc and lignite coal In 1924 large deposits of manganese were discovered

Commerce.—The economic development of Uruguay was long retarded by poor governments, by revolutionary outbreaks and by the transference of commercial undertakings from Montevideo to Buenos Aires on the opening of the harbour and docks at that port Recent years have brought renewed commercial activity.

The principal imports consist of machinery, textiles and clothing, food substances and beverages, fuel and live stock The chief exports are animal products and agricultural products The accompanying table, given in thousands of gold pesos, contains the latest available statistics of foreign commerce —

Countries	Imports		Exports	
	1923	1924	1923	1924
Great Britain	11,592	11,398	25,536	24,253
United States	10,340	14,917	14,013	7,103
Germany	5,166	6,613	12,530	17,731
Argentine	5,460	6,211	6,007	11,384
France	2,378	3,516	10,429	13,791
Brazil	4,927	5,295	1,802	6,135

Trade is controlled by foreigners, the British being prominent in banking, finance, railway work and the higher branches of commerce; the Americans in the meat packing business; Spaniards, Italians and French in the wholesale and retail trade. Uruguayans find an insignificant place in commerce The foreign trade passes mainly through Montevideo, where the port has been greatly improved

Communication.—There are 2,240 m. of national roads, and more than 3,100 m of departmental roads of which some 300 m are metalled. The railways have a length of 1,625 m open for traffic, radiating from Montevideo and connecting Uruguay at several points with the Argentine and Brazilian borders, rail travel now being possible from Montevideo to São Paulo and Río de Janeiro Mail and passenger aeroplane service is maintained with Buenos Aires, flights being made three times per week

Government.—The legislative power of the State rests with the general assembly, consisting of two chambers, one of senators (19 in number) and one of representatives The deputies of the lower house are elected for three years directly by the people, one deputy for every 12,000 adults who can read and write One senator is named from each department by an electoral college, whose members are elected directly by the people The senators are elected for six years, and one-third of their number retire every two years The executive power is exercised by the president of the republic, who is elected by direct popular vote for a four years' term. He is assisted by a National Administrative Council of nine members, elected by popular vote for a six year period, three retiring every two years There is no vice president. Cumulative voting provides for a representation of the minority. Woman's suffrage was adopted in 1921, Uruguay being the only South American country which has introduced this measure.

Education.—At the beginning of the twentieth century, nearly half the population over six years of age was illiterate. Since that time, however, marked improvement has taken place. Primary education is now compulsory and most of the children of school age attend In 1923 there were 1,045 Government schools, with 120,583 children in attendance Moreover (in 1922), private schools enrolled 20,168 pupils, and evening courses for adults were attended by 6,678 Higher education is provided for by the national university at Montevideo which in 1922 had a student body of 1,615, a State supported technical school, a military college and a national agricultural college, modelled on the best European and United States institutions Vocational training was given gratuitously to 185 pupils

Finance.—Of the national revenue nearly one-third is derived from customs duties, taxes being levied also on real estate, licences, tobacco, stamped paper and in other ways Nearly half the expenditure goes to meet debt charges, while Government, education, internal development, and defence absorb most of the remainder. The public debt of Uruguay was 129,774,119 pesos in 1900 and 176,693,631 pesos in 1924, a small relative increase. The budget estimates for 1924–25 were. revenue, 45,182,207 pesos and expenditure, 45,120,052 pesos Revenue for 1923–24 was 44,963,678 pesos and expenditure 43,033,998 pesos. Customs receipts in 1924 were 14,573,890 pesos

The Bank of the Republic was established in 1896 with a nominal capital of 12,000,000 pesos and in 1899 it received the right to issue further shares amounting to 5,000,000 pesos. Its note issue (for which it has an exclusive right) may not exceed the value of half the subscribed capital Besides a number of local banks, branches of German. Spanish, French and several British banks are established in Montevideo

There is no Uruguayan gold coin in circulation, but the theoretical monetary unit is the gold *peso nacional*, weighing 1 697 grammes, ·917 fine The silver peso weighs 25 g, ·900 fine A half, fifth and tenth of a peso are coined in silver

Army.—There is a standing army with a peace strength of about 7,000 officers and men. Service is voluntary In addition to this there is compulsory service in the National Guard (*a*) in the first class, consisting of men between 17 and 30 years of age, liable for service with the standing army, and numbering some 15,000; (*b*) in the second class, for departmental service only, except in so far as it may be drawn upon to make up losses in the active units in time of war, consisting of men from 30 to 45 years of age, and (*c*) in the third class, for local garrison duty, consisting of men between 19 and 45 years old. The army and guard are well equipped with modern arms.

History.—In 1512 Juan Díaz de Solís entered the Paranaguazú or sea-like estuary of the Plata and landed about 70 m east of the present city of Montevideo. Uruguay at that time was inhabited by Indians, of whom the dominant tribe was called Charrúa, a people described as physically strong and well-formed, and endowed with a natural nobility of character

Solís, on his second visit, 1515–16, was slain by the Charrúas in Colonia. Eleven years later Ramón, the lieutenant of Sebastian Cabot, was defeated by the same tribe In 1603 they destroyed, in a pitched battle, a veteran force of Spaniards under Saavedra During the next 50 years three unsuccessful attempts were made by the Spaniards to subdue this courageous people The real conquest of Uruguay was begun under Philip III by the Jesuit missions It was gradually consummated by the military and commercial settlements of the Portuguese, and subsequently by the Spaniards, who established themselves formally in Montevideo under Gov. Zavala of Buenos Aires in 1726, and demolished the rival Portuguese settlement in Colonia in 1777. From 1750 Montevideo enjoyed a provincial government independent of that of Buenos Aires The colonial history consists chiefly of a struggle between Spain and Portugal for the Banda Oriental del Uruguay which lay on the border between their possessions The American Revolutionary War, the French Revolution and the British invasions of Montevideo and Buenos Aires (1806–07), under Gens Auchmuty and John Whitelocke, all contributed to the extinction of the Spanish power on the Río de la Plata During the War for Independence, Montevideo was taken in 1814 by the Buenos Aires general Alvear (*see* further MONTEVIDEO) The long struggle for dominion in Uruguay between Brazil and the revolutionary Government of Buenos Aires was concluded in 1828, through the mediation of Great Britain, Uruguay being declared a free and independent State The republic was formally constituted in 1830 Subsequently Juan Manuel Rosas, dictator of Buenos Aires, interfered in the intestine quarrels of Uruguay: and Montevideo was beseiged by his forces, allied with the native partisans of Gen Oribe, for nine years (1843–52)

After the declaration of independence the history of Uruguay became a record of intrigues, financial ruin, and political folly and crime. The two great political factors for generations have been the *Colorados* and the *Blancos* So far as political principles were concerned, there was small difference between them Men were *Colorados* or *Blancos* largely by tradition and not from political conviction. The *Colorados* have held control for many years, and the attempts of the *Blancos* to oust them have caused a series of revolutions, the last of these being in 1910. The military element, moreover, has frequently conspired to elect a president amenable to its demands. The old *Blancos* and *Colorados* are superseded by conservatives or progressives, the latter favouring advanced social legislation.

In May 1910, a boundary treaty between Uruguay and Brazil settled several minor but long-pending questions. A treaty of May 7, 1913, since carried out, provided for delimiting the boundary Brazil ceded to Uruguay "the waters and navigation" of Lake Mirím and the Jaguarão river, and the parties agreed not to fortify their new frontiers

The social and educational progress of the country continued during the second administration of José Batlle y Ordóñez (1911–15), who succeeded Williman. Hours of labour were regulated, a National Insurance Bank was established and experts were brought from the United States and Europe to advance education, particularly industrial and agricultural training A law of July 12, 1911, set aside 100,000 pesos for the encouragement of immigration. The first South American International Conference of Agricultural Defence was held at Montevideo on May 2, 1913, and 200,000 gold pesos (1 peso = $1.03) annually was appropriated for free seeds for farmers. Uruguay continued to prosper under President Feliciano Vieira (1915–19), who relied on able advisers

of the young and progressive group who had studied abroad.

In 1916 a convention met to discuss a new constitution to replace that of 1830 This came into effect on March 1, 1919. There was the definite separation of Church and State. The Church was given control of those places of worship wholly or partly constructed by funds from the national treasury. The clergy were eligible for election as representatives or senators Decentralization of the Federal Government was brought about and the executive power was divided between the president and the National Administrative Council In the latter part of Vieira's administration, Uruguay broke off diplomatic relations with Germany (Oct. 1917). On Nov. 9, 1917, the eight German merchant vessels in Montevideo harbour were seized by the Uruguayan Government. No military or naval aid was sent to the Allies A credit of 15,000,000 pesos (approximately £3,000,000) was advanced to England by the Uruguayan Government at 5%, to be used for the purchase of supplies in Uruguay

Uruguay's youngest president, Baltasar Brum, took office on March 1, 1919. Uruguay ratified the Treaty of Versailles in 1919, and also concluded obligatory arbitration treaties with Great Britain and Italy in that year. In 1922 Uruguay became a non-permanent member of the Council of the League of Nations A system of old-age pensions was introduced in 1919, and a total of 20,000 pensions had been granted by 1925 José Serrato, an engineer of Italian descent, served as president from 1923 to March 1, 1927, when Dr Juan Campisteguy was inaugurated for the term ending in 1931

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URUGUAYANA, a city and river port of Rio Grande do Sul, Brazil, on the Uruguay river, 348ft. above sea-level. Pop (1900) 13,638, (1920) 20,776 The upper Uruguay is navigable from the Quarahim to the town of São Tomé Opposite Uruguayana is the Argentine town of Restauracion, or Paso los Libres The river is 2m. wide at this point, and 154ft above sea-level Uruguayana is prettily situated on a low hill rising gently from the riverside and its low houses are surrounded by orange groves. There are military barracks near the shore, a theatre and a custom-house Uruguayana was captured by a Paraguayan force under Gen Estigarribia on Aug. 5, 1865, and was recaptured without a fight by the allied forces under Gen Bartolomé Mitre on Sept. 18

URUMTSI (URUMCHI, TIHWAFU), the capital of the Chinese province of Sinkiang, in a valley of the Tienshan, at about 3,000 ft. above sea-level Estimates of population vary up to 50,000 There is a large Turki element and some Mongols. The place trades in furs and skins. It is on the main route from Kansu to Dzungaria and the Ili region.

USBEGS. The Usbegs form the ruling clan in Bokhara, Khiva and Kokand, occupying there a very similar position to that of the Osmanli in Turkey. They are also found in Samarkand and in some parts of Syr Daria and Ferghana, in which latter place the Kipchak also live, and should probably be classified as Sarts They are a mixed people, closely allied to the Mongols, and are in a transition from a nomad to a sedentary life

USHAK, a town of Asia Minor, altitude 3,160 ft. in the Kutaiah vilayet, connected with Smyrna and Konia by rail Pop (1927) 88,665 It is noted for its heavy pile carpets, *khali*, known as "Turkey carpets" The Oriental character of the carpets has been impaired by the adoption of aniline dyes

USHANT (Fr *Ouessant*), the most westerly of the islands off the coast of France, about 14 m from Finistère Pop (1926) 2,512 Ushant was ravaged by the English in 1388 In 1778 a naval action was fought off Ushant between the English and the French. Ushant is about 3 850 ac. in extent and granitic, with rugged coasts accessible only at a few points, and rendered dangerous by fogs The island pastures a breed of small black sheep

USHAS, in Vedic Hindu mythology goddess of the dawn (from the same root as Lat *Aurora* and Gr Ἠώς) Celebrated in some 20 hymns of the *Rig-Veda*, she is its most graceful creation Borne on a car drawn by ruddy kine, the sun is her lover. She rises resplendent . showing her charms—ever shortening the lives of men she reveals their paths and bestows new life . . . she opens the doors of darkness as the cows their stalls

USHER (or USSHER), **JAMES** (1581–1656), Irish divine and archbishop, was born in the parish of St. Nicholas, Dublin, on Jan 4, 1581 He was sent to a school in Dublin opened by two political agents of James VI of Scotland, who sought to secure a party for James in Ireland in the event of the queen's death In 1594 Usher matriculated at the newly founded university of Dublin, whose charter had just been obtained by his uncle, Henry Usher, archbishop of Armagh He graduated M A in 1600, became a fellow of Trinity College, and was ordained in 1601 In 1607 he became regius professor of divinity and also chancellor of St Patrick's cathedral, Dublin In 1613 he published his first printed work, though not his first literary composition—*Gravissimae Quaestionis de Christianarum Ecclesiarum. . Historica Explicatio*, wherein he took up the history of the Western Church from the point where Jewel had left off in his *Apology for the Church of England*, and carried it on from the 6th till past the middle of the 13th century James nominated him archbishop of Armagh in 1625 As archbishop he discountenanced (1629) Bishop William Bedell's proposal to revive the Irish language in the service; he shared in drafting (1634) the code of canons of the Irish Church, and defeated the attempt to make the Irish Church conform exactly to the doctrinal standards of the English In 1640 he paid another visit to England on one of his usual scholarly errands, meaning to return when it was accomplished But the Great Rebellion of 1641 prevented his return Usher pleaded in vain with Charles I not to abandon Strafford By way of compensation for the loss of his Irish property he received the temporalities of the vacant see of Carlisle In 1643 he declined a seat in the Assembly of Divines at Westminster He quitted Oxford in 1645 and went into Wales, where he remained till 1646, when he returned to London, and was in 1647 elected preacher to the Society of Lincoln's Inn, an office which he continued to hold until near his death In 1648 he conferred with Charles I in the Isle of Wight, on the abortive negotiations with parliament on the question of episcopacy In 1650–54 he published the work which was long accounted his most important production, the *Annales Veteris et Novi Testamenti*, in which he propounded a now disproved scheme of Biblical chronology, whose dates were inserted by some unknown authority in the margin of reference editions of the Authorized Version In 1655 Usher published his last work. *De Graeca LXX. Interpretum Versione Syntagma* He died on March 20, 1656, in Lady Peterborough's house at Reigate, and was buried in Westminster Abbey

Usher's works are very numerous, and were first collected by C R Elrington and J. H Todd, Dublin (1847–64, in 17 vols). See *Life* by Carr (1895); W B Wright, *The Ussher Memoirs* (1889).

USK, a small market town on the Usk river, Monmouthshire, England Pop. (1921) 1,494 It was a Roman fort, *Burrium*,

and there are ruins of a castle built by the de Clares in defence of the Welsh marches The castle was taken by Simon de Montfort in 1265 and suffered under Owen Glendower The church of St. Mary perpetuates a Benedictine nunnery founded by Richard de Clare in 1236. There is 12th century work. Usk is well known to anglers

USK, a river of Wales and England, 70 m. long, flowing to the Bristol Channel The source is the north flank of Carmarthen Van, a summit of the Brecon Beacons; the course passes Brecon, Crickhowell and Abergavenny, below which the valley broadens, and the river becomes sinuous as it flows by Usk and Caerleon. The river is noted for its salmon and trout fishing.

USKOKS, a Serbo-Croat name meaning "refugee," applied to certain Christians who, after the Turkish conquest of Bosnia in 1463, fled, first to Ghssa, in Dalmatia, then to Zengg, in the Croat military frontier They soon turned to piracy, and, became the terror of Adriatic commerce, which was largely either Venetian or protected by Venice They received covert support from Austria, and an unsuccessful attempt by Turkey in 1592 to capture Zengg led to war between Turkey and Austria In 1602 Austria allowed Venice to send a force against Zengg; but it was defeated; and the piracy went on until in 1615 the outrages led to war between Austria and Venice The Treaty of Madrid (1617) provided that the Uskoks should be disbanded and their ships destroyed; they were accordingly transported inland to the mountains to which they gave their name.

USTARANA, a Pathan tribe living to the extreme south of Dera Ismail Khan in the North-West Frontier of India

USTER (1,532 ft), a town in the canton of Zürich, Switzerland, near the Greifen See and on the railway Zürich-Rapperswil. It is an industrial centre with 10,000 inhabitants who speak German and are chiefly Protestant.

ÚSTÍ NAD LABEM, a town in N N.W. Bohemia, in a highland district at the confluence of the Bela and the Elbe, is the most important Czechoslovak port Pop. (1921), 64,876

USTYUG VELIKIY, a Russian town in the North Dwina province. lat. 60° 47′ N , long. 46° 22′ E. Pop. (1926) 19,092. The town is the focus of post roads to Vologda and Nizhniy-Novgorod. It has distilleries, breweries, timber mills, leather factories and workshops for the production of agricultural machinery. It has two annual fairs. Special crafts include silver engraving and the making of boxes with secret locks

USURY. The practice of lending at interest which exceeds a lawful or reasonable rate. For an account of professional money-lenders, legal rates of interest and legal control over usurious transactions, *see* MONEY-LENDING.

A long legal development has accompanied the allowance of interest against defaulting creditors By Roman law the defaulting party to a contract was compelled, beyond fulfilment of the agreement, to pay compensation for the difference (*id quod interest*) to the creditor's position caused by his default. This difference could be based on actual loss accrued, and also on the profit that might have been made had performance been carried out. Mediaeval lawyers used the phrase *damna et interesse* for such compensation, and for damages and indemnity generally Thus *interesse* became applied to the charge for the use of money, disguised as an indemnity for failure to perform a contract At English common law an agreement to pay interest was only implied when supported, as in the case of negotiable instruments, by mercantile usage, or by the constant practice of a trade or business, or by the course of dealing between the parties. Otherwise an express agreement was required. By the Civil Procedure Act of 1833, provision was made for the allowance of interest at a rate not exceeding the current rate of interest upon debts evidenced by a written instrument from the time when their payment became due and in debts not so evidenced from the time a written demand for their payment had been made. In the United States the law regarding the allowance of interest has been more liberal. When there is default in the payment of a money debt, interest at the legal rate is allowable as damages for the delay in payment. Many States upon a similar theory allow interest upon unliquidated contractual demands where the default consists in something other than a failure to pay money. As in England, no interest is allowable upon claims for damages consequent upon a tort, but in America interest upon damages for torts to property is generally allowed In both countries compound interest is only claimable by express agreement or by established mercantile practice.

In the United States a most significant development in the field of usury is the attempt to control the lending of small sums of money at usurious rates. The early statutes were ineffective to prevent usurious interest being demanded of necessitous borrowers, fixing rates of interest so prohibitively low as to drive the business outside the law. To remedy this situation a Uniform Small Loan Law, since adopted in many States, required licenses of lenders making loans under $300, supervised the conditions under which such loans were made, and permitted an interest rate not exceeding 3½% a month on unpaid balances. This legalizing of the small loan business at adequately remunerative rates has been highly effective, driving the illegal and extortionate lender from the field and opening it to the lawful investment of capital *See* Ham, *Small Loan Legislation* (1922) (J M LA)

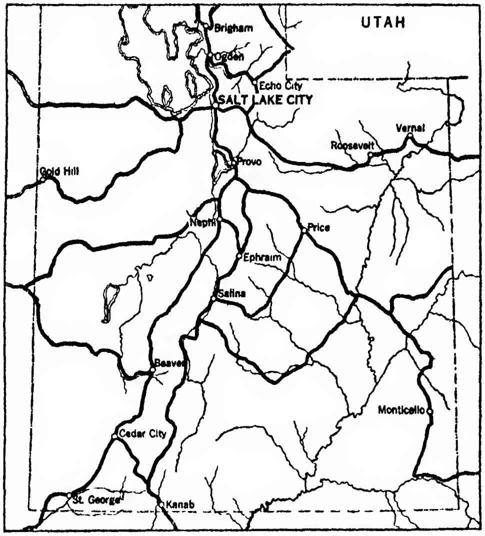
In the United States, where a penalty for usury is fixed both by State and Federal statutes, it is well settled that the penalty fixed by Federal legislation is superior to and exclusive of any State penalty

UTAH, long called "Deseret," which in the *Book of Mormon* means "land of the working bee," is one of the Rocky mountain States in the western part of the United States It is situated between 37° and 42° N and 109° and 114° W Its area is 84,990 sq m , of which an average of 2,806 sq m is water surface The area is equal to that of England and Scotland combined. Utah was the main habitat of the Ute tribe of Indians.

Physical Features.—A line drawn with a slight westward concavity from the middle of the northern boundary to the south-western corner would divide Utah into its two main physiographic regions, the Great Basin to the west and the plateau region to the east For a long distance this line would follow the high crest of the Wasatch mountains, a magnificent range running north and south, forming the great backbone of the State, and dividing the drainage of the Colorado river system from that of the Great Basin. Centuries ago the Great Basin region was covered by a vast expanse of water, about 19,000 sq m. in area, known to geologists as Lake Bonneville Shoreline at 17 distinct levels can still be traced on the mountain side Great Salt Lake is a shrunken remnant of this inland sea, and the rest of the basin is its one-time bed. The land of the basin floor, parched and barren in its uncultivated state, unless alkaline, is very fertile, and produces abundantly when irrigated. Along the eastern fringe of the basin, where the land can be watered by the streams flowing down from the Wasatch range, are to be found the most populous districts of Utah The monotony of the level basin floor is broken here and there by steep isolated north and south mountain ranges of monoclinal structure which rise abruptly several thousand feet above the plain. There is no drainage outlet, so the streams merely flow into the low places where, during the dry season, the water evaporates, leaving barren "mud flats" on the basin floor. In the larger depressions the water does not entirely evaporate but remains, forming saline lakes whose areas increase and decrease with the season. The largest of these is Great Salt Lake, having an area at its greatest extent of 2,000 sq. miles. One-third of this area is lost annually by evaporation. Its waters have an average salt density of 17% or about 3½ times that of the ocean. The lake is fed by Bear river from the north, Weber river from the north-east and Jordan river from the south-east. The Jordan carries the overflow from Utah lake, a fresh water body 127 sq.m. in area. South-west of Great Salt Lake is a broad flat stretch, more arid and barren than the rest of the basin, known as the Great Salt Lake desert. It is low, and in the spring covered partly by water. South of this desert and in the west central part of the basin is Sevier lake, fed by the Sevier river. This Lake at times attains an area of 188 sq.m., but during the dry season evaporates completely, leaving a crystalline residue of impure

sodium chloride and sulphide 5 in. in depth to mark the lowest portion of its site. The Great Basin as a whole rises gradually and imperceptibly from an elevation of 4,300 ft. at the shores of Great Salt Lake to an altitude of about 6,000 ft. in the south of the State.

East of the Wasatch range is the so-called "plateau region," much higher on the average than the Great Basin but deeply cut by valleys and canyons, which carry its drainage to the Colorado



MAP SHOWING THE MAIN ROADS IN UTAH

river On the north this area is bounded by the Uinta mountains, the highest range in Utah and the only important range in the United States to run directly east and west It extends at right angles to the Wasatch range and almost meets it on the west. King's peak (13,498 ft) is the highest altitude in the State, while Mt. Emmons (13,428), Gilbert peak (13,422), Mt Lovenia (13,250) and Tokewanna peak are the others rising above the 13,000 ft mark Between the peaks local glaciation has carved deep amphitheatre-like valleys, many of them containing alpine lakes, wild and difficult of access South of the Uintas the plateau summits rise to 9,000, 10,000 and 11,000 feet They are generally forested, but are too high and difficult of access to be inhabited. The people of this region live in the valleys along the streams between the plateaux. South toward the Colorado river the plateaux drop rapidly in a series of brightly coloured sandstone cliffs resembling giant terraced steps, and are named from the colour of the outcropping sandstone. The Pink Cliffs are the highest and most conspicuous; then come the White Clifts, Vermilion Cliffs and Grey Cliffs. In this southern portion also are several interesting mountain groups which do not properly belong to the plateau system. They have been formed by the intrusion of molten igneous rock between the layers of sediments, causing the overlying layers to arch up into dome mountains. Such groups are the Henry mountains, west of the Colorado, and the La Sal and the Abajo mountains, east of the Colorado. South-east of the Colorado, and especially in the region drained by the San Juan river, there are almost no areas capable of cultivation; the soil is sandy and the population scanty. Much of the area is relatively inaccessible even by pack horse for trails, and watering places are few. Yet here some of the most picturesque scenery of Utah is to be found. The richly coloured sandstone has been moulded by erosion into such fantastic figures as the Navajo Twins, Organ Rock, Needle Rock, Train Cliff, Ostrich Rock and the famous pear-shaped balancing rock in the La Sal mountains. In Monument park slender spires and mighty bluffs lift steep red stone sides perpendicularly to great heights. The region abounds in natural bridges, including the graceful Rainbow bridge, 308 ft. high and 274 ft. between its abutments. Dainty Kachina with a width of 186 ft. and height of 205 ft., and the massive Sipapu, 222 ft. high and 261 ft long, are wedged in the White Canyon Innumerable prehistoric ruins and cliff-dwellings are found in this region also, and are the best described in Byron Cumming's bulletin entitled *The Ancient Inhabitants of the San Juan Valley*. Many of these are in giant crevices several hundred feet above the canyon bottoms The region has been only partly explored archaeologically, and new ruins are constantly being reported Other caves have been found to contain remains of the basket-makers, predecessors of the cliff-dwellers. Many caves are covered with Indian pictographs and large paintings of animals In one place tracks of the prehistoric dinosaur were found imprinted in the sandstone In the Henry mountains, where the fossilized remains of dinosaurs and many other prehistoric animals have been found, Dinosaur National Monument has been created This whole region of south-eastern Utah, a vast, strange and weird land, was one of the last parts of the United States to be explored. It was not until 1904 that the outside world heard of its natural bridges, the largest in the world The deep twisting canyons provide the most awe-inspiring scenery but the greatest obstacles to travel through the region Besides the great canyons of the Colorado, the Green and Grand rivers, there are many of similar grandeur in the tributary streams The San Juan Canyon is sometimes called the "Little Grand Canyon of the Colorado" On the Rio Virgin in south-western Utah is Little Zion Canyon, now set aside as Zion National park It was named by the Mormons who discovered and settled it, though their settlers were later driven out by the Indians. In Bryce Canyon there are acres of fantastic tower and turret formations formed by erosion only, the softer red rocks being capped by a harder stratum which resists weathering

In Utah climatic conditions vary by altitude as well as by latitude In the lower valleys of the Great Basin the summer heat is often disagreeably high. Moderate summer temperature is found in the mountains and on the plateaux. Precipitation also varies with the altitude from 42 in at Silver lake in Brighton to 5 or 10 in. in the lowlands, and to 4 9 in at Salduro in the deserts The higher plateaux and mountain ranges bear forests of fir, spruce and pine, and the lower slopes are dotted with piñon, juniper and scrub cedar. Willows and cotton-woods grow along the streams Sagebrush is characteristic of the desert areas, and on the hill-sides bunch-grass affords valuable pasturage Bird life is prolific in Utah Besides the usual varieties found in the Rocky mountains, white pelicans have established a rookery on Hat island, so named from being shaped like a cowboy's hat, now known as Bird island, where vast members of pelicans, blue herons and sea-gulls live happily together Large numbers of geese (snow, Canada, black brant and others) thrive about the lake. Bird sanctuaries are being provided by law

Population.—Utah's first census, taken in 1850, gave a population of 11,380 In 1920 it was nearly 40 times as much or 449,396. The estimate of the U.S census bureau for 1927 was 522,000 The increase between 1900 and 1910 was 34 9% and between 1910 and 1920 20 4% The density per square mile increased from 3·4 in 1900 to 4·5 in 1910 and 5·5 in 1920 In 1920 there were 441,901 whites, 1,446 negroes, 2,711 Indians (as opposed to 3,123 in 1910), 342 Chinese and 2,936 Japanese Foreign born made up 19·4% of the population in 1900 and 12·8% in 1920. Of the 56,455 foreign-born whites 19,657 were from the British Isles, 15,152 from the Scandinavian countries, 3,589 from Germany, 3,225 from Italy and 3,000 from Greece Other countries furnished less than 2,000 each It is partly because of the proselytizing of the Mormons, their zealous work for new settlers and their judicious treatment of immigrant bands that Utah has such a variety of nationalities. In very early days Brigham Young received whole communities from the countries of the Old World and planned systematic settlements for them in the many fertile valleys of the State The numbers of males and females are more nearly equal in Utah than in other

western mountain States In 1920 62·6% of the females and 59·1% of the males over 15 years of age were married In 1924 births numbered 13,969 and deaths 5,048 The birth rate per 1,000 was 28·8, a figure exceeded only by North Carolina with a rate of 32·2 per 1,000. The infant mortality rate of 64 deaths per 1,000 infants under one year is very low.

The urban and the rural population are nearly balanced, the figures in 1920 showing 48% urban and 52% rural In 1910 the percentage had been 46·3 urban and 53 7 rural The rate of shift from the country to the city was probably accelerated after 1920 by the farm depression Approximately half of the total population are Mormons or Latter Day Saints Next in strength are the Catholics. The Methodists and Presbyterians are the leading Protestant denominations Salt Lake City, the capital and largest city, has a population of 133,000 (1926 estimate of U S census bureau) and Ogden, the next largest city, has 37,600.

Government.—The Constitution of Utah was formed by a convention at Salt Lake City, March 4–8, 1895, submitted to the people on Nov. 5 and ratified by a vote of 31,305 to 7,687. It came into effect Jan. 4, 1896, the day Utah was admitted to the Union. It provides that no law can be passed restricting the freedom of the press or the establishment of religious sects There is no imprisonment for debts unless the debtor absconds Males and females enjoy equal privileges in civil, political and religious rights One provision, which guarantees religious freedom, forbids sectarian control of public schools, prohibits polygamy and defines the relation of the State to the public lands of the United States, is irrevocable unless with the consent of the U S Government All citizens of the United States who have lived in Utah a year, in the county four months and in the precinct 60 days have the right of suffrage Only those who have paid a property tax the year before may vote in elections levying a special tax creating indebtedness or increasing the State rate of taxation.

The powers of Government are divided into three distinct departments, the legislative, executive and judicial The legislative power is vested in (1) a senate and a house of representatives, and (2) the legal voters, who are given the power of initiating desirable legislation and of referendum on all laws not passed by a two-thirds vote of both houses No person is eligible for office in the legislature who is not a citizen of the United States, 25 years of age or more, a qualified voter in the district from which he is chosen, and a resident of Utah for three years or of his district for one year Regular sessions of the legislature are held in odd-numbered years, opening on the 2nd Monday in January They cannot last more than 60 days except to try cases of impeachment Representatives are elected for two years; senators for a four-year term, one half the number retiring every two years The number of senators must not exceed 30 and the representative body must be at least twice as large as the senate. In 1927 there were 20 senators and 55 representatives.

The executive officials are the governor, secretary of State, State auditor, State treasurer, attorney general and superintendent of public instruction. The auditor and treasurer are ineligible to election as their own successors. The governor and secretary of State must be at least 30 years of age, the attorney general at least 25 and in good standing at the bar The governor has the right of veto unless overruled by the bill repassing with a two-thirds majority in both houses. The governor, justice of the supreme court and attorney general compose the board of pardons.

The judicial power is vested in the senate sitting as a court of impeachment, a State supreme court, district courts, city courts, justices of the peace and other courts inferior to the supreme court as established by law

Finance.—There are four major sources of State revenue. The most important is the general property tax. In 1926 this amounted to 7·4 mills on an assessed valuation of taxable property amounting to $696,061,566. For an odd period of 19 months (due to a change in the fiscal year), Dec. 1924 to June 1926, $9,495,811 or $40.08 per caput was obtained from this source; 76·4% of the amount was credited to educational purposes, and the rest devoted to general administration expenses. The next most important source is the special taxes, such as the tax on gasolene sold, fees for motor vehicle registration, corporation tax, inheritance tax, etc. This source for the same 19 months yielded $3,666,717 or 20 69% of the revenue The third important source is the income derived from the sale and rental of Federal and State lands, and interest on investments belonging to the State land grant funds From this source $851,922 was derived for that period The fourth is the income received from the Federal Government for the building of new roads throughout the State. This amounted to $1,760,867. All other sources, including fees from State officials and State institutions, amounted to $1,941,152

Total receipts for the period amounted to $22,491,420 and total disbursements to $22,966,236. Of the disbursements 33 55% went for educational purposes—$6,508,810 to public schools and $1,195,232 to the university, agricultural and branch agricultural college—17·79% or $3,975,643 was for highways and $4,933,995 for the general fund which, in addition to paying the salaries and expenses of State officials, provided for the financing of the State Industrial School, State Mental Hospital, State Prison and School for the Deaf and Blind The bonded indebtedness of Utah amounted to $9,660,000 in 1926 Over $7,000,000 of this was for roads and $1,600,000 for the capitol building fund

The value of all tangible property in the State in 1922 was $1,535,000,000 or $3,247 per caput The first bank in Utah, established by the Walker Brothers in Salt Lake City in 1859, and the Deserêt National Bank, the first national bank established by Brigham Young in 1872, are still doing business For many years banking was handled mostly by important Morman officials and such strong confidence was developed that during the severe panic of 1893 not a bank closed its doors In 1925 there were 111 banking institutions in Utah with capital and surplus of $19,084,000, resources of $162,000,000, and savings deposits of $61,161,000 Twenty-one were national banks The savings deposits had increased from $27,904,000 in 1913 to $51,600,000 in 1920

Education.—In Utah school attendance for at least 20 weeks annually is compulsory for all children from 8 to 18 years of age, unless they are lawfully excused As a result 141,483 pupils, or 98% of a school census population of 148,811, were enrolled in 1926–27; 114,309 of these were grade pupils and 27,174 high school students There were 2,985 elementary school teachers, 590 junior high school teachers and 876 high school teachers Much time and money have been spent by Utah in the consolidation of rural schools. Buses are used to carry the children from smaller districts; and in 1926–27 11,640 children were transported at a cost of $394,889 Through consolidation better equipment and teachers were provided for 13,741 children, and only 94 one-room schools were left in the State

The expenditure for education in Utah increased from $30 76 per caput of the school population in 1909–10 to $77 43 in 1926–27 In 1920 slightly over one-third of the total public expenditure, State and local, was for education, and in this ratio Utah was exceeded only by Montana While the State ranked 34th in its per caput income, it ranked sixth in its per caput expenditures for education The income for education in 1926–27 was $10,566,560, of which $3,205,840 was provided by a tax of 4·8 mills and $6,652,306 by local district taxes The expenditure for education in 1926–27 totalled $11,076,674. Expenses for instruction were $4,379,538 for elementary schools, and $1,681,744 for high schools The average salary for elementary teachers in one-room schools was $841; two-room schools, $906; and larger schools was $1,064 This does not include salaries of principals. The average high school teachers' salary exclusive of principals was $1,432 The State has also endeavoured to further education by supporting libraries and for this purpose $207,957 was expended in 1924–25

The University of Utah, at Salt Lake City, was organized in 1850 as the University of Deseret, and placed under the control of a chancellor and board of 12 regents appointed by the governor. It closed in 1851 for lack of funds and did not reopen until 1867, though during all this period the board was regularly appointed and functioned in supervising the public schools. In 1869 the university was reorganized to include classical and normal schools and in 1892 was given its present name The registration in

1927–28 was 3,065 for the regular session and 913 for the summer session. In the extension department 3,900 more were enrolled. The proportion of men to women students was about three to two. The Utah Agricultural college at Logan has co-operated efficiently with the farmers on arid-land problems. The Latter Day Saints church maintains the Brigham Young university at Provo, which had an enrolment of 1,417 in the regular session of 1926–27 and 458 in the summer session of 1927. Its 12 trustees are elected triennially by the vote of the church. Four normal schools are also supported by the Latter Day Saints. Other private schools are the Sacred Heart academy at Ogden, Logan Junior college at Logan, St. Mary of the Wasatch, Rowland Hall and Westminster college at Salt Lake City, and Wasatch academy at Mount Pleasant. The 1920 census placed Utah ninth lowest among the States in illiteracy. In 1923 the number of illiterates within the State totaled 6,264 or 1·9% of the entire population. Most of these came from the foreign-born population.

Charitable and Penal Institutions.—The State Prison is in Salt Lake City. The number of prisoners decreased from 321 in Dec. 1924 to 203 in June 1926. Prison labour cannot be let out on contract, but "honour prisoners" are allowed to work on roads and irrigation projects, on additions and repairs to prison buildings and on the prison farm. While doing so their families are paid one dollar per day, and, at the end of his confinement, the prisoner receives a $15 gratuity. The State Industrial school at Ogden, established for delinquent boys and girls, endeavours to help them by teaching manual training, home economics, printing and mechanical repair work. A School for the Deaf and Blind, also at Ogden, teaches caning of chairs, broom-making and printing and linotyping. The Mental Hospital, at Provo, cares for the insane. Efforts are being made to segregate the feeble-minded. Legal provision is made for juvenile courts and for minors under 18 years of age.

Agriculture and Live Stock.—In Utah farm lands make up but 9·5% of total land area of the State, a much smaller percentage than in any other State except Nevada. Agriculture is, where possible, dependent almost entirely upon irrigation which counteracts drought. Soil that can be watered is generally very rich. In early days, under the Mormon system, farm plots were but five, ten or twenty acres. Gradually the average size of farms grew until in 1900 it was 212·4 ac., after which it slowly dropped till in 1925 it reached 192·2 acres. The total acreage in farms in 1925 was 5,000,724, of which 1,425,000 ac. is crop land. The total value of the crops, an exceptional year, was $50,000,000. In 1927 the crops were valued at $39,000,000. Between 1920 and 1925 the acreage of farm land remained about the same, but agricultural depression is reflected in the decline of farm population from 140,249 to 108,856. The value of farm land also decreased from $210,998,000 to $159,908,000 or from an average of $41.78 to $32.00 per acre. The area irrigated in 1909, 999,410 ac., increased to 1,100,000 ac. in 1919. By 1919 $32,037,351, or $18.84 per ac. had been invested in irrigation projects. The average yearly cost of maintenance was $1.08 per acre. In the Strawberry project, water is brought from the east side of the Wasatch mountains, through a four-mile tunnel and used in the Utah valley 45 m. away. The Great Salt Lake Basin project, under construction in 1929, is designed to double the irrigated area in the northern valleys. It is an immense scheme, the completion of which requires several years. The water of all streams in Utah is the property of the public and the State engineer has entire charge of its distribution.

The most important crop is hay. In 1927, 644,000 ac. produced 1,574,000 tons of cultivated hay (3·06 tons per ac.) valued at $13,776,000; also 100,000 tons of uncultivated hay; of wheat, 242,000 ac. yielded 5,678,000 bu. (23·2 bu. per acre) valued at $5,792,000. Potatoes in 1927 yielded 2,970,000 bu. on 32,000 ac. (135 bu. per acre). Their value was estimated at $2,228,000. The year 1926 was a poor one for sugar-beets, 52,000 ac. producing but 391,000 tons, the yield per acre being only 7·52 tons as compared with 15·43 tons for 1925. In 1927, 56,000 ac. produced 678,000 tons; 12·1 tons per acre. The production of oats in 1927 on 51,000 ac. was 2,143,000 bu. (40 bu. per acre), valued at $1,285,-000. Barley amounted to 1,410,000 bu. on 30,000 ac. (estimated value, $1,072,000), and Indian corn 494,000 bu. on 19,000 ac. (valued at $543,000). The elevation, in general, is high for Indian corn. In 1927, 34 car-loads of pears, 1,783 car-loads of peaches and 1,660,000 bu. of apples were shipped out of the State.

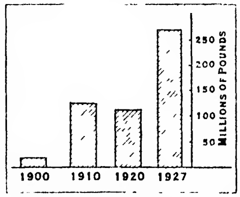
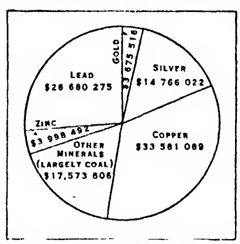


DIAGRAM SHOWING INCREASE IN COPPER PRODUCTION, 1900–27

Live stock on the farms (Jan. 1, 1928) was estimated at 2,730,-000 sheep valued at $30,517,000, 368,000 beef cattle valued at $15,014,000; 92,000 milch cows and heifers valued at $7,360,-000, 98,000 swine valued at $1,-225,000, and 106,000 horses and mules valued at $6,479,000. Butter production amounted in 1925 to 7,034,000 lb. as compared with 3,567,000 lb. in 1920. Cheese production similarly increased from 849,000 lb. to 1,753,000 pounds. The wool production for 1927 was 19,975,000 lb., an increase of 8,274,700 lb. or 71% over the production of 1920, giving Utah a rank of fifth among the States.

Mining.—In 1924 Utah led all States of the Union in metal output. Her total mineral production was valued at $84,356,626. Mining products supplied 85% of the freight traffic originating within the State. The mines and mills furnished employment to over 18,000 men, and the wages paid amounted to about $30,-000,000. In value copper was the leading mineral, the 1926 production being worth $36,045,027. The lead production was valued at $23,621,600, coal output at about $12,000,000, silver at $12,079,754, gold at $3,758,800 and zinc at $7,138,453. Utah is very rich in copper, silver, gold and zinc, but, owing to the fact that the ores are always found in combination, it has been impossible, until recently, to recover a high enough percentage of each to realize on the State's fortune. The invention of new selective flotation processes between 1915 and 1925 worked a mining revolution in Utah and sent its production skyward. From 1910 through 1922 Utah had ranked fourth in the production of copper, but from 79,665,000 lb. in 1922 the output leaped in a single year to 210,118,000 lb. for 1923. This placed the State third, and in 1924 it was second, but in 1925 it was passed again by Montana and so dropped to third place. In 1926 Arizona only surpassed Utah in copper output, the amount being 257,464,482 lb. The total metal output for 1926 was $82,622,884. The higher percentage of recovery together with increased prices caused Utah to produce 306,669,824 lb. of lead in 1925, breaking her own record and taking second place among the States. In the same year Utah broke her own record and maintained first place among the States in silver production with 21,276,689 oz. to her credit. Leaching mills with a chloridizing-roasting process were used to recover the silver precipitate.



GRAPH SHOWING VALUE OF MINERAL PRODUCTS MINED IN 1925

The most important non-metallic mineral in Utah is coal, 4,488,157 tons being produced in 1924 and 4,630,000 tons in 1925. Bituminous coal mining was begun for small bee-hive ovens near Cedar City in 1882 to secure enough fuel to work the neighbouring iron mines. Nine-tenths of the coal produced in the State comes from Carbon and Emery counties. Salt, another valuable product, is obtained by means of solar evaporation of the salt brine deposits in the Great Salt Lake regions; 88,000 tons were produced in 1925. During the World War when phosphates were in demand they were mined from large deposits around Great Salt Lake, the Salduro Marsh Alunite especially being used as a source. Since the war, however, this has not paid, but the deposits may be very valuable in the future. Another phosphate

bed 35 ft. thick extends through the Uinta mountains. Native asphalt to the amount of 36,536 tons valued at $664,280 was produced in 1924, also 90,221 tons of gypsum valued at $335,588. In 1925 268,529 tons of iron ore valued at $361,251 were shipped from Utah mines The rare metals uranium and vanadium are produced in small quantities on Yellow Cat, Wash.

Forests and Lumbering.—Heavy spring floods have caused vast damage especially where cutting has left the slopes exposed to erosion. The interests of irrigation also demand that the water be retained on these slopes as long as possible in the spring. Thus, though not so valuable commercially, Utah's forests are highly important as soil conservers. Eight national forests cover 7,455,070 ac. and contain 95% of the timber in the State. Their stand is estimated at 5,225,000,000 board feet Injudicious cutting between 1880 and 1900 almost bared the western slopes of the Wasatch range near Great Salt Lake The cut in 1889 amounted to 14,000,000 and in 1899 to 18,000 000 board feet, but regulation has decreased the output until between 1921–24 it averaged but 7,000,000 board feet annually The mills supply only about one-tenth of the local demand The receipts for annual sales already exceed the cost of the national forests.

Manufacturing.—In 1925 there were 586 manufacturing plants employing 15,901 workers and paying them $19,784,000 annually in wages. The cost of raw material used amounted to $191,590,000 and the value added by manufacturing was $61,838,000. In the various processes 141,671 primary horse power was used The most important products are beet sugar, metal articles, textiles, cement and lime, flour, cereals, butter and cheese Meat-packing plants, creameries and condenseries, canneries, flour mills, saw mills and the various mills for reducing and refining ores are numerous. Between 1920 and 1925 $4,000,000 of capital was added to the flour-mill business In 1924 the manufacture of pig iron was undertaken by the Columbia Iron and Steel Corporation, with a capital of $20,000,000. This corporation has coal mines at Columbia, Utah, iron mines at Iron Springs and blast furnaces at Ironton.

Transportation.—The Old Spanish trail, the Great Salt Lake trail and the Overland trail all aided in the early development of the State. The Union Pacific was the first railway and has continued to be the dominating one, sending its branches into nearly every important mining or commercial centre Other railways are the Denver and Rio Grande Western, the Southern Pacific and the Los Angeles and Salt Lake, operated by the Union Pacific. In 1928 all railways had 3,031 62 m of steam track and 310 61 m. of electric track, exclusive of street railways, within the State. At the close of the 1927 season 3,436 m of road within the State belonged to the State highway system Of this, 1,400 m. were graded and drained, 1,400 were surfaced, either paved or gravelled. The mileage of local and country roads in 1928 was 20,249, of which 3,000 miles were unimproved.

History.—Utah was acquired by the United States from Mexico in 1848 by the Treaty of Guadalupe Hidalgo, which terminated the Mexican War Before Mexico had become an independent nation, however, Utah was a part of Spanish possessions and the Spaniards were its first explorers The first extensive exploration occurred in 1776, when Father Escalante and Father Dominguez set out to find an overland route from Santa Fe to Monterey, on the California coast. Crossing south-western Colorado, they entered Utah in the east about where the Grand river enters the State, continued west across the Green river, followed an Indian trail over the Wasatch range, and descended the Spanish Fork to Lake Utah, where they camped and preached to a large gathering of Indians. From them the fathers heard of a great salt lake to the north, but they did not visit it. Instead they headed south-west, crossing the divide to the Sevier river and thence across Sevier desert. Here their guide deserted them, so they decided to return to Santa Fe. The fathers did not fully accomplish their purpose, but the first part of their route later became part of the old Spanish trail from Santa Fe to Monterey. Three separate parties of American trappers under Wolfskill and Ewing Young journeyed over the entire route in 1830. It was also the road taken by Frémont on his return eastward in 1843–44.

The first Americans to penetrate Utah or the Great Basin region it seems, were the four men Miller, Hoback, Robinson and Rezner, detached in 1811–12 from the overland expedition of John Jacob Astor to trap in eastern Idaho. Their vague account seems to indicate that they crossed north-eastern Utah. There has been much discussion as to who discovered Great Salt Lake. On a map of North America engraved for Gutherie's *New System of Geography* (1811) a considerable lake with no outlet is represented in the same position approximately as Great Salt Lake, and it bears this legend "Lake, etc., laid down according to Mr. Lawrence, who is said to have travelled through to California in 1790–91." As nothing further is known of Lawrence, credit is usually given to James Bridger, who came into the country with a trapping expedition sent out in 1824 by William Ashley of St Louis. The expedition was divided into detachments, Bridger accompanying that which wintered on Bear river, while Étienne Provost led another which may have wintered on Great Salt Lake. If so, Provost was the discoverer of the lake, for Bridger did not make his discovery until the spring of 1825, when, to settle a wager as to the outlet of Bear river, he went down its course to the lake. Finding it salt he believed it was an arm of the ocean. In 1826, the next year, Smith started from Great Salt Lake to explore the unknown south-west to the Pacific. On his return he struggled 20 days across the deserts of Nevada and Utah to reach Great Salt Lake, which he did without loss of a man It was the first expedition to cross the western country by the central route or to penetrate any distance into the basin west of Great Salt Lake, so opening up a vast territory.

It was July 24, 1847 that the first company of Mormons looked upon Salt Lake Valley, and Brigham Young, their leader, said "This is the place." From Feb, 1846, when they were forced to leave Nauvoo, Ill, they had been on the move About 15,000 Mormons crossed Iowa that summer, and wintered along the Missouri in camps they built. In April, Brigham Young's advance party of 143 men, 3 women and 2 children left Missouri with 73 wagons loaded with seeds and implements. In July Parley P. Pratt's party of 1,550 started with 580 wagons This party, typical of later ones, was divided into companies of 100 wagons, and these again into companies of ten, each with its captain. Horses, cattle, sheep, hogs and chickens were taken along. About 2,000 Mormons were in Salt Lake Valley at the end of autumn in 1847. In 1848 other parties were on their way, and about 1,000 wagons arrived that year. But this did not end the expeditions. Missionaries were working throughout the east and in Europe, especially in England and the Scandinavian countries, preaching of the new Zion Party after party crossed the plains by ox-teams in the years following until the Union Pacific railway was built in 1869. Many of the immigrants came from far lands. A fund was provided by the Church to aid the poor, and the money was returned as soon as the immigrant could afford to pay. In 1856 there was such an increased number of poor refugees from Europe that a cheaper way to transport them to Utah was needed. So handcarts were provided them at Iowa City, the terminus of the railroad, and three expeditions set off during the summer. The first reached Utah safely, but the last two were caught by winter storms on the plains, and before they could be rescued 66 of the first party and nearly 250 of the second died from lack of food and the cold

The winter of 1848–49 severely taxed the resources of the pioneer community at Salt Lake, but after the emigration of gold-seekers to California began in 1849 matters brightened. A large percentage of the teams came by way of Salt Lake City and found the settlement a welcome stop on their long journey. The Mormons traded with them, receiving high prices for fresh horses and food supplies. In Feb. 1849, after the South-west was transferred to the United States, a convention was called to organize a State under the name of Deseret. The petition for Statehood was sent in at once and a provisional State Government set up to function meanwhile. In the first election Brigham Young, already the president of the church, was elected governor. Instead of gaining Statehood at this time, Deseret was only made a Territory and its name was changed to Utah. Young's election was confirmed by appointment from the President. In contrast to other

western States, order and harmony prevailed in Utah before the government was established because the Church superintended matters and acted as a Government. Its officials distributed provisions, apportioned lots and farm plots, and ordered what work was to be done and the methods to be followed Even after the territorial government was under way, the church continued to direct affairs, and so often came into conflict with the appointive officers sent out by the Federal Government.

The very same afternoon that the advance body of Mormons reached the valley of Great Salt Lake, three ploughs were put into the soil, potatoes were planted and the waters of City Creek turned over the plot. Thus began the agricultural life upon which their communities were founded, and thus also began the irrigation which was to make agriculture possible. The Mormons were the first to practise irrigation on a large scale in the United States The farm area grew quickly along the western slopes of the Wasatch range, but the church did not rely on that only Explorers were sent in all directions to select the most fertile valleys with plenty of convenient water available. Colonists were then selected, 30 or 40 families from those that were constantly coming, to go and settle each valley. In 1848 the Ogden valley was settled, in 1849 the Sampete valley, in 1850 Utah valley and the valley of Little Salt Lake In time there were few valleys in Utah that Mormon colonies had not settled, spreading like bee swarms from the mother hive at Salt Lake City They really settled by church congregations as in early New England, and the meetings where the pioneers came together and discussed their local affairs resembled the New England town meetings Most of the manufactured articles needed were made in the home, though small grist and saw mills and tanneries were quickly set up In 1850 the U S. census gave the value of manufactures in Utah as $291,-220. Merchants were establishing stores and bringing their stock over the plains from the east by long freight trains, one of them in 1853 numbering more than 400 wagons Coal was early sought, and the mines developed In 1849 iron was discovered, plans for an iron foundry laid, and the call sent to Europe for "blowers, moulders and all kinds of furnace operations" In 1852 the first pig iron was made. Erastus Snow went to England to study the great iron factories of that country and in 1853 became president of the newly incorporated Deseret Iron Company. The mining of precious metals, however, was discouraged by President Young, partly because he felt prosperous farms made better homes than the feverish, impermanent mining camps, and partly because he knew gold discoveries would draw hordes of "Gentiles," out of harmony with his ideals and plans, to his colony. In 1863 when General Conner brought his company into Utah, he allowed his men, many of whom were old California miners, to prospect, and he also actively aided them He himself staked the first claim in the State. Thus even during Young's lifetime many mines were opened. The early ore was sent to Wales for smelting, but in 1870 the Woodhull Brothers of the Little Cottonwood mine completed the first smelter. In 1871 the Walker brothers built the Pioneer Crushing and Amalgamating Mill with 15 stamps to work the silver ore of the Ophir mine, which they had located the previous year. The coming of the Union Pacific railway in 1869 greatly stimulated mining It also brought an influx of non-Mormons who were to increase steadily as the years went by. The Utah Central and the Utah Southern railways built extension lines to the Bingham, Little Cottonwood and American Fork mining districts Later the Utah Eastern passed up Parley's Canyon and helped in the development of the Park City mines. The *Deseret News*, pioneer newspaper of the Rocky mountains, was established at Salt Lake City in June 1850. The *Salt Lake Herald* (independent policy) and the *Salt Lake Tribune* (anti-Mormon) followed. The *Tribune* became the mouthpiece of the liberals

Six separate efforts, in 1849, 1856, 1862, 1872, 1882 and 1887, to gain Statehood were made by Utah. Each time a Constitutional Convention met, a Constitution was drawn up and a petition sent to the Federal Government. They were refused Statehood because of their polygamous practices. The U S Government had enacted legislation in 1862, 1882 and 1887 forbidding polygamy. Resistance was made by the Mormons which resulted in fines, imprisonment, and, in the case of President Taylor, exile Church property amounting to $100,000 was temporarily confiscated Finally in 1890 the church yielded and refused henceforth to sanction plural marriage. The final movement for Statehood came from the U S. Congress in 1893, when it passed the enabling act, one of the provisions of which was that the Constitution of the new State should forever prohibit polygamous marriages The Constitution was framed at a convention in 1895, submitted to the voters at the general election in November and approved The proclamation of admission was signed by the President on Jan 4, 1896 Utah came into the Union with a population of 207,905, property assessed at $97,942,000, 39 banks with deposits of $9,689,267, and 1,376 m. of railway in operation. Such had been its progress since the Mormons made the first settlement in 1847

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UTAMARO (1754–1806), one of the best known of the Japanese designers of colour-prints. was born at Kawayoye As a painter, his landscapes and drawings of insects are most highly considered by Japanese critics; but his fame will always rest among Europeans on his designs for colour-prints, the subjects of which are almost entirely women—professional beauties and the like The colour-prints of Utamaro are distinguished by an extreme grace of line and of colour His composition is superb, and even in his lifetime he achieved such popularity among his contemporaries as to gain the title Ukiyo-ye Chūkō-no-so, "great master of the Popular School" His work had a considerable reputation with the Dutch who visited Nagasaki, and was imported into Europe before the end of the 18th century

See E de Goncourt, *Outamaro* (1891), E F Strange, *Japanese Illustration* (1897), and Japanese Colour-Prints (Victoria and Albert Museum *Handbook*, 1904) (E. F. S)

BY COURTESY OF MUSEUM OF THE UNIVERSITY OF PA

A UTE INDIAN MAN

UTE, a Shoshonean tribe of western Colorado and eastern Utah which gave its name to the latter State, and, with the Aztecs, to the great Uto-Aztecan family of Indians. The name was pronounced *Yoo-tah*, as preserved in the name of the State Of the Utes, 1,900 remain

UTICA, a city of ancient Africa, 15½ m N W. of Carthage. The site of the town is covered with low-lying marsh lands It was important as a commercial centre, and is mentioned in the commercial treaty of 348 B C. between Rome and Carthage Agathocles easily captured it in 310. After the destruction of Carthage it received the rank of a *civitas libera* with territory After the battle of Thapsus in 46 Cato shut himself up in Utica for the final struggle against Caesar, and there committed suicide. Utica was the seat of a bishop from the 3rd century onwards But its harbour was beginning to silt It was captured by Gaiseric and the Vandals in 439, reconquered by the Byzantines in 534, and finally, in 698, it fell into the hands of the Arabs and was depopu-

lated Very little is left above the level of the ground In 1869 excavations revealed the fortifications, the acropolis, the quays of the commercial harbour and of the military harbour or Cothon; also the ruins of the amphitheatre, which was capable of holding 20,000 spectators, of the theatre, the baths, the reservoirs and the aqueduct which brought drinking water to the city.

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UTICA, a city of central New York, U S A, the county seat of Oneida county, on the Mohawk river and the State Barge canal, 85 m from Albany, with a municipal airport Pop. (1920) 94,156 (20% foreign-born white, including 1,376 from Wales), 1928 local estimate 109,000.

The city covers 22 sq m, at an altitude of 450 ft Also, it is the seat of a State hospital for the insane (1843) and the extensive State Masonic home (1893) There are 200 m of paved streets, and a park system embracing over 600 ac. The valuation for 1927 was $131,482,683 The water-supply (privately owned) comes from the Adirondacks Hydro-electric power is developed at Trenton falls (15 m. N) and the city is one of the loading centres of the system serving the eastern States There are two daily papers. the *Observer-Dispatch*, established in 1793, and the *Press* (1882) Weeklies are published in Welsh, German, Polish and Italian Utica has several musical organizations of long standing and a wide reputation A Welsh eisteddfod lasting through several days is held annually, under the auspices of the Cymreigyddion Society

Utica manufactures a third of the knitted underwear made in the country, also producing cotton cloth, ventilating and heating apparatus, cotton yarn, sheets and pillowcases and men's clothing. The output in 1925 was $77,553,719. The retail trade embraces a population of 350,000

The site of Utica was in the 22,000 ac manor granted by George II in 1734 to William Cosby and his associates During the Seven Years' War a palisaded fort was built here, at the ford of the Mohawk, and named after Col Peter Schuyler Later, when Ft Stanwix at Rome was renamed Ft Schuyler, the Utica fort was known by the name Old Ft Schuyler In 1792 Cosby's manor was put up for sale by the sheriff, and was bid in by Gen Philip Schuyler, Gen John Bradstreet, John Morin Scott and others, for £1,387 (about 15 cents an acre) After the close of the Revolution settlers began to come in, largely Palatinate Germans from the lower Mohawk. In 1786 the proprietors had the manor surveyed, and in 1788 an inn was built New settlers came, from New England, among whom in 1789 was Peter Smith (1768–1837), later a partner of John Jacob Astor, and father of Gerrit Smith, born here in 1797 In 1792 a bridge was built across the Mohawk In 1797 Oneida county was established and the village was incorporated under the name of Utica It was chartered as a city in 1832. By 1860 it had a population of 22,529, which grew to 33,914 in 1880 and 56,383 in 1900 In the next two decades it increased 32% and 26 5% respectively, and between 1910 and 1925 the area within the corporate limits was more than doubled

UTILITARIANISM, the form of ethical doctrine which teaches that conduct is morally good according as it promotes the greatest happiness of the greatest number of people (Lat. *utilis*, useful) The term "utilitarian" was noticed by J S. Mill, in a novel of Galt, but it was first suggested by Bentham

It is in a clerical work written against Hobbes, Bishop Cumberland's *De Legibus Naturae* (pub in 1672), that we find the beginnings of utilitarianism.

Another clergyman, John Gay, in a dissertation added to Law's translation of Archbishop King's *Origin of Evil* (pub in 1731) expanded Cumberland's doctrine Further advances along the same line of thought were made by Abraham Tucker in his *Light of Nature Pursued* (pub. 1768–74) Gay and Tucker supplied nearly all the important ideas of Paley's *Principles of Moral and Political Philosophy* (pub. in 1785), in which theological utilitarianism is summarized and comes to a close. Hume's *Inquiry concerning the Principles of Morals* (pub. in 1751), though utilitarian is very far from being theological. Hume, taking fo granted that benevolence is the supreme virtue, points out tha the essence of benevolence is to increase the happiness of others

Bentley, the founder of political utilitarianism, took up th greatest happiness principle not as an attractive topic of study but as a criterion to distinguish good laws from bad. Sir Joh Bowring tells us that when Bentham was casting about for suc a criterion "he met with Hume's *Essays* and found in them wha he sought" These opinions are developed in his *Principles o Morals and Legislation* (pub. in 1789) and in the *Deontolog* (published posthumously in 1834) Philosophically Bentham makes but little advance upon the theological utilitarians. Hi table of springs of actions shows the same mean-spirite omissions that we notice in his predecessors; he measures th quantity of pleasures by the coarsest and most mechanical tests and he sets up general pleasure as the criterion of moral goodness These principles of Bentham were the inspiration of the philosophic radicals of the early 19th century From Bentham th leadership in utilitarianism passed to James Mill, who made n characteristic addition to its doctrine, and from him to Joh Stuart Mill whose essay *Utilitarianism* (pub. in 1863) sums u in brief and perfect form the essential principles of his doctrine The last writer who, though not a political utilitarian, may b regarded as belonging to the school of Mill is Henry Sidgwick whose elaborate *Methods of Ethics* (1874) may be regarded a closing this line of thought.

Even before the appearance of Sidgwick's book utilitarianism had entered upon its third or evolutional phase, in which principle borrowed from biological science make their entrance into mora philosophy The main doctrine of evolutional or biological ethic is stated with admirable clearness in the third chapter of Darwin' *Descent of Man* (pub. in 1871) The most famous of the sys tematic exponents of evolutional utilitarianism is, of course, Her bert Spencer, in whose *Data of Ethics* (1879) the facts of morality are viewed in relation with his vast conception of the total proces of cosmic evolution. The best feature of the *Data of Ethics* is it anti-ascetic vindication of pleasure as man's natural guide t what is physiologically healthy and morally good Leslie Stephen with less brilliance but more attention to scientific method worked out in his *Science of Ethics* (1882) the conception of morality as a function of the social organism

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UTILITY. In economics the utility of a good is not conceived to be its usefulness, as judged by any objective standard, but its importance to a consumer. Capacity to excite desire rather than to yield benefits or bestow happiness is the measure of a good's utility, in this technical sense, and only as the conduct of life is completely rational and guided by adequate foresight are the two capacities the same

The law or principle of *diminishing utility,* which serves in economics as a logical foundation for the laws of demand, is merely a general statement respecting an obvious aspect of the way in which men apportion their time and their means Summarized, it is that progressively diminishing importance is attached by a consumer to successive additional increments of a good. Diminishing utility has two aspects. absolute and relative One suit of clothes is more important than a second, and a second is more important than a third It is more important that in a cold climate one should have coal enough to keep one room warm during the winter than that a second, or a third or a fourth room should be heated. It cannot be said, however, that

all luxuries and particularly such as minister to the "desire for distinction," have different uses which can be ranked in an order of diminishing importance.

Marginal utility is the utility of the last increment (not necessarily last in point of time) which the consumer thinks worth acquiring. (*See* also ECONOMICS and VALUE) (A. Yo.)

UTMAN KHEL, a Pathan tribe who occupy the hills to the north of Peshawar in the North-West Frontier Province of India. They claim to be descendants of Baba Utman, who accompanied Mahmud of Ghazni in his expedition into India in 997. The Utman Khel are a tall, stout and fair race, but in dress and general customs follow the neighbouring peoples of Bajour.

UTO-AZTECAN FAMILY, perhaps the most numerous and important stock of North American Indians, is named after a representative northern and southern tribe, and it extended in a long irregular tract, broken only in Arizona, from Idaho to Tabasco, Mexico, and beyond as far as Panama in scattered populational islets The bond of union was linguistic and geographic, not racial or cultural. In customs there is little common to the lowly northern tribes and the barbarically advanced ones of southern Mexico.

The organization is as follows, tribes separately treated being asterisked:— I, Shoshonean sub-family. (*a*) Pueblo branch, *Hopi; (*b*) Plateau branch, comprising 1, *Ute, southern *Paiute, Chemehuevi, Kawaiisu; 2, *Shoshone, *Comanche, Gosiute, Panamint; 3, Bannock, northern *Paiute (Paviotso),*Mono; (*c*) Kern river branch, Tubatulabal; (*d*) southern California branch, comprising 1, Serrano; 2, *Gabrielino; 3, Luiseño, Cahuilla, Juaneño, Cupeño II Piman or Sonoran sub-family. *Pima, *Papago, Sobaipuri, *Tarahumare, Opata, Mayo, *Yaqui, Tepecano, Tepehuane, Cora, *Huichol, etc III. *Nahua sub-family, in which the *Toltec and *Aztec were most conspicuous (A. L. K.)

UTOPIA, an ideal commonwealth whose inhabitants exist under perfect conditions Hence *Utopian* is used to denote a visionary reform, which fails to recognize defects in human nature The word first occurs in Sir Thomas More's *Utopia,* published in Latin as *De optimo Reipublicae statu, deque nova insula Utopia* (Louvain, 1516) It was compounded by More (*q v*) from the Greek *οὐ*, not, and *τόπος*, a place, no-where.

The idea of a Utopia is, even in literature, far older than More's romance; it appears in the *Timaeus* of Plato and is fully developed in his *Republic.* The idealized description of Sparta in Plutarch's life of Lycurgus belongs to the same class of literary Utopias. A similar idea occurs in the Greek, and the mediaeval Norse, Celtic and Arab legends which describe an earthly paradise in the western or Atlantic ocean (*see* ATLANTIS) Few of these survived after the explorations of Columbus, Vasco da Gama and others in the 15th century; but in literature More's *Utopia* set a new fashion· the imaginary voyager arrives at the ideal state. In Bacon's *New Atlantis* (1624–29) science is the key to universal happiness; Tommaso Campanella's *Civitas Solis* (1623) portrays a communistic society; James Harrington's *Oceana* (1656), which had a profound influence upon political thought in America, is a treatise rather than a romance, and is founded on the ideas that property, especially in land, is the basis of political power, and that the executive should only be controlled for a short period by the same man or men With these may be compared the Christian Utopias, J. V. Andreae's *Christianopolis* and S Golt's *Nova Solyma* (1648). Bernard de Mandeville's *Fable of the Bees* is unique in that it describes the downfall of an ideal commonwealth. Other Utopias are the "Voyage en Salente" in Fénelon's *Télémaque* (1699), Vairasse's *Histoire des Sevarambes* (1716), Mercier's *L'An 2440* (1742); James Burgh's *Account of the Cessares* (1764); J. B. Say's *Olbie* (1800); Etienne Cabet's *Voyage en Icarie* (1848); Bulwer Lytton's *The Coming Race* (1871); Samuel Butler's *Erewhon* (1872) and *Erewhon Revisited* (1901); Edward Bellamy's *Looking Backward* (1888); William Morris's *News from Nowhere* (1890); H. G. Wells's *Anticipations* (1901), *A Modern Utopia* (1905) and *New Worlds for Old* (1908). Many Utopias, like the *Fable of the Bees* and *Erewhon,* are satires. Others are inspired by socialistic ideals; among these may be mentioned *Freiland, ein soziales Zukunftsbild* (1890) and *Reise nach Freiland* (1893), by the Austrian Theodor Hertzka (b Budapest, 1845), portraying a commune in Central Africa

UTRECHT, the smallest Netherlands province, has the Zuider Zee washing its very short northern frontier. The south-east polder now being drained will be in contact with Utrecht (*see* NETHERLANDS, *Impoldering*), but its present area is 526 sq m , and with a population of 384,574 (1926) it ranks third in the list of most densely-populated provinces This is also the position which it occupied at the beginning of the 20th century, but between 1900 and 1926 its average density increased from 470 per sq m to 707 per sq mile Utrecht city (*q v*) has over 151,000 inhabitants (fourth in the country) and Amersfoort nearly 36,000 The other settlements are relatively small The province falls entirely within the Rhine delta. (*See* NETHERLANDS, *Relief*) The southern limit of the Scandinavian ice passed diagonally through the province from north-west to south-east in the vicinity of Utrecht city, and the western part of the province consists of clay lands and, in the north-west, of low fen The sand and gravel eastern region is covered with bare heaths and patches of woods, and the occupations of the scanty population are chiefly those of buckwheat cultivation and peat-digging Amersfoort is here the only large town, but along the western edge of this tract there is a row of thriving villages, such as Amerongen, Driebergen, Doorn and Zeist The southern area is picturesque with more extensive woodlands and has long been popular for country seats Zeist provided a hunting-box for William III , and Doorn a retreat for ex-Kaiser Wilhelm II Venendaal, on the south-eastern border, is a market for the local bee-keeping industry Amersfoort, one of the chief seats of the Old Catholics, is now a thriving garrison town, with a variety of crops, including tobacco, growing on the sandy hills in its neighbourhood It retains the Koppelpoort spanning the Eem, a gateway which is probably the finest and least altered mediaeval entry to any town in the Netherlands Within the town the old ramparts are now laid out as leafy promenades Baarn, farther downstream, is a popular summer resort for Amsterdam citizens, and on the east side of the Eem are the typical peaceful fishing villages of Bunschoten and Spakenburg

At Maarsen, near Utrecht, is situated Zuylen castle, which is of some note. Rhenen was once the seat of an independent lordship, though afterwards joined to the bishopric of Utrecht The ancient church has a fine tower (1492–1531). Wijk-by-Duurstede, originally a Roman settlement, was of considerable commercial importance as early as the time of Charlemagne, but decayed owing to Norman raids in the 10th century The tower of the ruined castle of the bishops of Utrecht still stands

Ecclesiastical History.—The province represents the bulk of the ancient see, founded in 722 by St Willibrord The bishopric was weak compared with Holland, Gelderland and Brabant, and the middle ages saw local wars Holland's growth in the 14th century forced Gelderland and Brabant to relinquish their claims over the see. Later, in the 15th century, her supremacy passed to the dukes of Burgundy and, still later, to the emperor Charles V Notwithstanding the elevation of Utrecht to an archbishopric (1559), it was one of the seven provinces on the Protestant side which signed the Union of Utrecht (1579) against Spain The chapter of the see was secularized and the power of the members of the five ecclesiastic colleges was severely curtailed Under the vicariate of de la Torre (1651), trouble began with Rome, which claimed the right of appointing successors It started in 1702 when Codde, the nominee of the Dutch secular clergy, was accused by the Jesuits of Jansenism (*q v.*). Although innocent, he was deposed, and his chief opponent, de Kock, was appointed in his stead De Kock was expelled from the country by the States-General and the Church of Utrecht was without a head

In 1713 the French Government enforced the bull *Unigenitus*, and in the following years many refugee priests entered Holland, including Dominique Varlet who settled in Amsterdam in 1720 Steenoven, in 1723, was elected archbishop by the chapter of Utrecht and his subsequent consecration by Varlet led to a general excommunication by the pope. The Jansenist Church of Holland has continued as an independent body accepting the general councils, but rejecting *inter alia* the Vatican council and the infallibility

of the pope. Two suffragan sees were created. Haarlem (1742), Deventer (1757); and though, in the following century, the Church lost membership, yet it has recently attracted numbers of the less rigid Roman Catholics. At first the Jansenist church of Utrecht established close relations with the Old Catholic movement in Germany, but it subsequently viewed with strong disapproval the departures of the German members from Catholic tradition. The Jansenists refused to recognize the validity of Anglican orders, and in 1908 a singular offshoot of the Church of Utrecht was established in England when Dr. Gerard Gul (Jansenist archbishop of Utrecht) consecrated Arnold Harris Mathew, bishop of the Old Catholics in England. Meanwhile, in 1851, in Holland itself the Roman Catholic hierarchy had been restored, with Utrecht as the archiepiscopal see

For general statistics *see* NETHERLANDS.

UTRECHT, a city of Holland, capital of the province of Utrecht, on the Crooked Rhine, which here divides into the Old Rhine and the Vecht Pop (1927), 151,045 It is an important junction station 22 m S S E. of Amsterdam by rail It is a picturesque and interesting old town The line of the ancient ramparts, demolished in 1830, is now only marked by the Singel, or outer canal, which surrounds the oldest part of the city, with pleasant gardens and promenades laid out on the inside Two canals, the Oude and the Nieuwe Gracht, intersect the town from end to end Utrecht is the seat of a university, and of a Roman Catholic archbishopric. It is also the seat of the archbishop of the Dutch Old Catholics. The Domkerk, dedicated to St Martin, is a large Gothic building erected in 1254–1267 on the site of the original church founded by St Willibrord about 720 and completed by Bishop Adelbold about 1015 An open space forming the heart of the square in which the church stands separates the solitary western tower (14th century) from the choir and transept, the nave having been blown down by a violent hurricane in 1674 and never rebuilt. In the crypt are preserved the hearts of the German emperors Conrad II (1039) and Henry V. (1125). The Roman Catholic cathedral of St Catherine dates from 1524 and has been restored in modern times Other churches of very early foundation in Utrecht are the Pieterskerk and the Janskerk Attached to the Domkerk by fine old Gothic cloisters is the university, which was founded in 1634 and enlarged in 1894.

Connected with the university are a valuable library, occupying the palace built for Louis Bonaparte, king of Holland, in 1807, and containing upwards of 200,000 volumes and mss ; a museum of natural history; a botanic garden; an observatory, etc. The archiepiscopal museum (1872) contains examples of all branches of sacred art in the Netherlands In the Museum Kunstliefde is a small picture-gallery, chiefly remarkable for some pictures by Jan Scorel (1495–1562); the museum of antiquities contains a miscellaneous collection Other buildings of interest are the museum of industrial art; the so-called "Pope's house," built in 1517 by Adrian Floriszoon Boeyens, afterwards Pope Adrian VI., and a native of Utrecht, the royal mint of Holland, the Fleshers' Hall (1637); the home for the aged, occupying a 14th-century mansion, and the town hall (1830)

The country round about Utrecht is pretty and plentifully studded with country houses, especially on the road to Arnhem Close by, on the north-east, is the village of De Bilt, the seat of the Dutch meteorological institute Four miles north-west of Utrecht stands the 13th-century castle of Zuilen, which was carefully restored in 1752, and is still in excellent preservation Five miles east of Utrecht is the village of Zeist, the seat of a Moravian settlement established here in 1746 There are also a fine castle (1667) and grounds, a sanatorium for children and numerous modern villa residences At Ryzenburg, close by, is a Roman Catholic seminary, founded in connection with the establishment of the Roman Catholic hierarchy in 1853 and practically serving as an archiepiscopal palace.

History.—Utrecht (*i e., Oude Trecht* or Old Ford, rendered in Latin documents *Vetus Traiectum*) is a city of great antiquity. The place is mentioned in the itinerary of Antoninus, but its importance began when St. Willibrord (*q.v.*), the apostle of the Frisians, established his see there. The bishop's seat had to be fortified against the incursions of the heathen Frisians and Northmen, and the security thus afforded attracted population till, after the destruction of its rival Dorestad by the Normans in the 9th century, Utrecht became the chief commercial centre of the northern Netherlands. On the accession of Bishop Balderic (A.D. 918–976) to the see, Utrecht had just been sacked by the Northmen. He succeeded in driving the raiders away, rebuilt the walls, and during the 58 years of his episcopate the town grew and prospered. Its gradual acquisition of civic rights followed the same line of development as in the German episcopal cities Bishop Godebald (1122–1127) granted to the inhabitants of Utrecht and of Muiden, the neighbouring port on the Zuider Zee, their first privileges, which were confirmed (June 22, 1122) by the emperor Henry V. The magistrates, the *Schout* or high bailiff and his assessors, the *Schepenen* (*scabini, échevins*), were nominated by the burgrave from the order of knights. In 1196 we read for the first time of councillors as assessors of the magistrates, but these, who a little later were known as the *Raad* or council, were also nominated. As the 13th century advanced, the council, representing the wealthy and powerful gild of merchants, began to take a larger share in the government, and to restrict more and more the direct exercise of the episcopal authority.

The struggle between the town of Utrecht and its ecclesiastical sovereign reached its climax (1481–84) in the "groote vorlag," or great quarrel, between the citizens and Bishop David, the Bastard of Burgundy. With the aid of John, burgrave of Montfoort, who had been called in, and endowed with supreme power for the defence of the town, the Utrechters defeated all the efforts of their bishop, aided by the Hollanders and an aristocratic faction They only succumbed when the weight of the archduke Maximilian was thrown into the scale against them (1484). The struggle continued with intermissions till 1527 when Bishop Henry of Bavaria sold his temporal rights to the Emperor Charles V. Utrecht took a leading part in the revolt of the Netherlands. The union of the seven northern provinces, proclaimed at Utrecht in 1579, laid the foundation of Dutch independence (*see* NETHERLANDS) After the death of William the Silent, the Utrechters, jealous of the influence of their old enemies the Hollanders, elected a stadtholder of their own. The Roman Catholics had but little influence on the city, where the aristocrats inclined to the moderate (libertine) opinions advocated by the preacher Hubrecht Duifhuis, while the democrats were organized in the new church order introduced by the uncompromising Calvinist Petrus Dathenus (d 1581). After the advent of the earl of Leicester as governor-general of the Netherlands in 1585, the previous dominance of the aristocrats was broken and the ultra-Calvinistic Adolph, count of Nuenar, who was elected stadtholder, placed the people in power. The English governor-general made the town his headquarters during residence in the Netherlands, and took it under English protection. His withdrawal from the Netherlands was followed by the return of the aristocratic party to power From this time until the French Revolution, the democratic institutions of the city remained only a name.

UTRECHT, TREATY OF, the general name given to the important series of treaties which in 1713 and 1714 concluded the War of the Spanish Succession (*q v*).

The congress opened on Jan. 29, 1712 But it was not until July 10, 1712, that King Philip of Spain signed a renunciation of his rights to the succession of the crown of France. Then, England and France having concluded a truce, the pace was quickened and the main treaties were signed on April 11, 1713.

By the treaty between England and France Louis XIV. recognized the Protestant succession in England and undertook to give no further aid to the Stuarts. France ceded to England, Newfoundland, Nova Scotia or Acadia, the island of St. Kitts or St. Christopher, and the Hudson's bay territory, and promised to demolish the fortifications of Dunkirk.

The treaty between France and the United Provinces was mainly concerned with securing the barrier of fortresses. These arrangements were somewhat complicated and to a large extent provisional, as Austria and Bavaria, two countries deeply interested in the fate of the Netherlands, had not yet assented to

the terms of peace. By a commercial treaty concluded on the same day, France gave the Dutch privileges similar to those enjoyed by England. Other treaties concluded at the same time were between France and Savoy, France and Prussia, and France and Portugal By the first the duke of Savoy regained Savoy and Nice, and France undertook to obtain for him the island of Sicily and the title of king. By the second Prussia secured some small additions of territory, including part of Gelderland and Neuchâtel; in return France definitely and finally obtained the principality of Orange. The treaty between France and Portugal mainly concerned the Portuguese settlements in Brazil, her claim to these being recognized by France.

Other treaties were signed at Utrecht between Spain and the allies, Philip now concluding these as the recognized king of Spain. On July 13, 1713, a treaty was signed between England and Spain, which embodied certain commercial arrangements previously made between the two countries Spain ceded to England Gibraltar and Minorca, and promised to give up Sicily to Savoy She gave also to England the monopoly for 30 years of the lucrative slave trade with Spanish America, hitherto enjoyed by France. this was the famous Asiento Treaty. The peace between Spain and the United Provinces was signed on June 26, 1714, but the conclusion of that between Spain and Portugal was delayed until the following February The former was concerned mainly with commercial matters, Spain giving the United Provinces most-favoured-nation treatment.

The Treaty of Utrecht also provided compensation for the Emperor Charles VI as soon as he surrendered his claim to Spain. He was to receive Naples and Milan, and also the Spanish Netherlands, henceforward known as the Austrian Netherlands

But the general pacification was still incomplete, as France and the Empire continued at war It was not long, however, before Charles VI. realized that without allies he was no match for France Accordingly, his representative, Prince Eugène, met the French marshal Villars at Rastatt in Nov 1713, and here peace was made on March 7, 1714, Charles VI concluding the treaty without waiting for the assent of the States of the Empire This consent, however, was necessary, and a little later the representatives of some of the princes of the Empire met those of France at Baden, where, on Sept 7, 1714, the Treaty of Baden, the last of the treaties included in the general peace of Utrecht, was signed This dealt entirely with the question of the frontier between France and the Empire, which was restored as it was before the war except that France gained Landau

One other important matter was dealt with at Utrecht A second barrier treaty between England and the United Provinces was signed on Jan. 30 1713, and a third treaty signed at Antwerp on Nov. 15 1715 clinched the matter Seven fortresses were to be garrisoned by a total of 35,000 men, three-fifths of the cost being borne by the imperial government and the remainder by the United Provinces

The treaties were bitterly assailed by the Whigs, and after the accession of George I. four of its Tory authors, Bolingbroke, Oxford, Ormonde and Strafford, were impeached for concluding it, the charges brought against them being that they had corresponded with the queen's enemies and had betrayed the honour and interests of their own country.

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UTTOXETER, a market town of Staffordshire, England Pop. of urban district (1921) 5,363. The town lies on high ground near the river Dove.

Uttoxeter (*Wotocheshede, Uttokeshather, Utcesier, Uttoxater*) formed part of the estates of Algar, earl of Mercia; at Domesday it was held by the king; later it passed to the Ferrers family and in the 12th century Earl Robert de Ferrers constituted Uttoxeter a free borough. Uttoxeter, with the rest of the honour of Tutbury, escheated to the Crown in 1266; it was regranted to Edmund Crouchback, and belonged to the duchy of Lancaster until 1625.

In 1308 Thomas, earl of Lancaster, obtained the grant of a fair on the vigil, day and morrow of St. Mary Magdalene. The market was the greatest in that part of England for cattle and provisions; The church of St. Mary has a fine Decorated tower and spire; the rest of the fabric dates from 1828. Alleyn's grammar-school was founded in 1558 At Denstone, 5 m. N. of Uttoxeter, is St Chad's School

UXBRIDGE, a market town in Middlesex, England. Pop (1921) 3,394 Near the Grand Junction canal there are sawmills, and wharves for timber, coal and slates There are also flour mills, a brewery and engineering works. Uxbridge is said to date from Alfred the Great. but is not mentioned in Domesday. Here negotiations were begun, on Jan 30, 1645, between the commissioners of Charles I and the parliament, but were broken off on Feb 22 A part of the "Treaty House," in which they were carried on, remains In 1647 the parliamentary headquarters were in the town It remained a garrison town until 1689. It was granted a market by Henry II.

UXBRIDGE, a town of Worcester county, Massachusetts. Pop (1920) 5,384; 1928 local estimate 6,500. It is in a picturesque region of low hills and small lakes. The principal industry is the manufacture of woollen goods Uxbridge was divided from Mendon and incorporated as a town in 1727.

UXMAL, the ruins of an ancient Mayan capital city of the new empire about 50 m S of Merida, in Yucatan, Mexico; in 89° 42′ W and 20° 18′ N It was one of those frontier Mayan cities that did not rise to prominence until shortly before A D. 1000 when the League of Mayapan was formed with three cities, Mayapan, Chichen-Itza and Uxmal dominant in "the New empire" of the Mayas With the earlier fall of the Old empire in Guatemala and southern Mexico the Itza established themselves at Chichen (The mouths of the Wells), the Cocom made Mayapan their capital, and the Tutul Xiu, a kindred tribe, settled at Uxmal The period subsequent to the formation of the League of Mayapan constitutes the golden age of the New empire of the Mayas, when peace and plenty provided favourable opportunity for the development of trade and religion and science and art, particularly architecture. Great stone temples and colonnades elaborately carved and ornamented rose in every city; religion flourished; the sciences, especially astronomy and mathematics, were fostered; and a renaissance of culture held sway for over two centuries The buildings of this period at Uxmal surpassed those of the other cities in their grandeur and elegance. When the New empire crumbled under internal dissension and the conquest of the Aztec-Toltec imperialists from central Mexico, about the middle of the 15th century, Uxmal succumbed with the rest, and it is reasonably certain that only vagrant tribes lingered about the old ruins at the time of the Spanish conquest

The region of the Uxmal ruins, like most of Yucatan, is a dry grass savanna, in places rather heavily wooded as about Uxmal. The relief is negligible, the terrain for the most part being as level as a floor, though a range of low hills lies between Uxmal and Ticul, the railway station about 20 m. eastward. The water-supply of the city was furnished by "cenotes," or wells, within the city, or by pools some distance to the west, now partly filled up and vanished, but in the rainy season so marshy as to be the breeding-places of myriad mosquitoes that spread malaria, fever and disease. It may have been some of the mosquito-borne pestilences that destroyed the Mayan civilization.

The main ruins occupy an area not much over 160 ac., but outlying remnants indicate a residential district much larger, for which the central group, massive and extremely impressive, merely constituted the religious and civic nucleus The stone used in the structures is the pale, yellowish and reddish-grey limestone, obscurely marbled, which was probably obtained not far from the

city, though the quarry has not yet been definitely located. The body of the walls and the framework of the temples is generally of fragmental stone set in a whitish mortar of excellent composition made of lime burned in the neighbourhood The facings and ornaments are all cut exquisitely yet daringly, and in view of the fact that the Mayan artisans laboured without metal tools, the excellence of their work is amazing The faces and edges are graved and hewn with perfect precision and the joints are in many cases so perfect as to conceal the mortar Much plastering was done, and nearly all surfaces, and apparently even the intricate details of mouldings and sculptures were smoothed painstakingly by white plaster and finished in many colours

The walls are massive, averaging 3 ft in thickness, but in some ruins 9 ft, approximately vertical on the exterior to the full height, and to the spring of the arch inside. Few recesses or projections disturb the smoothness of the exterior walls, but elaborate ornamentation relieves the monotony Rigid mouldings divide the walls into upper and lower zones, the latter faced with smooth stone except for a narrow band of design near the base, and the former, a development of the entablature, compositely graven and bordered by a heavy band of mouldings at the top The shoe-shaped coping stones held the level cement roof The corners of the buildings were square or rounded No windows or other openings admitted air or light (or mosquitoes) The doorways, confined to the lower panel of the wall, were simply constructed and of medium to large size The jambs were faced with cut stone and the longer lintels were of zapote wood dressed square or partially so.

The buildings were generally long rectangular with one, or more usually two, ranges of rooms, and as a rule these buildings were arranged in groups of four forming a quadrangle. None of the buildings was over one storey in height, and nearly all were built on terraces or pyramids of varied ground plan and profile The rooms were high and spacious, with vaulted ceilings formed of the usual wedge-shaped arch built from horizontally laid stones corbelled and bevelled with the slope Stairways were numerous, wide, steep and well built of cut stone

Five principal buildings or groups of structures were the pyramid-temple of the Magician crowning a majestic pyramid 80 ft. high and 240 by 180 ft. at the base; the Nunnery quadrangle composed of four large rectangular buildings enclosing a court, all on a terrace 300 ft square and 15 ft above the level of the plain, and all divided into numerous small rooms probably occupied by the priesthood, the Governor's palace, an imposing structure set upon a triple terrace, and said to be the most important single unit of its kind in America; the House of the Turtles, a smaller structure distinguished by a frieze of sculptured turtles on the moulding; and the House of the Pigeons, a quadrangle like the Nunnery quadrangle, of which one building carries a peculiar roof-comb of colossal size perforated by hundreds of openings which make it appear like a great dove-cot, and which may have been occupied by statues like the roof-combs of Palenque Besides these a number of smaller or less important ruins or groups of ruins dot the locality and help to create a scene of ancient power, prosperity and culture, probably unsurpassed in Yucatan and certainly rivaled only by Mayapan and Chichen-Itza.

Bibliography.—W. H Holmes, *Ancient Cities of Mexico;* Field Columbian Museum, Anthropological Series, *Publication 8*, pp 80–96, vol i., No 1 (W E E)

UZ, a land, the scene of the story of the book of Job Its precise location is uncertain, but the name in the Old Testament appears to be associated with three districts.

(1) *Northern Mesopotamia*, a district to which Uz, son of Aram, is commonly referred (Gen x 23).

(2) *Damascus* and the country lying to the south of it. Josephus (Antiq i. 6. 4.) commenting on Gen. x. 23, remarks that Uz founded Trachonitis and Damascus.

(3) *Edom.* In Gen xxxvi. 28, Uz appears in the genealogy of Seir in the land of Edom, and in Lam. iv. 21, Uz stands as a parallel to Edom.

The suggestion has been made that if the name is so widespread, the explanation may be that it is tribal rather than territorial The transcription of the name in the Greek version suggests the Arabic *Audh* a well known deity, and might well be a tribal designation. Lam. iv. 21 appears to be the sole passage, which gives a clear indication of locality, and it is emphatic for Edom.

See S. R. Driver and G. Buchanan Gray, ***The Book of Job*** (1921), p. xxvii. *seq.* (E. Ro.)

UZBEK or **UZBEG REPUBLIC,** an administrative unit of Russian Central Asia, created in 1924. Area 186,251 sq kilo.; pop (1926) 4,447,600 Afghanistan lies to the south, the Turkmen S.S.R. to the west, Kazakstan to the north, and the Kirghiz A.S S R and the Tadzhik A S S R. to the east. Its territory including the Autonomous Tadzhik S S R and the mountain Badakshan autonomous area (*q v*) includes the oasis of Khwarezm, Khorezm or Khiva, Samarkand and most of the former khanate of Bokhara, with the Ferghana valley

Physical Characteristics.—The region is an ancient centre of oasis cultivation dependent on irrigation from glacier fed streams which are fullest at the time of the melting snows and are thus peculiarly favourable to agriculture. Its life depends on the Syr Darya, Amu Darya and Zarafshan rivers, on the spongy loess soil, and on the clear sunshine and heat of summer which combine to give rich harvests of grain and fruit to the cultivator The climate is continental, with little rain or cloud, and with intense bright sunshine in the six summer months Extremes of temperature range between −25° C and 47 5° C or more, the contrast being greatest in the plains and least in the hill regions The severe winter prevents the growth of perennials, but annuals flourish in the summer heat Rainfall is always inadequate, but varies greatly from year to year

The Zarafshan feeds the oases of Samarkand and Bokhara, the former getting the first and freshest supplies It rises in a glacier in the Alai mountains of the Tadzhik A S S R and flows through a longitudinal valley with the Turkistan range to the north and the Hissar range to the south, its total length being 400 m. and its average gradient 21 feet per mile Formerly it reached the Amu Darya, probably near Charjui, but now 12 m of sand, the Sundukli desert which connects the Kyzyl Kum from the north, and the Trans-Caspian Kara Kum from the south, intervene and the river is lost in the creeping wind-blown sands which are slowly advancing on the little town of Kara Kul, the last settlement dependent on the "gold-strewer," as the Zarafshan is called.

The Kara Darya and the Naryn in the north-east unite near Namangan to form the Syr Darya and upon them depends the Ferghana valley with Andijan, Marghelan, Ferghana, Khokand and Khojent Tashkent lies to the north on the Chirchik tributary of the Syr Darya A short portion of the Amu Darya forms the southern boundary of Uzbekistan and receives the right bank Surkhan tributary; the river then flows north-west through the Turkmen S S.R. until it re-enters Uzbekistan and feeds the oasis of Khiva (*q v*) now suffering from difficulties caused by the increasing desiccation of the region and from the perpetual eastward shift of the river on its course to the Aral sea. Formerly the river entered the Caspian by the Sary-kamysh depression and the oasis was then much more prosperous Desert everywhere encroaches on the oases, in the north-east the famine steppe or Bak-pak-dala, with its salty dark grey clay soils, approaches close to Khojent. The Kara Darya and Naryn bring down vast quantities of sand which is deposited near their banks and especially on the banks of the Syr Darya, in the region where it cuts its way through the Khojent-Ajar ridge

Under the influence of the south-westerly winds this vast expanse of sand everywhere steadily encroaches on cultivated lands In the north-west the Kyzyl Kum is advancing towards the Kamimikh district, and the oasis of Khiva lies between the Kyzyl Kum and the Kara Kum deserts. Even in the fertile Ferghana valley there are stretches of rubble and stony, as well as of sandy, desert. The whole area is undergoing geological change; rivers have changed their courses and lakes their outlines, while in some cases they have dried up altogether. Traces of dried-up lakes and of river beds which were the main arteries of prosperous regions within the period of written history, are evident. Bokhara and

Khiva owe part of their decay to this gradual desiccation. Earthquakes occur, more especially on the line from Khojent to Vyernyi (Alma-Ata) in the Kazakstan A.S.S R. In some regions, especially in the Urta Chul district between the western slopes of the Hissar range and the Amu Darya, there is stony steppe land, and steppe surrounds some of the oases and thus lessens the advance of sand.

The juniper is common on the hill regions and poplars and willows grow by the streams. The Russian government established a plant testing station to select shrubs to plant by the railway and thus prevent it becoming sand-covered and at Marghelan there is a government forest station from which poplars and other young trees are distributed to cultivators, the quick growth of the poplar making it specially suitable for planting round orchards and fields The former prairie fauna of the steppe regions is giving way to the drought resisting plants of the semi-desert steppe, among these the *saxaul* scrub is particularly useful in a region deficient in fuel

Agriculture.—During the civil wars and disorders following the 1917 revolution the irrigation canals, which need constant cleaning and repairing, were neglected, and the sown area much diminished. This period was followed by a complete disorganization of the former system of water distribution, a disaster where every drop of water is precious Only in 1925 was order restored and a new system introduced, based largely on the confiscation of water rights from former wealthy owners, and the redistribution under government control of water and of land from the large estates. In a region where life was based on tribal and traditional systems, with recognition of the chieftain as owner and controller, this change, following on the disorders of civil war, has made life difficult, especially as most of the inhabitants are illiterate and therefore find new laws particularly difficult to understand However the age-long skill of the cultivators, primitive though their methods may be, and the great fertility of the region, have resulted in the revival of agriculture and in 1926–27 about 70% of the pre-war area was again under cultivation

The Russian government attaches particular importance to cotton cultivation for the supply of raw material to the cotton factories of the Moscow region. Efforts are therefore being made to discourage the growing of rice, which demands a great deal of water, only on the left bank of the Chirchik in the Tashkent area can rice be cultivated without loss of water to other crops Cotton from Uzbekistan, and especially from the Ferghana and Andijan district, supplied 40% of the requirements of the Russian cotton mills in 1926–27 The number of small cotton cleaning workshops has been reduced and larger centres now give a greater output, thus 47 centres gave $\frac{3}{4}$ of the output of 200 centres which existed in 1913. In 1926–27 a large cotton factory was built with 40,000 spindles and another is under construction which will have 60,000 These are the first textile factories in central Asia and their construction will, it is hoped, supply Siberia with cotton goods at cheaper rates than the European factories because of lessened transit costs In 1926 a cement factory was opened at Khilkov for the same reason The railway linking central Asia with the trans-Siberian line is being pressed forward rapidly, for this development of cotton growing has made the local grain supply insufficient and the republic will depend more and more on imported Siberian grain. Hydro-electric energy for the cotton industry is planned and a station at Boz Su to supply Tashkent is already working

The impact of industrialism on this region of immemorial tradition is already felt, especially among the women, some of whom have abandoned the veil and have formed co-operative clubs, especially in Tashkent and Samarkand Other products are wheat, lucerne, maize, sorghum, barley, melons, cucumbers, fruits, vines, oilseeds, millet and opium poppy The almond is common in the Ferghana valley In the small areas not dependent on irrigation, wheat and barley are the chief crops. In 1925 a government grant was made for the introduction of more modern agricultural implements, especially for cotton cultivation and for new irrigation schemes and the rapid increase of yield between 1925 and 1928 indicates that, granted settled conditions, agriculture should develop in a remarkable way in the next few years. Stock raising of sheep, goats, working cattle, horses, camels, asses, mules and pigs forms an important item among the nomad and semi-nomad tribes. It suffered even more severely than cultivation during the civil war, partly because of the commandeering of horses for army purposes and of the slaughter of sheep during the food shortage, but also because many herdsmen crossed the frontier during the troubled times Even by 1927 the number of animals was barely 70% of that in the pre-war period and the number of horses is still markedly below normal Silkworm breeding is an old and important occupation.

The republic has some mineral wealth, little developed as yet. Naphtha near Ferghana gives an annual output of about 28,000 tons and coal, formerly exploited by peasants in a primitive way, but now under government control, yielded 101,000 tons from the mountains near the town of Andijan This development is due to the efforts of the Soviet government to encourage local supply so as to leave the Donetz coal for the factories in European Russia. Ozokerite is worked in Ferghana and its output in 1926–27 exceeded that of 1913 Radioactive ores have been found at Tyuya Muyun in the Ferghana valley and are being exploited. Iron, silver, lead and copper are mined by the peasants for local use, but have little economic importance

Industry and Communications.—Peasant industries everywhere supply local needs and supplement income They include the making of clothing and of felt for the tents of the herdsmen, of leathern bottles and shoes, paper, woollen and silk goods (including carpets and shawls) and metal goods Dried fruits are an important export Brick-making is unnecessary, for the loess, owing to its lime content, hardens and loess mud huts are common

Many types of life are found within the republic There still exist some purely nomadic herdsmen seeking different pastures according to opportunity, but their numbers are rapidly diminishing; others are semi-nomads with fixed summer and winter quarters In the foothills there is some mixed farming with cattle raising and grain cultivation dependent on rain, while in the oases there is intensive grain and fruit cultivation under irrigation

City life, with ancient trading bazaars and more recent beginnings of factory industry, is well developed Tashkent has a population of over 300,000, Samarkand of over 100,000, while Namangan, Andijan and Khokand have between 60 and 70 thousand inhabitants Marghelan, Bokhara and Khojent are between 37,000 and 46,000 Khiva is much reduced and has less than 20,000 inhabitants For an account of the ancient importance and present conditions of these famous cities see the separate articles on them. It should be noted that all, with the exception of Khiva, are on the railway, a vital factor in their revival The two main lines are the Orenburg-Tashkent and the line from the Caspian which meet at Tashkent A branch goes along the Ferghana valley with a north and south loop from Khokand, and a branch from Bokhara goes south to Termez on the Amu Darya, with a loop which will ultimately reach Samarkand Air communication is an important development since the revolution and Tashkent, Samarkand, Termez and Diushambe are linked by regular air services and fortnightly services from Diushambe through Kulyab to Sarai on the Afghan frontier are planned There is no railway to Diushambe and the road is difficult, so that the value of this air link which brings Diushambe into touch with Tashkent and the railway by a six hours' flight cannot be overestimated In this region of sharp contrasts, the camel caravan still crosses the desert and depends on wells which yield somewhat salty water or on the rare fresh water springs

The Population diminished markedly during the civil war The most densely peopled regions are the Andijan and Ferghana districts and the Tashkent and Khiva oases The total population of the latter oasis is little more than that of Tashkent city.

Uzbegs form about 74%, and other nationalities include Tadzhiks, Russians, Ukrainians, Kazaks, Kirghiz, Arabs and Jews The latter are possibly descendants of Jewish prisoners brought here by Assyrian and Babylonian kings. They speak Persian, but retain their ancient customs and are known as Bukhara Jews, because of the numbers in that city The name Uzbeg dates back to the reign of Uzbeg Khan, a chief of the Golden Horde, who

died in 1340 and who introduced Islamism among his subjects; his coins have been found minted at all the towns of the Horde which struck money up to that date. Before the Mongol invasion, the Turks, of whom the Kazaks, Uzbegs, Turkmens and Osmanli are the four chief groups, occupied Dzungaria and the Mongolian desert. The great effect of the Mongol invasion was to push the Turks westward, and it was apparently Turkish tribes who adopted the name of Uzbeg from their Mongol ruler who introduced Islamism The term Uzbeg is used by 14th and 15th century writers to indicate Mohammedan as opposed to Shamanistic Turks.

Klaproth gives four divisions of the Uzbegs, the Naiman, Kipchak, Kungrad and Mangut The Kunkurats or Kungrads were driven from their original home near Lake Dalai Nor by the Mongols, and their name survives in the town of Kungrad on the Amu Darya delta The Kipchaks form an important element in Khokand, while Tatar Uzbegs predominate in Khwarezm, where they founded an independent principality but allowed the Sart and Turkmen cultivators to remain. In the 15th century Timur defeated the Uzbegs and sacked Samarkand, but the struggle between the Uzbegs and the Kalmucks in the early 16th century resulted in the former again occupying Samarkand

The Uzbeg (Jagatai Turkish) tongue, though closely related to Turki, seems to have had a separate origin and development Various indications connect it with the old Uighur dialect found in the *Kudatku Bilik* (A D 1070); an Uzbeg tribe in the Andijan district is called Uighur At the present time, mainly as a result of the long illiteracy of the general population, there are numerous Uzbeg dialects, the four chief being those of Bokhara-Samarkand, Ferghana, Tashkent and Khiva, others being those of the mountain Uzbegs, of the Kashka Darya and Surkhan, the Afghan and the Kashgar districts Their variety reacts to-day by adding to the difficulties of education

So much admixture of Mongol and Turk and original cultivators of the oases has gone to produce the Uzbeg, that the physical type is by no means uniform The different proportions of Tadzhik, Sart, Persian and Afghan blood, as of Mongolian and Turkish, have led travellers to give most diverse accounts of the physical type of the Uzbegs The Kuramas of the Chirchik (Tashkent district) seem to have much Kazak blood The name *Sart,* from old Turkish *to wander,* is found in the *Kudatku Bilik* in the sense of merchant as opposed to nomad and then indicated an Iranian people In later times it denominated the original Iranian cultivators and ultimately has been used loosely of the peasant cultivators in the oases; it has no strict ethnological significance. The Persian speaking Tadzhiks were the aboriginal cultivators of the fertile parts of Turkistan and are tall and dark, with straight noses and much facial hair. They form a striking contrast to their Mongol and Turkish neighbours and are specially numerous in the towns For the history of the struggle between Turk and Mongol and Persian in this region and the varying fortunes of the khanates *see* H. Howorth, *The History of the Mongols* (1876).

History.—One of the earliest records of relations with Russia is the sending of envoys by the Uzbegs of Khiva to Tsar Feodor (1584–1598). In the previous reign an English merchant Jenkinson travelled to Bokhara, Ivan IV (1533–1584) having granted an English company trading rights with Persia Khiva was for long a slave market where in the 18th century as many as 10,000 Russian and Persian slaves sold in its markets by Kazaks, Turkmens and Kalmucks were working in the fields and on the irrigation canals The Uzbegs became less hostile to the Russians after Peter the Great's campaign against their enemy, Persia, though a force which he sent against Khiva was annihilated.

In the 19th century Russian scientists and travellers visited the region, among whom was the famous Russian geographer Semenov, later called Semenov-Tian-Shansky. In 1847 Russian troops established a fort on the Sea of Aral at the mouth of the Syr Darya and in 1853 a steamer was launched in the hope, which was not fulfilled, owing to navigation difficulties, of establishing trading communication with Ferghana. In 1853 Ak Metchet (Perovsk) was captured and in 1864 Tashkent was occupied by the Russians, and two years later Khojent fell. In 1867 General Kaufmann was appointed governor of the newly created Turkistan province and in the next year Samarkand was captured. In 1870 the emir of Bukhara submitted to the Russians; since Bukhara is entirely dependent on Samarkand for its water supply a struggle would have been disastrous. Khiva, however, secure in her desert fastnesses, still defied the Russian power. A Russian expedition under General Perovsky in 1869 was compelled to retreat by the difficult winter conditions in the Ust Urt plateau desert, with a loss of 3,000 men and most of the transport animals. In 1873 a triple attack from Tashkent, Chikishliar and Orenburg was organized and the city was captured. Khiva and Bukhara remained nominally independent vassal states of Russia until the 1917 revolution.

Soviet Government.—After that year they declared themselves independent republics and treaties with the Soviet government in 1920 and 1921 were signed in which their independence was recognized. Their form of government, however, was not socialist and soviet in type and civil war, complicated by the intense religious feeling of these Sunnite Mohammedan peoples, broke out Finally in 1924, after prolonged civil fighting and disorder, the two republics disappeared and were merged in the Uzbeg S.S R The creation of the new republic does not, however, imply a unity of feeling among its subjects. The Uzbegs themselves are divided into about 80 tribes with varying branches that bear at least 150 different names The other races noted above complicate the problem and the difference of speech, custom and type of life will make amalgamation a slow and difficult process, and the difficulty is increased by the poor school provision.

The gulf between the materialist view of the Soviet government and the religious fanaticism of the Sunnite Mohammedans, especially of the town centres, will not be bridged quickly, though the first vigour of the Soviet attack on the Islamic faith has died down and many children in this region attend Mohammedan schools or *madrasas.* The encouragement of publication in the vernacular and of research in the institutes of Tashkent especially is producing a scientific and literary outlet for the more cultured Turkish peoples and the adoption of the Latin script in place of the more difficult Arabic makes for the increase of literacy, with an ultimate possibility of improving sanitary and social conditions

UZÈS, a town of southern France standing on a height above the Alzon Pop. (1926) 3,688 Uzès, the seat of an episcopal see from the 5th century to 1790, has a cathedral flanked by a 12th century round tower of five storeys. The Duché preserves a 12th century donjon; the main building, flanked by a Gothic chapel, is Renaissance in style.

UŽICE, the capital of the Užice department of Serbia, Yugoslavia. Pop. (1921) 4,893. Užice (meaning "the narrow places") is built in a narrow, lonely glen, 1,385 ft. above sea level, on a stream spanned by two mediaeval stone bridges. Though poor, it has a well-built school, in the entrance to which is a Roman altar stone, and also a girls' school where weaving is taught The surrounding heights produce excellent tobacco, and there are linen and cotton mills. Commerce is retarded by the bad roads.

In the 13th century Užice was the seat of St. Sava, the first archbishop and patron saint of Serbia.

UZZIAH, more correctly called Azariah, was seated on the throne of Judah in succession to his father Amaziah by popular choice at the age of sixteen (2 Kings xiv. 21 *sq.*, xv. 1–7). The records assign to him a reign of fifty-two years, covering roughly the first part of the 8th century B.C., but during part of this time his son Jotham, who succeeded him *c.* 740 B.C , acted as regent, because Uzziah had become a leper. He was for some years contemporary with Jeroboam II. of Israel, and both kingdoms flourished Uzziah repaired the walls of Jerusalem and recovered and rebuilt the port of Elath on the Gulf of Akaba The account of his military reorganization and successful campaigns in 2 Chronicles xxvi. is probably not without historic basis. The Chronicler explains his leprosy as a punishment for infringing priestly prerogatives. A certain Azriau of Yaudi appears in the inscriptions as leading a combination against Tiglath Pileser III. *c.* 739. It has been contended that the reference is to Azariah of Judah. Despite the striking coincidence of names, it seems probable that the leader was king of Y'di, a small independent kingdom mentioned in the Aramaic inscriptions found at Zenjirli. (W. L. W.)

V The history of this letter is identical with that of *U*, from which it was not differentiated till the 15th to 17th century. The letter passed out of Latin having a majuscule pointed form V and a minuscule rounded form u and doing duty for two sounds, the high rounded vowel (English *oo*) and the voiced labial spirant (English *v*). The consonantal sound was that most usually occurring when the letter was initial, in which position the majuscule form V would most generally be used Thus the pointed form V became identified with the consonant, the rounded form with the vowel A minuscule *v* and a majuscule *U* were then adapted as required. (B F. C A)

VAAL, a river of South Africa, chief affluent of the Orange (*q.v.*). It rises at an elevation of over 5,000 ft above the sea in the Drakenberg mountains, of the Transvaal, about 170 m in a direct line west of Delagoa bay. It flows in a general S W direction, with a markedly winding course, across the plateau of inner South Africa, joining the Orange in 29° 3′ S., 23° 36′ E The river valley is 500 m. long, the length of the river being 750 m.

The first considerable tributary is the Klip (80 m. long), which rises in the Drakenberg and flows N W, its junction with the Vaal being in 27° S, 29° 6′ E, 12 m. S W. of Standerton. From this point to the eastern frontier of the Cape the Vaal forms the boundary between the Orange Free State and the Transvaal. The river is usually shallow and is fordable at many places, known as *drifts* But after the heavy summer rains the stream attains a depth of 30 or more feet. At such times the banks, which are lined with willows and in places very steep, are inundated. As a rule little water is added to the Vaal by its tributaries On the north the basin of the Vaal is contracted by the Witwatersrand and the Magaliesberg ranges, and its tributaries are few.

The Mooi rises in the Witwatersrand west of the Klip and, after running almost due S 75 m., unites with the main stream about 90 m. below Vereeniging. In its course through Griqualand West, the Vaal flows in a wide rocky channel, with banks 30 ft high, through an alluvial plain rendered famous in 1867–70 by the discovery of diamonds in the bed of the river and along its banks The diamonds are washed out by the water and found amid debris of all kinds, frequently embedded in immense boulders The last affluent of the Vaal, the Riet river, rises in the Beyers Bergen S.E. of Reddersburg and flows N.W. 200 m through Orange Free State, being joined, a mile or two within the Cape frontier, by the Modder river (175 m.), which rises in the same district as the Riet but takes a more northerly course The united Riet-Modder joins the Vaal 18 m above the Orange confluence.

The name Vaal is a partial translation by the Dutch settlers of the Hottentot name of the river—Kai Gariep, properly Garib (yellow water) which refers to the clayey colour of the stream. The Transvaal is so named because the first white immigrants reached the country from the south by crossing the Vaal.

VAALPENS (dusty-bellies), a little-known nomadic people of South Africa, who lived in small groups in the Zoutpansberg and Waterberg districts of the Transvaal, especially along the Magalakwane river. The Vaalpens were so called by the Boers from the dusty look of their bodies, due, it is said, to their habit of crawling along the ground when stalking game. But their true colour was black. In height the men averaged about 4 ft., *i.e.*, somewhat less than the shortest Bushmen. The Vaalpens lived entirely by hunting and trapping game, and dwelt in holes, caves or rock-shelters. They wore capes of skins, and procured the few implements they needed in exchange for skins, ivory or ostrich feathers. Their speech was full of clicks.

VACARESCU, the name, according to tradition, of one of the oldest noble families in Walachia. The first member of historical importance was Ianache (b. 1654), the grand treasurer of Walachia, who was killed with his master, Prince Brancovan in Constantinople, 1714. His grandson through his son Stephan, also called Ianache (or "Enakitza the Ban," 1730–1796), started a line of Rumanian scholars and poets; he was the author of the first known Rumanian grammar in the vernacular, printed in 1787 While in exile in Nicopolis he wrote the contemporary history of the Turkish empire in two volumes (1740–99). He was also the first to attempt Rumanian versification. Greater as a poet is his son Alecu (Alexander), who died as a prisoner in Constantinople in 1798. In 1796 a collection of his poems appeared in Rumania His brother Nikolaes (d 1830) also wrote some poems, but they remained in ms until 1860, when they were published

By far the greatest member of the Vacarescu family in the male line was Iancu (1786–1863), the son of Alexander An ardent patriot, he sided with the national movement in 1821, and assisted in establishing the Rumanian theatre, translating many books and plays from German and French into Rumanian, notably the *Britannicus* of Corneille, a literary event of no small importance at the time He inaugurated modern Rumanian poetry. In 1830 appeared his first volume of verse. He died in 1863. A niece of Alexander is the gifted writer Elena Vacarescu (Hélène Vacaresco), maid-of-honour to the queen of Rumania, and Rumanian delegate to the League of Nations, who inherited the poetical talent of her family and has enriched Rumanian literature with her *Bard of the Dimbovitza*, and other poems and novels in Rumanian and in French, including *Chants d'Aurore*, which was crowned by the French academy, *L'Âme Sereine*, and *Rumanian Ballads*, which obtained the Prix Jules Favre at the French academy. (M. G.)

VACARIUS (1120–1200?), Italian civilian and canonist of the school of Bologna, the first known teacher of Roman law in England, was brought to Canterbury, possibly by Becket, together with a supply of books upon the civil law, to act as counsel (*causidicus*) to Archbishop Theobald in his struggle, which ended successfully in 1146, to obtain the transfer of the legateship from the bishop of Winchester to himself. We next hear of Vacarius as lecturing at Oxford, in 1149, to "crowds of rich and poor," and as preparing, for the use of the latter, a compendium, in nine books, of the Digest and Code of Justinian It became a leading text-book at Oxford, and its popular description as the *Liber pauperum* gave rise to the nickname *pauperistae* applied to Oxford students of law Nearly complete mss of this work are still in existence, notably in the cathedral libraries at Worcester and Prague and in the town library at Bruges Fragments of it are also preserved in the Bodleian and in several college libraries at Oxford Stephen suppressed the teaching of the civil law and ordered the books on it to be destroyed, but after Stephen's death it flourished again. The same year (1154) Roger de Pont l'Évêque, a colleague of Vacarius at Canterbury, was made archbishop of York, and took Vacarius with him as legal adviser and ecclesiastical judge He is last heard of in 1198. It is doubtless to the second half of the life of Vacarius that the composition must be attributed to two works the ms of which, formerly the property of the Cistercian abbey of Biddleston, is now in the Cambridge university library.

Bibliography —Most of the original authorities are textually set out and annotated by Prof T E. Holland in vol. ii of the *Oxford Historical Society's Collectanea* (1890) Wenck, in his *Magister Vacarius* (1820), prints the prologue, and a table of contents, of the *Liber pauperum*, from a ms. now lost. F. Maitland in the *Law Quarterly Review*, xiii., pp. 133, 270 (1897), gives a full account of the Cambridge mss., printing *in extenso* the *Summa de matrimonio*.

VACCINATION, the term originally devised for a method of protective inoculation against smallpox, consisting in the intentional transference to the human being of the eruptive disease of cattle called cow-pox (*vaccinia*). The discovery of vaccination is due to Dr. Edward Jenner (*q.v.*), whose investigations were

first published in 1798 in a pamphlet entitled *An Inquiry into the Causes and Effects of the Variolae Vaccinae, etc* His first case of vaccination (May 1796) was that of a boy, whom he inoculated in the arm with cow-pox matter taken from a sore on the hand of a dairymaid, who had become infected with the disease by milking cows suffering from cow-pox It was apparently in 1798 that he made his first attempt to carry on a strain of lymph from arm to arm.

In applying to cow-pox the term "variolae vaccinae," Jenner expressed his belief that this disease was small-pox of the cow

As the outcome of much experimental work it may be definitely stated that small-pox lymph, especially if obtained from the primary vesicle of a case of the inoculated form of the disease, by passage through the system of the calf becomes deprived of its power of causing a generalized eruption, while inducing at the site of inoculation a vesicle indistinguishable from a typical vaccine vesicle; and, more important still, that when transferred again to man, it has by such treatment completely lost its former variolous character Such being the case, it is usually considered that cow-pox, or rather that artificially inoculated form of the disease which we term *vaccinia,* is *variola* modified by transmission through the bovine animal

The cause of vaccinia is a filter passing virus (*q v*) more resistant to the germicidal effects of glycerine than ordinary microbes Advantage is taken of this fact, in the method devised by S Monckton Copeman, and now employed officially in England, on the Continent and in America, for ensuring the bacteriological purity of vaccine lymph

In 1889 an English Royal Commission on vaccination was appointed The evidence given was published at intervals in a series of Blue-books, and in August 1896 the final report made its appearance As regards the effect of vaccination in reducing the prevalence of, and mortality from, small-pox, the following conclusions were arrived at, with two dissentients "(1) That it diminishes the liability to be attacked by the disease (2) That it modifies the character of the disease and renders it (*a*) less fatal, and (*b*) of a milder or less severe type. (3) That the protection it affords against attacks of the disease is greatest during the years immediately succeeding the operation of vaccination. It is impossible to fix with precision the length of this period of highest protection Though not in all cases the same, if a period is to be fixed, it might, we think, fairly be said to cover in general a period of nine or ten years (4) That after the lapse of the period of highest protective potency, the efficacy of vaccination to protect against attack rapidly diminishes, but that it is still considerable in the next quinquennium, and possibly never altogether ceases. (5) That its power to modify the character of the disease is also greatest in the period in which its power to protect from attack is greatest, but that its power thus to modify the disease does not diminish as rapidly as its protective influence against attacks, and its efficacy, during the later periods of life, to modify the disease is still very considerable (6) That re-vaccination restores the protection which lapse of time has diminished, but the evidence shows that this protection again diminishes, and that, to ensure the highest degree of protection which vaccination can give, the operation should be at intervals repeated (7) That the beneficial effects of vaccination are most experienced by those in whose case it has been most thorough We think it may fairly be concluded that where the vaccine matter is inserted in three or four places, it is more effectual than when introduced into one or two places only, and that if the vaccination marks are of an area of half a square inch, they indicate a better state of protection than if their area be at all considerably below this." For the evidence, statistical or otherwise, on which these conclusions are based, the Reports of the Royal Commission should be consulted.

Efficient Vaccination.—The clinical activity and bacteriological purity of the lymph employed for vaccination; the skilful performance of the operation itself; the making of an adequate number of insertions of lymph over a sufficient area; the observance of strict asepsis, at the time of vaccination and until the vaccination wounds are soundly healed—all these are essential to "efficient vaccination " Certain principles are generally recognized, and for public vaccinators, whose work comes under government inspection, instructions on these several points are prescribed The lymph universally employed in Great Britain is glycerinated calf lymph, the use of which has entirely superseded, in public vaccinations, the arm-to-arm method Glycerinated lymph, under proper conditions, usually retains its potency for many weeks or months; but is liable to become gradually weakened, and even eventually to become inert

There exists no official definition of what constitutes a "successful vaccination." The standard long ago laid down by the Local Government Board—the production, namely, of a total area of vesiculation of not less than half a square inch, divided among four separate vesicles or groups of vesicles, not less than half an inch from one another—has for the most part proved easily attainable in practice, and should be aimed at in private as in public work

Alleged Injurious Effects.—In a certain small proportion of cases vaccination has been followed by various inflammatory complications, which are not peculiar to vaccination, but constitute the danger of any local lesion of the skin, however caused A few authenticated cases have been recorded in which there was reason to believe that syphilis was conveyed by arm-to-arm vaccination Tubercle in its various forms and leprosy have also been included in the list of possible complications of vaccination, though without any sufficient proof The employment of glycerinated calf lymph obviates these dangers for even if tubercle bacilli or the streptococcus of erysipelas were by chance present in the lymph material when collected, it has been found experimentally that they do not survive prolonged exposure to the action of a 50% solution of glycerine in water Leprosy and syphilis are not communicable to the calf In view of the frequency of various skin eruptions in infancy; it is to be expected that in a proportion of cases they will appear during the weeks following vaccination Eczema and impetigo in particular have, *post hoc,* been attributed to vaccination, but no direct connection has been proved to exist between the operation and the occurrence of these disorders Of a different order is the post-vaccinal encephalitis described by Turnbull and McIntosh at the British Medical Association meeting in July 1928 The condition has been noticed in some hundreds of cases and manifests itself on the average 10–14 days after vaccination as headache, delirium, paresis and ultimately coma and death in fatal cases.

Legislation.—Legislation making vaccination *compulsory* was first introduced in Bavaria (1807), Denmark (1810), Sweden (1814), Wurtemburg, Hesse and other German states (1818), Prussia (1835), the United Kingdom (1853), German empire (1874), Rumania (1874), Hungary (1876), Serbia (1881), Austria (1886). But in many cases there had been earlier provisions indirectly making it necessary In the same way, where there is no compulsory law there are government facilities and indirect pressure, apart from the early popularity of vaccination which made it the usual practice In the United States there is no federal law, but many of the separate states make their own compulsion either directly or indirectly, Massachusetts starting in 1809

The benefit of vaccination proved itself in the eyes of the world by its apparent success in stamping out small-pox; but there continue to be people, even of the highest competence, who regard this as a fallacious argument—*post hoc, ergo propter hoc* In addition they point to the dangers enumerated above as reasons for their opposition to the practice and insist that the diminution of small-pox is due to improved general hygiene and segregation

The cause of "anti-vaccination" has had many followers in England, and their persistence has had important effect in English legislation. Under the provisions of the Vaccination Act 1898, the Vaccination Order (1898) of the Local Government Board and the Vaccination Act 1907, numerous changes in connection with vaccination administration and with the performance of the operation were introduced, in addition to the supersession of arm-to-arm vaccination, by the use of glycerinated calf lymph. Thus, whereas by the Vaccination Acts of 1867 and 1871 the parent or person having the custody of any child was required to procure its vaccination within three months of birth, this period by the

act of 1898 was extended to six months. Again, parents were relieved of any penalty under the compulsory clauses of the Vaccination Acts who afforded proof that they had, within four months of the birth of a child, satisfied a stipendiary magistrate, or two justices in petty sessions, that they conscientiously believed that vaccination would be prejudicial to the health of the child. Moreover, the public vaccinator was now required to visit the homes of children for the purpose of offering vaccination with glycerinated calf lymph, "or such other lymph as may be issued by the Local Government Board" Much good has arisen from the substitution of domiciliary for stational vaccination.

There have naturally been some curious discussions before the magistrates as to what is "conscientious" or not, but the operation of the so-called "conscience clause" has tended to the more harmonious working of the Vaccination Acts, though at the cost of a high proportion of unvaccinated persons in some towns of England The act of 1907 repeals sec 2 of the 1898 act and substitutes for the certificate of a magistrate a statutory declaration before a commission for oaths. By the same act the penalty, 20 shillings, for failing to have a child vaccinated is abolished With slight variations the same holds good for Scotland

On July 31, 1928, there was published as a large Blue Book (Stationery Office, Cmd 3148) the report of the committee set up by the minister of health to inquire and report from time to time on various matters connected with vaccination The committee consisted of medical men, under the chairmanship of Sir Humphry Rolleston, and made several recommendations, the most important of which from the public point of view is that they consider "it is expedient now to make a trial of vaccination in one insertion in a manner calculated to produce as little discomfort as possible, and to urge strongly the necessity for re-vaccination in like manner at stated intervals"

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VACCINE THERAPY. This consists in the introduction into the body of a suitable vaccine, in order to stimulate the tissue cells to elaborate a sufficiency of specific antibodies to resist the subsequent invasion of a particular micro-organism; or in the case of an already infected individual to prevent the further multiplication and diffusion of the invading bacterium—in other words, to establish a condition of active immunity

To Edward Jenner belongs the credit of exploiting the use of an attenuated virus for the production of an active immunity to smallpox, and originally the term "vaccine" was restricted to the virus of smallpox as altered by its passage through the bovine species, in which it gives rise to cow-pox or vaccinia Pasteur then applied the principle to the prophylaxis of bacterial infections and Almroth Wright expanded it to embrace not only the prevention but also the treatment of microbial disease Consequently, the word "vaccine" now includes suspensions of bacterial cells and emulsions of bacterial protoplasm, which when introduced into the human economy result in the formation of specific antibodies

In either case the plan adopted was to inject successive quantities of bacterial protoplasm derived from artificial cultures of the particular micro-organism under study In the initial stages of the process these cultures are usually modified by some physical agent, such as heat, in order to attenuate or destroy the virulence of the microbe For instance, Pasteur vaccinated sheep with cultures of the anthrax bacillus which had been attenuated by growth at a temperature (41° C) some degrees above the optimum, to protect them against the natural disease splenic fever; and Wright used cultures of *B typhosus*, killed by heating to 60° C for the protection of British soldiers in India against typhoid fever.

The success that attended this work of Wright, sufficiently notable in the later stages of the Boer War, reached its culmination during the World War, when first typhoid, and subsequently para-typhoid, fevers were eliminated from the British Army by the use of appropriate vaccines, and in consequence prophylactic vaccination against these diseases has established its position in preventive medicine.

Attempts have naturally been made in the direction of prophylaxis against many other infective diseases by the use of special vaccines, as, for example, cholera, plague, dysentery, cerebrospinal fever; tuberculosis, pneumonia, influenza and the common "cold", but although considerable success has been attained, the results have not presented the uniformity of those achieved in the prevention of typhoid and para-typhoid fever At the same time, it must be conceded that it is a difficult matter to arrange "mass" experiments in which the numbers of inoculated and uninoculated or "control" individuals are sufficiently large to permit of the application of statistical methods in the evaluation of the results obtained, particularly in view of the very brief "incubation" period of many of these diseases This difficulty becomes even greater when vaccines are employed in the treatment of individuals already incapacitated by bacterial infections, for here each case must be judged as a separate entity and accessory means of treatment to say nothing of the long arm of coincidence, are factors which cannot be ignored when attempting to form a just estimate of the value of vaccine therapy In the opinion, however, of those who have devoted themselves to the study and application of this type of medication no reasonable doubt exists as to the importance of what may be termed specific therapy

Types of Vaccines.—Vaccines belong to one of two main types—"stock" or heterogenous—that is to say prepared from a cultivation of the required species of microbe which has already been isolated from an infected individual and after identification stored in the laboratory, and "autogenous" prepared from the actual organism isolated from the particular patient under treatment Obviously "stock" vaccines must of necessity be utilised in the attempt to immunise the normal individual prior to exposure to infection by the corresponding microbe Stock vaccines also possess a distinct value in therapeutic medicine particularly in the case of certain chronic infections such as tuberculosis, but since bacteria exhibit so many biological variations presumably due to the operation of environmental factors, the employment of a number of different "strains" of the same species, thereby rendering the "stock" vaccine "polyvalent," for this purpose is advocated (*see* also SERUM THERAPY) In the treatment of acute diseases, however, "autogenous" vaccines are immeasurably superior even to polyvalent stock vaccines When the serum containing the specific immune antibody for a particular strain of micro-organism is available it may be combined with that germ during the process of manufacture and a "sensitised" vaccine—either stock or autogenous, as the case may be—results

Detoxicated Vaccine.—Another variety of vaccine, in which the bacterial protoplasm has been so modified as to remove its toxicity; as well as its infectivity, is known as "detoxicated" Pasteur's anthrax cultures incubated at an unsuitable temperature, and Raw's tubercle cultures grown for a long period of years upon artificial culture media, were detoxicated in this sense by purely biological methods Recent workers have attempted to effect the same object by treating the bacterial protoplasm with either mineral acids or alkalis These chemical methods, however, profoundly change the protoplasm of the organism, and the injection of the resulting vaccines into the animal economy is not as a rule followed by the production of any large amount of the "specific" antibodies as at present recognized That detoxicated vaccines of this type do subserve a useful purpose is beyond question, however, although the mechanism which is here brought into action is probably closely allied to that of protein shock (*see* IMMUNITY).

Mode of Preparation.—All the above varieties of vaccines are prepared on very similar lines. The selected organism is cultivated usually on a solid substratum, under optimum conditions for that particular period which will give the maximum development, and the resulting growth is emulsified in normal saline

solution. In the preparation of sensitized vaccines the appropriate anti-serum is added to the emulsion and the mixture is allowed to stand at 0° C for a period of about 12 hours. Next, the amount of bacterial protoplasm held in suspension per unit volume (1 c c) is measured, and several methods are available for the purpose Undoubtedly the most accurate method involves drying and weighing the mass of bacteria, but this is a lengthy process, and often the time factor is of paramount importance where therapeutic vaccines are concerned For this reason the plating methods ordinarily employed for the estimation of the number of bacteria suspended in fluids, such as water, are rarely resorted to, and other more rapid methods have been utilized Thus Sir Almroth Wright mixed equal volumes of the bacterial emulsion and blood from a normal individual, and by means of microscopical films estimated the ratio existing between the red cells and the bodies of the bacteria in the mixture This ratio having been ascertained, a simple calculation determines the number of bacteria in the unit volume, since the number of erythrocytes normally present in man is a remarkably constant factor (amounting to 5,000 million per cubic millimetre). Again, the bacteria may be counted by means of the ordinary haemocytometer, or the estimation may be made by comparing the suspension of bacteria with standard tubes containing opaque fluids corresponding to definite numbers of various organisms per cubic centimetre

In most instances the microbes contained in the emulsion are now altered by heat coagulation (by suspension in a water bath adjusted to the thermal death point of the particular organism) by autolysis, or by lysis due to the action of chemicals such as sodium fluoride or carbolic acid, so that their infectivity is destroyed; in the case of sensitized vaccines the microbes may, at the discretion of the bacteriologist, be left in the living state and unaltered—save for their combination with the corresponding antibody In the chemically detoxicated vaccines the solution of the bacterial protoplasm is effected at this stage by the addition of the requisite acid or alkali, and the vegetable protein is further purified by repeated precipitation and solution

Finally, the emulsion, is adjusted to some pre-determined standard by dilution or concentration, a small quantity of a preservative, such as tricresol or phenol, is added and the finished product stored in suitable receptacles

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VACCINIUM, a genus of shrubs of the heath family (Ericaceae, *q.v*), comprising about 130 species found widely throughout the northern hemisphere, and extending to Madagascar and the Andes. They are erect or creeping shrubs, with deciduous or evergreen leaves. The small flowers bear much resemblance to those of the true heaths (*Erica*), from which they differ in having the ovary inferior. The fleshy berry-like fruits are usually edible. Four species occur in Great Britain: *V. Myrtillus,* the bilberry, blaeberry or whortleberry; *V. uliginosum,* the bog bilberry; *V. Vitis-Idaea,* the red whortleberry or cowberry; and *V. Oxycoccus,* the cranberry (*q v.*), all of which are found widely distributed throughout large areas in Europe, Asia and North America, being especially abundant in cool northern and mountainous regions.

In North America some 40 species occur, more abundant in the northern and mountainous parts of the continent. In the eastern States and adjacent Canada several species, commonly known as blueberry (*q.v.*), are prized for their fruits. In northern Canada the red whortleberry, commonly called mountain cranberry, is gathered for cooking purposes *V. macrocarpon,* the American cranberry, is extensively cultivated. Several species occur in the Rocky Mountain region and about 10 are found in the Pacific States, the latter including *V. occidentale,* the western blueberry; *V. parvifolium,* the red bilberry, and *V ovatum,* the California huckleberry.

VACUUM, an empty space Strictly speaking, for a space to be a vacuum it must contain no traces of gas of any kind, but even with the most refined modern means of exhaustion there will be a few million million gas molecules in a glass bulb five inches or so in diameter which has been rendered as empty as possible This represents, however, a pressure only a ten thousand-millionth of the atmospheric pressure It is customary to speak of a space in which the pressure has been reduced to a thousandth of an atmosphere or less as a vacuum, and to specify the pressure, while a space in which the pressure has been reduced to a lesser extent, however little below atmospheric pressure, is sometimes referred to as a partial vacuum. There is, however, no fixed rule in these matters, the term vacuum being in general applied to a space in which a low gaseous pressure prevails, and whether a given pressure is considered to be low or not generally depends upon the class of phenomenon or experiment under consideration

The study of gases at very low pressures has assumed enormous importance in the last fifty years both from the point of view of pure science and from the point of view of the electrical industry The study of the discharge of electricity in evacuated tubes which became so marked a feature of physical research at the end of last century, and has remained so since, led to the discovery of the electron and of X-rays, and to the host of important discoveries in atomic physics which is associated with the Cavendish Laboratory at Cambridge, and with such names as Lenard and Wien on the continent. On the other hand the manufacture of electric lamps of all kinds, of X-ray tubes and of thermionic valves has necessitated a profound study in the great industrial laboratories not only of the means of producing vacua and measuring low gaseous pressure, but also of the behaviour and influence of the gases occluded on metal and glass surfaces, and of many properties of the low pressure discharges. It would, perhaps, not be too much to say that the physics of the vacuum dominates the modern laboratory.

HISTORY

Guericke's Experiments.—The first experiments on vacua were made by Otto von Guericke (1602–1686) whose original plan was to fill a vessel with water, and then pump the water out with a water pump, so leaving an exhausted space. His earliest attempts were certainly carried out before 1652; Gerland suggests as early as 1632 to 1638. He filled a cask with water, and pumped out the water by means of a brass fire-squirt, adapted for the purpose. Naturally enough the cask proved not to be air-tight, and the air was heard to rush in through the pores and crevices. He then tried the same experiment with a large copper sphere in place of the cask, but after the pumping had proceeded for some time, the copper sphere collapsed "with a great noise, to the terror of all," a fact which, later, Guericke correctly attributed to the pressure of the air. These early experiments are described in Guericke's famous book *De Vacuo Spatio* (of which the full title is *Experimenta Nova [ut vocantur] Magdeburgica de Vacuo Spatio*), which was not, however, published until 1672 After these abortive attempts Guericke constructed several true air pumps, consisting simply of cylinder and piston with two valves, the whole pump being immersed in water to make the joints as far as possible airtight. These pumps are not described by Guericke, but an account of one of them was given, with Guericke's approval, by Caspar Schott in 1657, in his *Mechanica Hydraulico-Pneumatica.*

The cylinder is arranged at a slope, so that the lower end can be immersed in water, to seal the joints, and is provided with two valves, one in the side, opening outwards, and an internal valve at the lower end, opening inward. The receiver is connected to the lower end of the cylinder by a vertical pipe. Schott records the increasing difficulty of operating the pump as the exhaustion proceeds, and states that it is necessary to work for two or more hours to exhaust the receiver. With such a pump Guericke performed in 1654 several striking experiments before the Emperor Ferdinand III. at Regensburg, of which the most celebrated is the experiment of the Magdeburg hemispheres. Two copper hemispheres, about 22 inches in diameter, were laid together to form a sphere, a ring of leather soaked in wax and oil being placed between them to make an airtight joint. The air was exhausted through an opening which could be closed by a tap. It was then found that two teams, consisting of eight horses each, when pulling in opposite directions, were unable to drag the hemispheres apart

A description of one of the earliest improved pumps is given in *De Vacuo Spatio*. The cylinder is put vertically on a tripod, and the piston is pushed up and down from underneath by a lever and connecting rod. The top of the cylinder has two valves, a leather flap valve, and a plug valve. These valves are for alternative use, when the air pressure is no longer sufficient the valve is withdrawn and replaced by hand at the correct part of the stroke The spherical receiver is provided with a tap, which tap, as well as the connection between receiver and pump, is made air-tight by being covered with water held in the funnel-shaped bucket provided for the purpose This is reminiscent of the mercury seals in use to-day

It must be remembered that *this* pump was not constructed until after Boyle had published his account of the pump which we are about to describe, and that it embodied many features of Boyle's pump

Robert Boyle and His Contemporaries.—Robert Boyle, the first of the great English school of vacuum enthusiasts, learnt of Guericke's early experiments from "a book that I had heard of, but not perus'd, publish'd by the industrious Jesuit Schottus," and set about constructing an air pump, in which task he had the help of Robert Hooke The pump, which represented a great advance on Guericke's earlier efforts, is described in *New Experiments Physico-Mechanicall*, 1660 The piston was operated by a rack, and the operation of pumping was carried out with the help of a tap, controlling the passage to the receiver, and a hand-operated valve consisting of a peg ground to fit into a hole bored in the top of the cylinder The tap being open, the peg in place and the piston at its highest point, the piston was then fully withdrawn, and the tap closed. The valve was then opened by the withdrawal of the plug, and the piston raised, expelling the air. The valve was then closed, the tap opened, and the process repeated The receiver was very large, and objects could be introduced through a lid at the top, cemented into place. With this pump Boyle carried out a variety of curious experiments, especially on the effect of the reduced pressure on animal life. About this time the members of the Accademia del Cimento were performing experiments with what may be termed the earliest mercury pump, namely the Torricellian vacuum, which is produced by filling a long tube, closed at one end, with mercury and inverting the tube with its open end in a mercury cistern, when the mercury falls to the barometric height, leaving a vacuous space—a single stroke pump. The closed end of the tube was enlarged, to enable objects to be placed in it. These experiments are described in the *Saggi di Naturali Esperienze*, published by the Academy in 1666. The fact that smoke falls in a vacuum was demonstrated with an apparatus of this kind.

Improvements in the piston pump were rapidly made. In 1669 Boyle published an account of his "second engine," in which he immersed the cylinder in water, and provided an automatic arrangement for opening and closing the tap. In this pump a plate was provided, to which the bell jar, used as a receiver, was cemented, an arrangement which is used till this day for certain experiments. About the same time Denis Papin worked with Huygens on the subject, and published in 1674 an account of a pump provided with a plate for the receiver, and with a water gauge for indicating the pressure. In 1682 Boyle described a pump which Papin, who had worked as his assistant, made with him. It constituted a great advance in that it had two cylinders, the pistons being connected together by a cord passing over a pulley, so that the pressure which the outside air exerted on the one helped to raise the other—a great saving of labour The pump also had automatic valves of leather Another celebrated pump, made by Senguerd, employed a two-way tap, a device usually attributed to him, but actually employed earlier by Papin

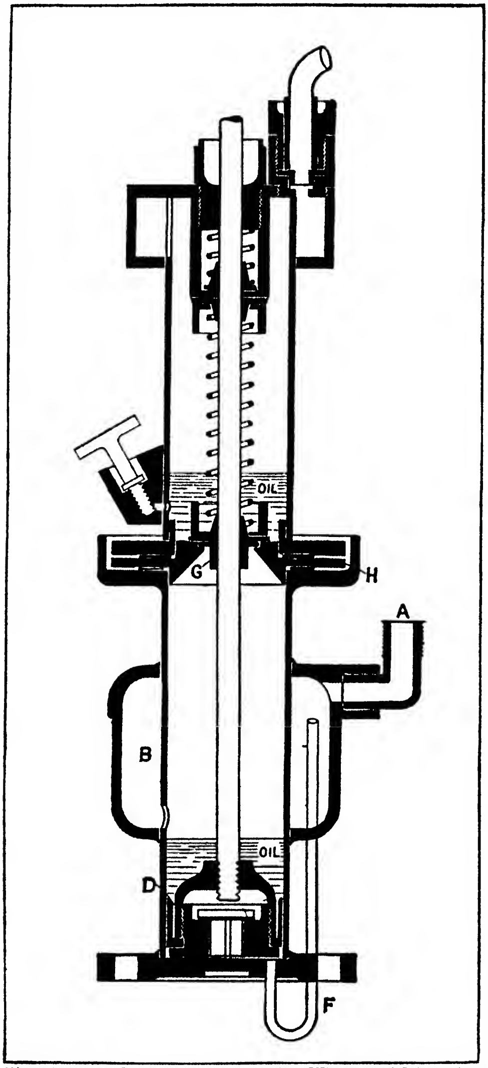
Hauksbee's Pump.—In 1709 Francis Hauksbee published in his *Physico-Mechanical Experiments* an account of an improved pump which long remained a pattern. It was a two-cylinder pump, the pistons being raised and lowered by a pinion wheel working between the racks attached to the pistons. The receiver was placed on a plate at the top of the pump, and provided with a mercury gauge disposed so as to be well protected from chance blows The original pump is preserved in the collection of the Royal Society and may be compared with the picture published by Hauksbee in 1709. This type of pump, with certain improvements in the valves, persisted in use until the end of the nineteenth century In some pumps made towards the end of the century special devices were introduced to diminish the disadvantageous action of the dead space still left when the piston has advanced to the end of the cylinder. In the older pumps this space fills with air at atmospheric pressure, the devices in question arrange that it shall fill with air at low pressure only.

Oil Pumps.—A great advance in cylinder pumps took place about the beginning of the present century, when the so-called oil pumps were placed on the market, although an oil pump was actually made by Robert Gill as early as 1874. The fundamental point about these pumps, of which the "Geryk" pump, invented by Fleuss, will serve as an example, is that at every stroke all air is displaced from the dead space by oil. The piston-rod passes through a spring-controlled valve G seated in a partition halfway up the cylinder, both this valve and the piston D itself are covered by a layer of oil When the piston is raised it lifts towards the end of its stroke the valve G, and all the air and part of the oil on the piston pass through The valve cannot close until the piston has descended a short distance, which ensures the layer of oil on top of the piston being maintained These pumps were very widely employed in the electric lamp industry at one time, but have been superseded by more modern types. A special type of oil, of low vapour-pressure, has to be employed, and it is claimed that with carefully constructed two-cylinder pumps of this pattern vacua with pressures as low as 0002 mm of mercury have been attained

Mercury Pumps.—In the second half of the nineteenth century various types of mercury pump were introduced, which were used in all the early experiments on the discharge of electricity through gases at low pressure. The principle of all these pumps is to connect the receiver with a Torricellian vacuum created by the pump; the equalisation of pressure will then bring part of the air in the receiver into the Torricellian space The receiver which is being exhausted is then cut off from the vacuous space, and the vacuum recreated. This process can be carried out in various ways The simplest and earliest form of apparatus is that described by Geissler in 1862. This consists simply of a vessel connected by a flexible tube to an open reservoir of mercury; the vessel can by means of a two-way tap be placed in connection either with the outside air or with the space to be exhausted. The tap being turned so as to give passage to the air, the reservoir is raised until the vessel is full of mercury; the tap is then turned so that the vessel is cut off from the air and connected to the space to be exhausted, and the reservoir is lowered, so as to tend to create a Torricellian vacuum in the vessel, into which the air from the space to be exhausted rushes. This process can be repeated as often as desired, the fraction of air removed each time depending upon the relative volumes of space to be exhausted and the vessel.

A type of pump possessing many advantages over the Geis-

sler pump was devised by Töpler; it avoids all taps, the connections and disconnections being made by the mercury itself. An improved form of Topler pump is shown in fig 2, from which the working of the pump can easily be understood. V is a cylindrical



FROM MÜLLER-POUILLET, "LEHRBUCH DER PHYSIK UND METEOROLOGIE" (VIEWEG & SOHN)

FIG. 1.—SECTION OF CYLINDER OF GERYK PUMP DESIGNED BY FLEUSS
A. B, Passage to vessel to be exhausted: D, piston: G, valve seated in partition, H: F, tube joining space B to bottom of cylinder, to prevent piston sticking

vessel connected by the tube T to the space to be exhausted. M is a mercury reservoir which must be of somewhat greater capacity than V. When the mercury levels are as in fig. 2, V contains gas at the same pressure as S. The reservoir M is then raised: the mercury rises in the tube Z, cutting off V from S, and fills the vessel V, driving the gas from it down the tube T. The gas being thus expelled, M is lowered again, and the vacuous space V is once more in connection with S. The process is repeated as often as may be required. A valve at C, consisting of a glass float, the top of which is ground to fit on a seating at O, serves to prevent the mercury ever passing over into the vessel S, while the inclined position of the cylindrical vessel V has, among other advantages, that of lessening the shock of the rising mercury against the top of the vessel. Pumps of Topler type were widely used for produc-

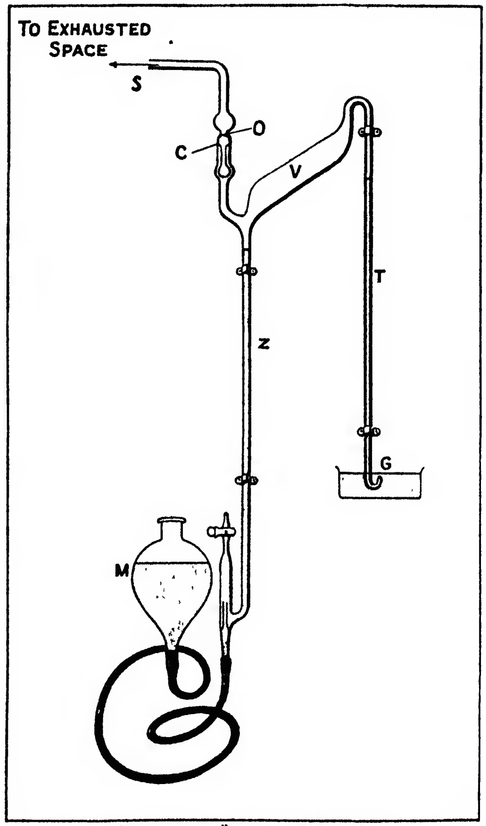


FIG 2.—THE TÖPLER MERCURY PUMP
When the reservoir M is lifted the mercury rises into the vessel V. and expels the gas down tube T. C is a float valve, seating at O, which cuts off the exhausted space

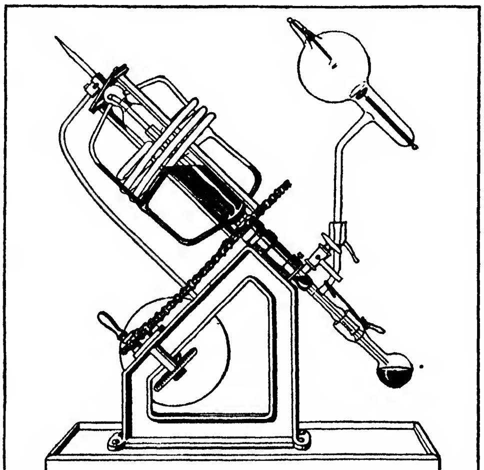
ing a vacuum in the researches of the first ten years or so of the present century, but with the coming of the Gaede rotary pump (*see* the part of this article devoted to MODERN METHODS AND TECHNIQUE) they became less and less popular. Pumping out with them was a tedious business. To-day they are only used when it is desired to collect the gases which are being pumped out; a purpose for which they are excellently adapted.

To avoid the tedious raising and lowering of the reservoir, a process which may have to be carried out for an hour or two to obtain the desired vacuum, automatic mercury pumps were devised. The earliest was that of Sprengel, which consists essentially of a narrow tube down which mercury flows from a reservoir: the top of the tube is connected to the space S to be exhausted. If the tube is of barometric height the pressure at the top will be zero, air will pass into it from S, and will be carried down as bubbles by the mercury, and discharged into a collecting vessel or into the air, as desired. This type of pump was much improved by Gimingham in 1877, and in this form used by Crookes

in his extensive investigations on electrical discharges in vacuum tubes. These pumps were not strictly automatic, in that the reservoir gradually emptied, and had to be refilled by hand. Devices were introduced by which the reservoir could be kept automatically refilled: a typical pump of this kind was that of Kahlbaum (1894), in which the flow of quicksilver was maintained by the help of a water-operated filter pump of ordinary type. The Sprengel type of pump, which came into very extensive use, like the widely known Topler type, was the subject of many modifications.

The passage from the old to the new vacuum technique may perhaps be said to be marked by Kaufmann's invention of a rotary mercury pump in 1905. In this pump, which needed a rough preliminary pump (or "fore pump," as it is called) to bring the pressure down to 2 cm. of mercury or so, the gas was trapped and driven out by mercury moving in two spiral glass tubes, rotating about an inclined axis (fig 3). This pump enjoyed a very short popularity, as it was speedily replaced by the Gaede rotary mercury pump, described under the heading MODERN METHODS AND TECHNIQUE.

Measurement of Low Pressures.—The first successful special device for measuring pressure too low to be correctly estimated by the ordinary U-tube manometer was the gauge invented by McLeod in 1874, and known by his name It consists in principle of a bulb B, some 250 cc. in capacity, provided with a fine calibrated vertical tube C (fig 4). The mercury surface can be adjusted to any desired height by the usual device of a mercury reservoir connected to the apparatus by a flexible tube The bulb B is connected to the space where the pressure to be measured prevails. The mercury surface is raised, cutting off a known volume of the gas, at very low pressure, in B, and then forcing it into the fine tube C. The pressure which the amount of gas present exerts in this confined space is then observed. To avoid error due to capillarity in measuring the pressure a side-tube D is



FROM MULLER POUILLET, "LEHRBUCH DER PHYSIK UND METEOROLOGIE" (VIEWEG & SOHN)

FIG 3.—KAUFMANN'S VACUUM PUMP, THE FIRST SUCCESSFUL ROTARY MERCURY PUMP

provided of exactly the same bore as C, and the difference of level in C and D measured Assuming Boyle's law, and knowing the volume of the bulb B and of the graduated tube C, it is easy to calculate the original pressure in B, which is the pressure required.

This gauge is still a standard instrument and receives further reference under the heading of MODERN METHODS AND TECHNIQUE, where the more recent methods for measuring minute pressures are discussed.

MODERN METHODS AND TECHNIQUE

It may be well to preface the description of modern work at low pressures with a note on the units used to express these pressures A pressure of 1 dyne per square centimetre is generally known as a microbar, a pressure of 1 million dynes per sq. cm being a bar This nomenclature, which has been widely adopted and is used by the meteorologists, who express their pressures in millibars, is used in the present article, but unfortunately some writers on high vacua (notably Dushman) use the term bar to denote a pressure of 1 dyne per sq cm and call a pressure of 1 million dynes per sq cm a megabar Some French writers call a pressure of 1 dyne per sq.cm. a barye The reader must, therefore, be on his guard

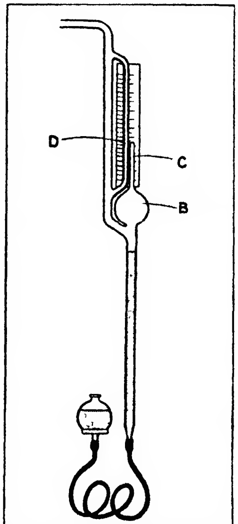


FIG 4—THE MCLEOD GAUGE FOR MEASURING LOW PRESSURES

The pressure conventionally taken as that of one atmosphere is 760 mm. of mercury at 0° C. latitude 45°, and sea level. Our bar, 10^6 dynes per sq cm, is almost exactly 750 mm of mercury at standard conditions For considerations of high vacua, it is often sufficiently accurate to take 1 bar as equivalent to 1 atmosphere, which is a great advantage of the unit

General Considerations at Very Low Pressures.—As a preliminary to the discussion of many features of modern high-vacuum technique, it is necessary to appreciate that the physical behaviour of gases at very low pressures is in certain respects quite different from that of gases at pressures above, say, a thousandth of an atmosphere The molecules of a gas at a given pressure travel, on the average, a certain distance between impacts with one another, this distance being known as the mean free path (*see* KINETIC THEORY OF MATTER) and the physical criterion which decides whether a gas behaves in what may be termed the normal way or in the low-pressure way is given by the length of the mean free path as compared with the linear dimensions of the vessels in which the gas is contained Taking oxygen as an example, the mean free path of the molecule at atmospheric pressure is about ·00001 cm, which is exceedingly small compared to even the finest capillary tubes used in gas manipulations The mean free path being inversely proportional to the pressure, it is ·01 cm at a pressure of ·76 mm of mercury, 1 cm at 0076 mm of mercury; and at a pressure of ·000076 mm. of mercury, which is easily attained with modern technique, the mean free path is a metre, which is large compared to the vessels generally used, especially compared to the diameter of connecting tubes. The thermal conductivity and the viscosity of gases, for example, which are independent of the pressure so long as the mean free path is much smaller than the dimensions of the vessel, vary markedly with the pressure at very low pressures, a fact which is utilized in the construction of certain low-pressure gauges described later. In general, the laws which gases obey when moving relative to the enclosing surfaces change completely at the very low pressures under consideration. the physical reason being that whereas at higher pressures the impacts of a gas molecule with the solid walls of the vessel are very infrequent compared to its impacts with other gas molecules, with high vacua a molecule makes very many more impacts with the walls than with other gas molecules. These considerations are of prime importance in connection with the so-called molecular pumps, and also lead to results on the passage of low-pressure gases through tubes which are essential in high vacuum technique.

At low pressures the difference of pressure between the two ends of a connecting tube is necessarily small, and for rapid pumping it is desirable that the gas shall pass easily through the tube under this minute difference. Knudsen, who has carried out classical investigations on the behaviour of gases at very low pressures, has dealt with this problem, and established the laws which govern the passage. The application of the formulae derived by him for the case when the pressure is sufficiently low for the mean free path to be large compared to the radius of the tube shows at once the necessity of using very wide connecting tubes in exhausting vessels at low pressures, a fact of prime importance in the design of pumps and pumping systems. To take an example, suppose that the gas in question is air at 15° C, and that the vessel to be exhausted has a volume of 2 litres. Let the connecting tube be 50 cm. long, and 5 mm. in diameter, which might be imagined, at first sight, to give ample freedom for the gas to pass. Let the pressure in the vessel at a given instant be 10 microbars and suppose the pump to maintain a pressure of ·1 microbar at the other end of the tube. The time required for the pressure in the vessel to fall to 2 microbar, twice that produced by the pump, is found from the formula to be over 5 minutes. Accordingly, whenever very low pressures are to be produced short wide tubes must be used for joining the pump to the system to be evacuated, and any taps which may form part of the connecting system must also be of large bore, for even with a tube only a centimetre or two long the time required for the fall of pressure specified in the example just taken will be a few minutes if the diameter is only 2 mm. Special large glass taps of very wide aperture are used in modern work.

One of the great troubles in producing very high vacua is to get rid of the vapours of any volatile liquids or soft solids which may be present, even in small quantities. The chief sources of such vapours are the mercury used in mercury pumps and the greases which must be used on taps to make them airtight. The vapour pressure of mercury is low, being a few ten-thousandths of a mm. of mercury at room temperatures, but such pressures cannot be tolerated in high vacuum work. To prevent the vapour arriving from the pump or from mercury surfaces of any kind which happen to be embodied in the apparatus, it is usual to insert "traps" between the mercury surfaces and the actual vessel in which the vacuum is required. Such traps may consist either of tubes which can be cooled by immersion in a cold liquid or of tubes coated on the inside with a metal having no great affinity for mercury, such as sodium or potassium. In the case of a condensation trap the temperature is best maintained well below 0° C, say at −78° C by solid carbon dioxide mixed with ether or alcohol, or, better still, at −180° C or so, by liquid air, since at very low pressures condensation is difficult to initiate.

As regards tap grease, there are special compositions, such as "Ramsay fat" (4 parts of pure unvulcanised rubber, 2 parts of vaseline, and 1 part of white paraffin) which have a very low vapour pressure, and should be used if some form of grease is inevitable. For some work the greased tap is replaced by a mercury seal, in which, by the lifting of a reservoir, a mercury level is raised so as to cut off communication between two tubes. A number of special cements and waxes are in use for joining together metal and glass parts of vacuum systems, such cements requiring low melting point combined with low vapour pressure. Sealing wax, which must be of best quality, has long been widely used for this purpose: a black cement called picein, similar in composition and appearance to Chatterton compound, is much used in Germany, while many American workers favour Khotinski cements, made of gum lac with a small percentage of a coal tar distillate. Whenever possible, the use of cements is avoided in high vacuum works. Glass parts are fused together, and metal parts soldered together, while recently a technique has been worked out, and is widely employed, which permits glass-to-metal joints to be made by fusion.

Both glass and metals contain large quantities of occluded gases and gases held at the surface by forces whose precise nature is undetermined, water vapour being particularly persistent in the case of glass. When a vessel is evacuated to low pressures, say to a ten-thousandth of a millimetre of mercury, the surface gases are liberated, slowly if the vessel is at atmospheric temperature, much more rapidly if it be strongly heated. Dunoyer quotes a case of a vessel of 9 litres capacity, which was evacuated down to a pressure of 1 microbar and sealed off. In 10 hours the pressure had risen to be nearly a hundred times as great, namely 95 microbars. If therefore a vessel be evacuated and sealed off without any special precautions, the vacuum will rapidly deteriorate. To get rid of the surface gases as far as possible tubes which are to be sealed once for all, such as X-ray tubes, are subjected to a prolonged baking in special ovens while being evacuated, the temperature being taken as high as is consistent with the safety of the glass. Metals heated in vacuo also give out gases, mainly water vapour and hydrogen. The behaviour of these occluded gases has been extensively studied in connection with the manufacture of electric lamps and thermionic valves, for example by Langmuir and his colleagues in the laboratories of the General Electric in America, and by Norman Campbell and his colleagues in the laboratories of the General Electric Company, Limited, in England.

Pumps.—The points which have just been reviewed demand consideration no matter what type of pump be used to produce the vacuum. Of recent years a large number of pumps of different types have been evolved for the rapid production of low vacua, which will now be described.

Modern pumps may be divided into two classes: those which rapidly produce a fairly high vacuum, but not a vacuum of the highest degree, say down to a hundredth of a millimetre of mercury, and those which produce a vacuum of the order of a millionth of a millimetre of mercury. Pumps of the former class are widely used to produce the preliminary vacuum required before the pumps of the second class can come into operation: they are therefore often called "preliminary" pumps, or "fore-pumps" (German *Vorpumpe*). The latter are called high-vacuum pumps.

Since rapidity of evacuation is one of the demands made on the modern pump it is necessary to arrive at some arbitrary definition of the speed of a pump which may be used to specify its performance. One suitable way of defining the speed is to say that it is the volume of gas removed per second, the volume being measured at the pressure prevailing in the vessel undergoing evacuation; it is tacitly assumed that the tubes connecting the pumping system to the vessel are so wide that they do not appreciably affect the performances. Another way is to define the speed as the ratio of the decrease of pressure per second per unit volume to the pressure prevailing in the vessel. Since Boyle's law may be taken to hold approximately over the range in question in these high vacuum measurements these two definitions come to the same thing.

If v be the volume measured at any instant at the pressure p prevailing in the vessel and V be the volume of the vessel, then, by definition,

$$\text{speed} = S = \frac{dv}{dt} = -\frac{V}{p}\frac{dp}{dt}.$$

If it be desired to express the speed in terms of the change of pressure produced in a given time the equation is integrated, giving:

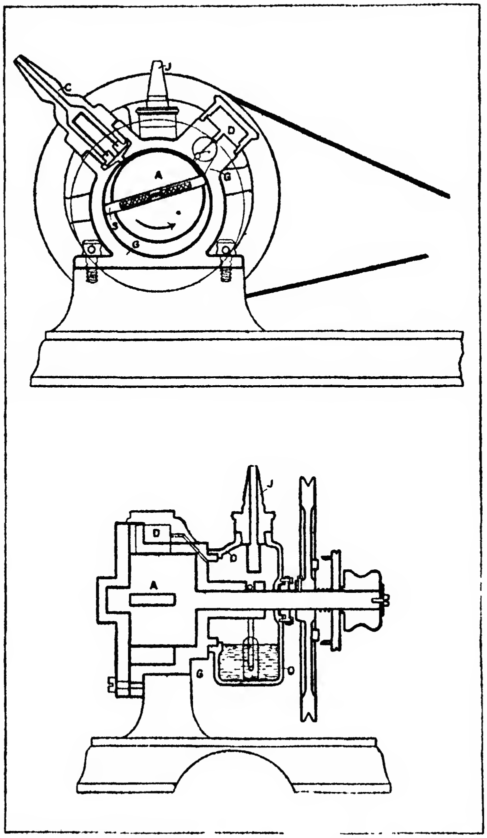
$$S = \frac{V}{t-t_0}\log\frac{p_0}{p}$$

where p_0 is the initial pressure at time t_0, p the pressure at a subsequent time t.

Even as so defined the speed of a pump differs at different pressures. It is expressed in cubic centimetres per second, the pressure at which it is measured being also specified. Thus, it is said that the speed of a certain Holweck pump is 2,500 cc. per second at ·001 mm. of mercury.

Preliminary Pumps.—While any type of piston pump, such as the Geryk, can be used to produce the fore-vacuum of a few millimetres of mercury with which most high-vacuum pumps will work (for some high-vacuum pumps the degree of vacuum produced by an ordinary water jet pump, the so-called filter pump,

suffices) the pumps in use as preliminary pumps at the present day are generally of the pattern in which the air is swept out by the help of vanes making an airtight contact between the outer casing and a revolving cylinder. As an example of such a pump we may take Gaede's rotary box pump (*Kapselpumpe*), which was the first to establish itself in the modern laboratory, although the design was closely adumbrated in the seventeenth century by Prince Rupert's "waterbolt" (*See* E. N. da C. Andrade, Journal of Scientific Instruments, vol. v., p. 78, 1928.) Gaede's box-pump is illustrated in vertical section in fig. 5, both a section along the shaft and one at right angles to the shaft being shown. A cylinder A, mounted eccentrically in the cylindrical boring of the casing G, carries two hardened steel plates (S) with rounded ends which



BY COURTESY OF G. LEYBOLD, KÖLN

FIG. 5.—A ROTARY BOX PUMP (GAEDE), USED TO PRODUCE A PRELIMINARY VACUUM, WHICH IS PERFECTED BY A PUMP OF THE HIGH VACUUM TYPE

are kept in close contact with the walls by centrifugal action when the shaft revolves. Air is taken in at C and forced through the valve D into the chamber O, which also serves as an oil chamber, lubricating the shaft by means of a loose ring. The chamber O is in free communication with the outside air by the tube J, through which the air is expelled. If C, instead of being connected to a vessel, is left free the pump acts as a very efficient blower, taking in air at C and delivering a jet at J. Many modifications of this pattern have been produced: the Trimount pump, for instance, has eight vanes of laminar construction, with a special device for maintaining them in contact with the walls. The pump made by the Central Scientific Company of America, called by them the Cenco Hyvac, has a single vane moving in a radial slot in the body of the pump, kept in contact with a rotating eccentric cylinder which has no vanes, the intake and outlet being close to the vane on either side. It is remarkably efficient.

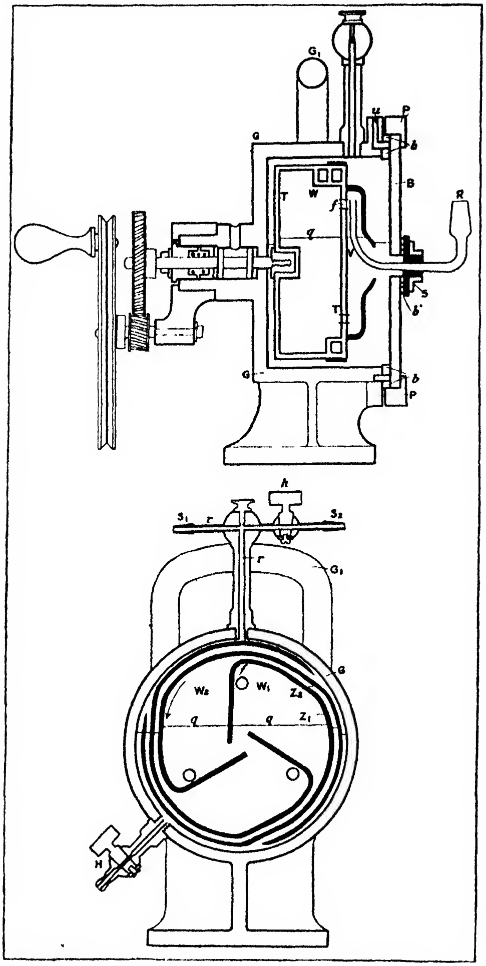
A good box-pump is very rapid. The pressure in a vessel of 10 litres can be reduced from atmospheric to less than 1 mm. of mercury in two minutes or so, and a final pressure of ·01 mm. of mercury can be attained with certainty. With some of the most recent rotary box pumps, which work immersed in oil, pressures as low as ·002 or even ·001 mm. of mercury have been attained, which is an astonishing performance. For rapid working two pumps are often connected in series, mounted on a common base and immersed in the same oil bath. Such an arrangement is widely used in lamp factories.

High Vacuum Pumps.—A revolution in high vacuum technique was brought about in 1905 when Gaede introduced his rotary mercury pump. In principle the pump, which is illustrated in fig. 6, is something like a gas meter run backwards. It consists of a porcelain drum W, rotating on an axis A, mounted in an iron vessel GG, the front of which is closed by a glass plate B, as shown in the upper figure. The drum is divided into two parts by a vertical wall T, the portion on the right of this wall enclosing a space V which communicates through the tube R with the vessel to be evacuated. The portion to the left of the wall is divided into three compartments by walls of the shape shown in the lower figure. The pump is filled with mercury up to the level *qq*. When the drum rotates in the direction of the arrow the compartment W_1, which communicates with V by the hole *f*, is filled with gas from the receiver while the gas in the compartment W_2, drawn from the receiver just before, is displaced by the mercury and ultimately passes into the space between the revolving drum and the casing. The action is continuous. It is, however, clearly necessary that the pressure prevailing in the space between drum and casing shall not exceed a few millimetres or so of mercury; the pump must therefore be run in connection with a fore-pump of the type described, which first reduces the pressure to a figure at which the rotary mercury pump can be put into operation, and subsequently removes, as long as necessary, the gases displaced by the mercury pump. The fore-pump is connected to the tube S_2, the other branch S_1 being connected to a rough mercury gauge.

With mercury pumps of this type a pressure as low as 10^{-5} mm. of mercury, as measured with the McLeod gauge, can be attained. There is, however, always the pressure of the mercury vapour itself, about ·001 mm. of mercury at ordinary room temperature, unless special precautions are taken to trap the vapour between pump and receiver. Further, the pump cannot deal with condensible vapours, such as water vapour, for the decrease of volume of the chamber during the expulsion of the gas leads to condensation of the saturated vapour in the drum. The pump needs a large mass of mercury. It has, however, the great advantage that it can be stopped without deterioration of the vacuum already attained, which cannot be done with other types of pump to be described. The speed is about 100 cc. per sec. over a wide range, but begins to fall off rapidly after a pressure of 10 microbars or so has been reached, being one quarter this value at ·1 microbar. This pump is still widely used in the laboratory.

In 1912 Gaede invented a pump working on an entirely different principle, the so-called molecular pump. This takes advantage of certain properties of low pressure gases demonstrated by Knudsen. If we consider a passage of rectangular cross-section, one wall of which (or two opposite walls) is moving in its own plane in the direction of the axis of the passage, then molecules striking the moving wall acquire a forward component of velocity equal to that of the wall. If the gas is at a pressure such that the mean free path is very small compared to the transverse dimension of the passage, this ordered velocity, imposed on top of the random velocities of the molecules, is, as we pass away from the surface, gradually dissipated into a chaotic velocity distribution by impact among the molecules. The motion is that considered in the ordinary treatment of viscous fluids, and a difference of pressure can

be maintained between the two ends of the passage which is proportional to the speed at which the wall is moving. As the pressure is diminished the viscosity remains independent of the pressure until this becomes so low that the mean free path is comparable with, or large compared to, the transverse dimensions



BY COURTESY OF G LEYBOLD, KOLN

FIG 6 —GAEDE'S ROTARY MERCURY PUMP

As the drum W rotates, the air is displaced from the chamber W_2 into the space between drums and casing G, and is drawn from the receiver into the chamber W, through opening f. The chamber W, moves into the position of chamber W_2, and the process is repeated

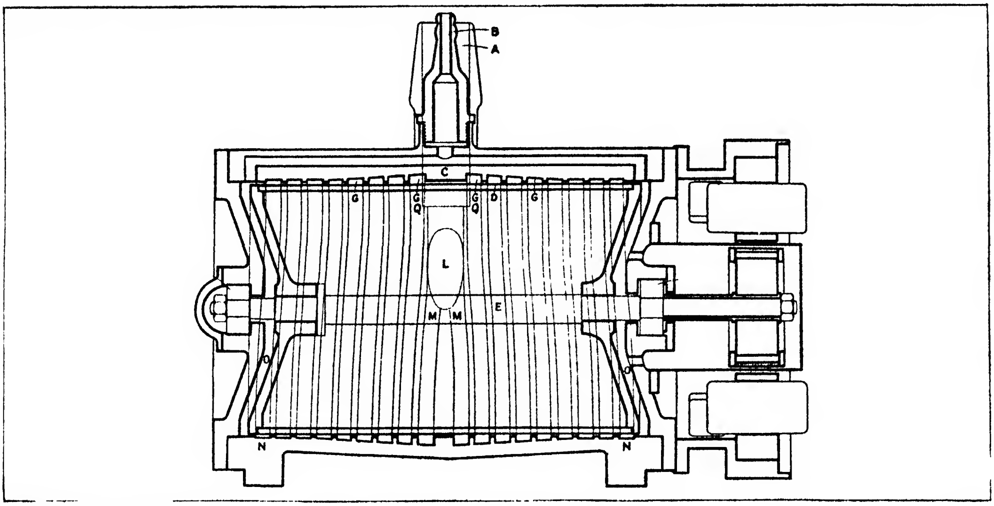
of the passage. (*See* KINETIC THEORY.) At very low pressures the experimental effects can be accounted for on the assumption that the molecules striking a stationary wall are thrown back in directions independent of the angle of incidence, the number of molecules streaming from the wall in a given direction obeying the same simple cosine law as governs the intensity of the light emitted from a glowing plate. As far as the direction of the "reflected" molecules is concerned, the gas behaves as if it were condensing on the wall and evaporating again. If the wall which the molecules strike is moving, the velocity of the wall must be added to that of the molecules (at any rate if the pressure is below ·001 mm. of mercury; at higher pressures the effect at the wall is somewhat complicated by the formation of a skin of gas, which has the effect of producing an apparent slip at the walls. (*See* Gaede, *Annalen der Physik,* 41, 289, 1913.) There will be effectively a convection of the molecules by the moving surface. Theoretical considerations on lines worked out by Knudsen and Gaede shows that with the low pressures contemplated the *ratio* of the pressures at the two ends of the passage is fixed by the speed of the wall, instead of the *difference* of the pressures, as at higher pressures.

Suppose now a deep and narrow groove cut in the periphery of a rotating cylinder, which fits closely into a casing, bored with two close holes communicating with groove Between the two holes a tongue projects from the casing into the groove, with which it makes a close fit. If the cylinder rotates quickly, the gas in the groove is between close moving walls, and molecules will be carried away from the side of the tongue from which the walls are receding, and carried to the side of the tongue which they are approaching. A vacuum will tend to be produced on the former side, so that of the two borings mentioned one will be the low pressure side and the other the high pressure side of the pump The two sides are in permanent communication by the groove, but molecules can only pass from one to the other by traversing practically the whole circumferential distance against the direction of the moving walls. With practicable speeds of rotation the ratio of the pressures at the two ends of the groove turns out to be sufficiently large to permit a very efficient high vacuum pump to be constructed on the principle of adding the velocity of the walls to the molecular velocity at low pressure

Gaede's molecular pump consists of a rotating cylinder with several circumferential grooves of the type just considered, into each of which projects a tongue connected with the housing The openings on either side of the tongues are connected from groove to groove so that the high pressure side of the one is joined to the low pressure side of the next, or, in other words, the separate pumps which the grooves virtually constitute are connected in series The high pressure side of the outermost grooves go to the fore vacuum; the low pressure side of the central groove is the point of lowest pressure, and goes to the vessel to be evacuated Special devices prevent the lubricating oil from penetrating into the grooves. A modified form of molecular pump, due to Holweck, is illustrated in fig. 7 In this pump the grooves are cut in the casing, the rotating part being a simple cylinder. There are two grooves of spiral form, leading from the central opening to the outer ends of the pump, where they communicate with the space leading by the tube to the fore-vacuum The grooves are deeper at the middle, where the pressure is lowest, than at the ends. The speed of the pump is high, being as great as 7,000 to 8,000 cc. per second at a pressure of ·001 mm for one size in which it is made, and the pressure produced is less than 10^{-6} mm of mercury.

A great advantage of the molecular type of pump is that it deals with condensible vapours, in particular with water vapour, as readily as with gases: a disadvantage is the expense necessitated by the mechanical difficulties of construction. The cheapness and simplicity of operation of the mercury vapour pump now to be described has rendered the use of the molecular pump a restricted one.

The action of the mercury vapour pumps depends upon the diffusion of the gas into a stream of vapour, and the condensation of the vapour to prevent it passing into the receiver: according as more stress is laid upon the diffusion or the condensation these pumps have been called diffusion pumps or condensation pumps A better name might be vapour-stream pumps, which is here suggested. Imagine a tube through which a stream of easily condensible vapour passes, for definiteness say mercury vapour, and let a side tube from a vessel containing gas lead into this tube at right angles. A certain amount of gas will diffuse into the mercury vapour stream, and a certain amount of mercury vapour will diffuse into the side tubes. If, however, the pressure of the gases is comparatively high, and the mean free path small compared to



BY COURTESY OF "REVUE OPTIQUE" PARIS

FIG 7 —A MOLECULAR PUMP, DESIGNED BY HOLWECK

L is the opening of the intake tube, connected to A, B is the output tube, connected to the fore pump. The gas is carried by the rotation of the drum D along the spiral channels G G, beginning at M M and ending at N N, cut in the casing C, and delivered into the space O O

the size of the opening into the vapour tube, impacts will be very frequent, and the diffusion very small If the mean free path is large, the interchange of molecules takes place freely, and gas and vapour each behave as if the other was not there the flow depends upon the partial pressure of each molecular species. The speed at which the gas molecules diffuse into the vapour stream can be calculated from the kinetic theory of gases, and it can be shown that it attains a maximum when the mean free path of the mercury vapour is about the diameter of the opening through which the diffusion takes place Gaede's original pump was based upon such considerations Communication between gas and vapour stream took place through a slit of carefully calculated size The most favourable mean free path of the mercury vapour was obtained by adjusting the temperature The mercury vapour passing into the gas space through the slit was removed by condensation

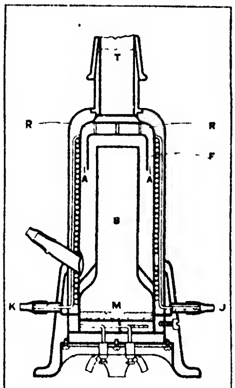


FIG 8 —LANGMUIR'S MERCURY VAPOUR PUMP

B the tube through which the vapour rises; F. the hood, hung on thin rods R R; A A. the annular space through which the gas diffuses into the vapour stream. The condensed mercury returns to M through small holes at the base of the tube (B). K and J are for the water supply to the cooling jacket. The heating is electrical

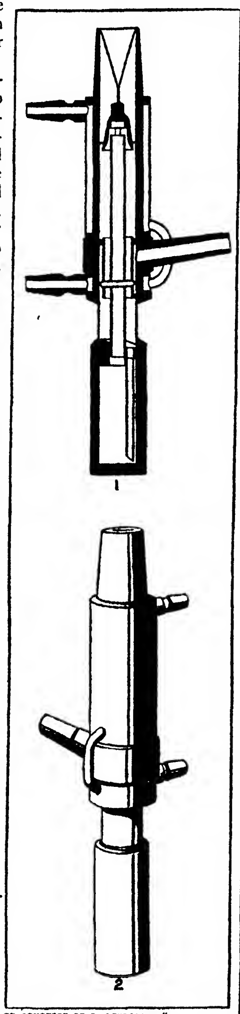
Shortly after Gaede's first account of his pump Langmuir devised a form of vapour-stream pump in which he insisted particularly upon the condensation, holding that his pump was essentially different in principle from Gaede's. In the form illustrated in fig. 8, a stream of vapour from heated mercury M passes vertically upwards through a tube B and is directed against a hood F, hung on thin rods R. The mercury vapour then rushes downwards and strikes the water-cooled walls of the cylindrical space, where it condenses. There is thus only a very small movement, by diffusion against the prevailing velocity of stream, of the mercury vapour upwards into the circular space A, through which the gas, entering by the wide tube T, diffuses into the mercury stream This method of condensation has obvious advantages, and has been widely adopted, but the pump is none the less a diffusion pump. A similar construction was afterwards adopted by Gaede, whose present one-stage diffusion pump is shown in fig 9 The mode of operation is clear from what has just been said.

Two stage and three stage mercury vapour pumps, in which the stages are arranged in series, so that the high pressure side of one is the low pressure side of another, are made for rapid work While, owing to the fact that at very low pressure it loses its jet form, the stream of mercury vapour in a diffusion pump exerts no such action as the steam jet does in an ordinary injector, at higher pressures the Bernoulli effect comes into operation and is, in fact, utilised in the preliminary stage or stages of a multiple stage pump, where, owing to the higher pressure the diffusion principle is less effective An interesting two-stage pump devised by Dunoyer, which works with a fore-vacuum pressure no lower than 25 mm of mercury or so, is illustrated in fig 10 The first stage operates on the principle of the steam injector, the rush of mercury vapour through the jet A taking the place of the rush of steam in the injector, and creating a low pressure in B Mercury vapour also passes through the holes T into the annular space C, and creates a high vacuum in D by diffusion and condensation in the same way as it does in the Langmuir pump

The mercury vapour pumps, on account of their simplicity and rapidity, and of the high vacua which they produce, have obtained a foremost place among the weapons of the worker with high vacua, and are to be found not only in nearly all physical laboratories, but also in the workshops of the makers of X-ray tubes, thermionic valves, and the like. They have the great advantage that the speed of pumping is constant down to the lowest pressures, and theoretically there is no limit to the degree of vacuum which can be produced, as there is with the molecular pump, where a given pressure ratio is established between high and low pressure side. Dozens of different modifications exist in one form there is no external heating, the vaporization of the mercury being produced by striking a mercury arc within the pump itself Some forms, like that of Dunoyer, work with relatively quite a high pressure as fore-vacuum, but it is usual to employ some form of rotary box pump as fore-pump. Pressures as low as a few millionths of a mm. of mercury have been produced with these pumps. The speed of a single-stage pump, with a fore-vacuum of 1 mm can

be as high as an evacuation of 10,000 cc. per second.

To prevent mercury vapour from the pump reaching the exhausted system, some form of trap is inserted between the two This may be a vessel of special form, offering a large surface to the vapour, cooled by liquid air, or vessels coated inside with an alkali metal, say sodium, may be used The alkali metals exert an extraordinary absorption for mercury vapour



BY COURTESY OF G. LEYBOLD, KÖLN

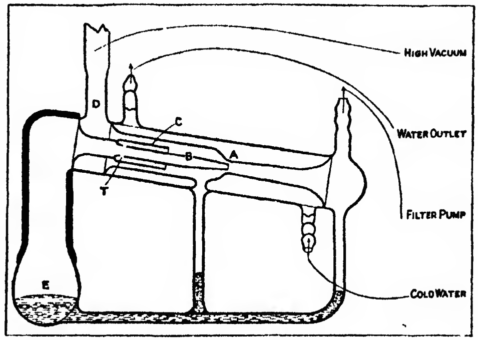
FIG 9.—A SINGLE-STAGE HIGH VACUUM MERCURY DIFFUSION PUMP, DESIGNED BY GAEDE

Vacuum Production by Absorbers and Discharge.—To remove residual gases and vapours from a space already exhausted by a pump and sealed off, use has been made of the strong absorption which purified charcoal exercises on gases when it is cooled. Sir James Dewar was the first to call attention to this technique The charcoal is prepared from cocoanut shell (originally from the fleshy part of the nut) by prolonged heating in vacuo A tube containing the charcoal is sealed onto the apparatus, and, after preliminary exhaustion has taken place, a vessel of liquid air is placed round the charcoal tube Very low pressures can be produced in this way, and before the invention of the molecular pump and of the mercury vapour pump the method was extensively used in the laboratory, and still finds employment in certain types of experiment A great deal of work was done on the absorbing power of charcoal for gases in connection with gas masks during the war.

For particular gases and vapours other absorbers are sometimes used Palladium black at low temperatures is particularly effective for hydrogen. The use of alkali metals for absorbing mercury vapour has received mention above. The liquid alloy of sodium and potassium is used for removing traces of oxygen, and other instances of substances used to take up residual gases by chemical action will be found in the standard treatises on high vacua.

For removing the residual gases from electric lamps, thermionic valves, and the like, an operation to which the term "clean up" is technically applied, processes of a chemical nature are widely employed. A minute amount of some substance known as a "getter," which combines vigorously with the gases, is introduced into the lamp, and the filament is then heated, when the clean up takes place. The process is described in the article ELECTRIC LAMPS AND VALVES, MANUFACTURE OF. The electric discharge in an evacuated lamp or similar vessel also leads to the disappearance of residual gases. The effect is a complicated one, which has been studied in detail by Norman Campbell and his co-workers in the laboratories of the General Electric Company, Limited.

Measurement of Low Pressures.—Pressures down to a millimetre of mercury or so can be measured by an ordinary mercury manometer, consisting of a U-tube of which one limb, closed at the upper end, is originally quite full of mercury When the other is connected to the vessel in which the pressure is to be measured the difference of level in the two limbs, which may be read with a cathetometer, indicates the excess pressure in the vessel above the vacuum in the closed limb Such manometers are commonly used for rough readings Lord Rayleigh (3rd Baron) devised a more sensitive mercury manometer, in which the two mercury levels are in contact with fine vertical pointers: the difference of pressure is measured by the angle through which it is necessary to tilt the manometer in order to restore the level when it is disturbed by the presence of gases on one side This gauge has been used to measure pressures from 1·5 mm to ·001 mm of mercury Shrader and Ryder have described another way of measuring very small movements of the mercury surface in a U-tube manometer A little float on the surface supports one end of a lever carrying a small mirror, and the tilt of the mirror is measured by a lamp and scale



FROM DUNOYER, VACUUM PRACTICE (BELL)

FIG 10.—A TWO-STAGE MERCURY VAPOUR PUMP, DESIGNED BY DUNOYER

The McLeod gauge, described in the first part of this article is still a standard instrument for the accurate measurement of pressures down to ·001 mm of mercury—or even lower, down to a hundredth of this value, with certain gases and suitable precautions The accuracy of the gauge depends upon the closeness with which the gas in question obeys Boyle's Law, which is assumed in the deduction of the pressure It is clear that the gauge cannot be used with condensable vapours, such as those of water or ammonia, which tend to liquefy on the walls; even with carbon dioxide the readings are not reliable. With such gases as hydrogen and nitrogen, on the other hand, the gauge works down to the limit of pressure just mentioned

A McLeod gauge cannot be used with gases, such as chlorine, which are chemically very active and attack mercury, so various types of membrane manometer have been devised. Very thin spiral glass tubes, working on the principle of the Bourdon gauge used for steam pressures, have been used for such gases, the movement being measured with mirror and scale: such gauges are not sensitive to pressures less than ·1 mm. of mercury or so. Scheele and Heuse have used the mechanical deformation of a very thin metal membrane to measure small pressures One side of the membrane is exposed to the gas or vapour, while on the other side the vessel is evacuated as thoroughly as possible by a high-vacuum pump. The very small movements produced are measured by an interference method, and results have been obtained down to ·0001 mm of mercury, but the instrument is troublesome to work with.

The exceedingly low pressures produced by modern technique have led to the construction of a whole class of new manometers, depending for their action on the anomalous behaviour of gases which begins to manifest itself as soon as the mean free path is

comparable with the linear dimensions of the vessel. The conductivity and the viscosity are properties which are independent of the pressure so long as the mean free path is small, but change rapidly with the pressure when the pressure is very small, becoming proportional to the pressure below a certain limit of pressure, depending upon the nature of the gas and the dimensions of the vessel. Again, at low pressures, the radiometer effect manifests itself; that is, there is a mechanical repulsion between a warm surface and a colder surface opposite it when gases at low pressure lie between them. (*See* RADIOMETER.) Further, with an apparatus of the type used by Foote, Meggers, and Mohler for measuring resonance potentials (*see* RESONANCE POTENTIAL), so long as, first, the pressure is low enough for the electrons to have a free path between the hot wire and the surrounding grid, and, secondly, the potential fall accelerating the electrons is well above the ionization voltage, the ionization produced between the grid and the surrounding cylinder is proportional to the pressure. All these effects have been utilised in the construction of special low pressure gauges.

Two types of viscosity gauges may be mentioned In one, devised by Langmuir and Dushman, a very light horizontal disc of mica hangs suspended by a quartz fibre directly above a second horizontal disc. This second disc is carried on a vertical shaft which can be set in rapid rotation by a rotating magnetic field established outside the glass vessel. The drag of the rotating disc on the suspended disc, which is proportional to the speed of rotation and to the pressure of the gas between the discs, is measured with the help of a mirror attached to the suspended disc. The effective viscosity depends not only upon the pressure but also upon the nature of the gas, so that the gauge requires special calibration On account of secondary effects it is not reliable below a certain low pressure, of the order of 5×10^{-4} microbars of mercury, and on account of the lack of proportionality of drag to pressure it cannot be used at pressures above ·02 mm. of mercury It has not found very wide employment

A much simpler form of viscosity gauge, due to Langmuir, consists merely of a vertical quartz fibre, rigidly fastened at the upper end to the top of the vessel. When the vessel is tapped the fibre is set into vibration, the amplitude of which decreases at a rate determined by the pressure of the residual gas in the vessel. The gauge can be used down to pressures of ·05 microbar.

The conductivity gauges, sometimes known as Pirani gauges after the deviser of the first model, or Pirani-Hale gauges since C. F. Hale introduced improvements, depend for the measurement of the conductivity upon the fact that the electrical resistance of a wire varies markedly with the temperature. The gauge is very similar to an electric lamp, consisting of a filament of pure platinum wire, which has a large temperature coefficient of resistance, enclosed in a glass bulb connected to the vacuum. The wire is put in one arm of a Wheatstone bridge, the current flowing through it raising its temperature by 100° C or so. The exact temperature at which it stands, and so its resistance, will depend upon the conductivity of the gas, which, for a given gas, measures the pressure. The change of resistance consequent upon the introduction of the gas may be measured, or, better still, as pointed out by Norman Campbell, the voltage change required to keep the filament at constant temperature, since calibration can then be carried out at one temperature.

The reading of a viscosity gauge or of a conductivity gauge depends upon the nature of the gas remaining in the vessel, since the physical properties in question are functions of the atomic weight as well as of the pressure. The magnitude of the radiometer effect is, however, independent of the nature of the gas, and the gauge constructed by Knudsen upon the radiometer principle is therefore often known as Knudsen's absolute manometer. If of two parallel strips one be maintained at an absolute temperature T_1, the other at an absolute temperature T_2 which is that of the rest of the vessel, then the repulsion between the two plates due to radiometric forces is $\frac{1}{2}p\ (\sqrt{T_1/T_2}-1)$ where p is the pressure of the gas (*see* RADIOMETER). This repulsion can be measured with various experimental dispositions A moving plate, of mica, glass, or metal, may be carried at one end of a short arm suspended from a torsion wire, with a small counterbalancing weight at the other end of the arm, and either a small part of the wall of the vessel, parallel to the plate, heated externally by a current of air, or by water, or the whole of the vessel heated, and the plate protected by an inner tube from molecules coming from all parts of the wall but that opposite one side of the plate. In another form electrically heated metal strips, introduced inside the vessel, are used as warm plates. The gauges are sensitive to pressures as low as a few times 10^{-8} mm of mercury The trouble with all the radiometer gauges is that it is difficult to be sure of the temperature of the cold plate, and the gauges all have to be calibrated by the introduction of measured minute quantities of gas into the highest possible vacuum

While the conductivity gauge is practically an electric lamp of ordinary filament type the ionization gauge of Dushman and Found is practically a thermionic valve (*q.v.*). The principle of its use has been already described The glass walls and metal parts must be carefully freed from gas by prolonged heating and pumping before the gauge is used With suitable conditions the desired proportionality between ionization and pressure is found to hold The calibration constant depends, of course, on the gas. This type of gauge has been much used in the technical laboratories attached to the great lamp companies. It can probably be used to measure pressures down to 10^{-4} microbars

It is perhaps, of interest to contrast the pressures produced by the pumps and measured by the gauges described with the highest attainable laboratory pressures, produced and measured by Bridgman The lowest pressures are certainly as low as 10^{-10} atmospheres (a ten-thousand-millionth of an atmosphere) Bridgman's highest pressures are 15,000 atmospheres which far exceed anything produced in the chamber of a gun during firing The range of pressures accessible in the laboratory is therefore from 1 to 150 million million Even at the lowest attainable pressure, however, there are more than a thousand million molecules present in every cubic centimetre

BIBLIOGRAPHY.—*Historical* The original sources for the most important early pumps are quoted in the text. For the general history of early air pumps *see* E. Gerland, F Traumuller, *Geschichte der physikalischen Experimentierkunst*, 1899, and E Gerland, *Geschichte der Physik*, 1913 A translation into German of Guericke's *De Vacuo Spatio* has been issued as Number 59 of Ostwald's *Klassiker der exacten Wissenschaften* The pumps in use round about the beginning of the present century are described in Winkelmann's *Handbuch der Physik*, vol i, part 2, 1908

Modern Saul Dushman, *Production and Measurement of High Vacuum*, 1922 F H Newman, *Production and Measurement of Low Pressures*, 1925 L Dunoyer, *Vacuum Practice*, 1926 (a translation, with additions, of the author's *Technique du vide*); A. Goertz, *Physik und Technik des Hochvacuums*, 1926. (E. N. DA C. A)

VACUUM BRAKE, a form of brake utilizing the force exerted on a piston by the pressure of the atmosphere So long as a vacuum is maintained in the system the brake-blocks are kept off the wheels But when air is admitted, this presses against one side of the piston and applies the blocks (*See* BRAKE; *Railway Brakes and Motor Car Brakes*.)

VACUUM CLEANER. An appliance for extracting and removing dust from fabrics, such as carpets, upholstered seats, cushions, etc, by suction, designed for the primary purpose of carrying out this operation without the necessity of displacing the articles to be cleansed from the positions which they normally occupy when in use It is also used to remove dust from such surfaces as those of floors, shelves and walls, etc It was so named by its inventor, H C Booth, who made and patented the first successful appliance in the year 1901

A vacuum cleaner consists essentially of an air suction pump, or exhauster, connected by a pipe or tube or directly to a nozzle having a slot shaped orifice which is passed over the material being cleansed, the surrounding lip of the orifice being kept in close contact with the material An air filter which cleanses the air either before or after its entry into the exhauster serves at the same time as a chamber, or receptacle, for collecting the dust, which can be removed therefrom conveniently and without dispersal. In the light portable or domestic types, this filter is of cloth in the shape of a bag In operation, suction from the

air exhauster causes air to rush violently into the nozzle through the interstices of the fabric being cleansed and to carry away with it the imprisoned dust. The stream of dust-laden air passes from the nozzle to the filter, in which the dust is retained while the cleansed air is drawn on through the pump or filtered through the dust bag and delivered thence to the atmosphere.

In the first instance the vacuum cleaner was made in the form of a portable plant and consisted of a pump driven by a petrol or electric motor, mounted with the filter on a portable trolley, which was taken round periodically to houses, offices, etc, when cleaning was required A long flexible hose with the cleaning nozzle attached was led into the house from the plant which remained outside. Such cleaners for house to house work are now mounted in motor vans

Central Installations.—Shortly after the introduction of the portable type of machine, fixed installations of central plants were established in large buildings, such as hotels and theatres. These had a permanent system of pipes running from the plants to the various floors with branch pipes to different parts of the building At convenient positions in the pipe lines, valves, or nozzles with removable caps, were fitted, to which flexible hose with cleaning nozzles could be attached It is now common practice to equip large modern buildings with such central installations.

In both forms of plant the suction pump or exhauster is now either of the positive displacement or of the multi-stage fan type, depending upon circumstances and the class of work to be done, the former being more suitable for giving a higher degree of vacuum with less volumetric capacity than the latter.

If of the positive displacement type, it should be capable of drawing from 28 to 35 cu ft. of free air per minute per cleaning nozzle at work, while maintaining inside the nozzle a degree of vacuum equal to 5 in. of mercury. If of the multi-stage fan type, it should be capable of drawing from 50 to 70 cu ft. of free air per minute per cleaning nozzle at work, while maintaining inside the nozzle a degree of vacuum equal to 3 in. of mercury.

The filter is a chamber generally formed in two parts, an upper fixed part containing a filtering fabric of unbleached calico, linen or other suitable material usually made in the form of an inverted bag or cone, and a lower part, readily removable, into which falls, and is collected, the dust intercepted by the filtering material.

The cleaning nozzle for use on carpets or upholstery has a slot shaped orifice usually from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. wide, and from 4 in. to 12 in. long, the rim of the orifice being formed with a continuous rounded lip so as to run smoothly over the fabric being cleansed and to ensure close contact therewith throughout its entire periphery. Other forms of nozzle are used for various purposes—those for removing dust from surfaces such as floors, or shelves, usually have felt or bristles mounted around the orifice.

The flexible hose to which the cleaning nozzle is attached is usually made of rubber, having a smooth bore and strengthened by embedded steel wire or strip which ensures sufficient strength combined with lightness and flexibility. If used with the positive displacement pump, it is generally of 1 in. internal diameter, or of $1\frac{1}{2}$ in. internal diameter if used with the multi-stage fan.

In central installations the diameter of the fixed iron pipes forming the mains which carry the dust-laden air to the filter is usually such as to allow an air velocity of between 40 ft. and 90 ft. per second.

Domestic Form.—The advantages of such a convenient and sanitary method of keeping homes free from accumulations of dust were widely appreciated and led in the course of a few years to the production of small cleaners in a variety of forms suitable for daily domestic use and driven by hand or by small electric motors which could be connected with the lighting circuit. Such machines are now common domestic appliances and have done much to displace the broom and duster, the employment of which is both inefficient and insanitary, owing to the unavoidable dispersal of dust in the atmosphere. It is well known that dust, when disturbed and caused to float about in the air, acts as a carrier of germs, and accumulations liable to be disturbed may be a considerable danger to health.

A bacteriological analysis of the dust in any public building gives a sufficient proof of this, and observations made over a series of years in a large printing works showed a marked improvement in the health of the workpeople after the installation and regular use of a vacuum cleaner.

During the World War many factories making high explosives were equipped with central installations of the vacuum cleaner for the purpose of minimizing the dangers of explosion and T N.T poisoning, and in one factory, fulminate of mercury was successfully dealt with.

Modified forms of the apparatus are now applied to many industrial processes in which the removal and conveying of dust or powdered material can be carried out economically and conveniently by pneumatic means. One of the more important recent developments is its application to the sooting or removal of fine ash from boiler casings, flues and economizer chambers, a laborious and unhealthy process when carried out by hand with brushes and shovels. In many cases the plant is arranged so that the operation can take place while the boilers are at work, thus rendering it unnecessary to close down, or for men to enter the casings or flues

In such a plant a positive acting pump is generally used, its capacity depending upon the number of tons of dust which it is required to remove per hour.

The air suction main leading therefrom passes to an air washer and thence to a cylindrical dust collecting chamber, provided with a dust discharge valve at its base, and usually mounted on a staging, so that it can be emptied into wagons or barges From this collecting chamber, a main pipe which conveys the dust-laden air is led to the boilers and economizers, etc, and branch pipes fitted with valves enter the boiler casings and flues, and terminate in one or more suction nozzles fixed at points where the dust accumulates. These nozzles are so designed as to admit a sufficient inrush of flue gases with the dust being sucked away in order to ensure its conveyance along the mains to the dust collecting chamber.

In other cases, where it is necessary to enter the flues for the purpose of cleaning, the operator uses a similar suction nozzle connected by a flexible metallic hose to a valve situated at a convenient point in the dust main, and in this manner one man can remove the dust, without inconvenience or disturbance at the rate of two tons per hour Cement dusts and arsenical powders have also been dealt with by similar plants.

Lampblack is collected by suction nozzles from rotating tables, and aluminium and bronze powders used in paints are transferred from the pulverizing stamps to collecting chambers. In these cases the filtration of the conveying air is carried out by means of fabric filters. (H. C. Bo.)

IN THE UNITED STATES

Some modern electric cleaners made in the United States clean and polish linoleum and varnished or waxed floors. One cleaner is equipped with a detachable handle for conversion into a portable unit for cleaning automobile upholstery, stair carpets, crevices and corners.

Types.—(1) "Built-in" or stationary type: a powerful motor usually placed in the basement of the building operates an exhaust fan or a suction pump from which metal pipes lead to valved inlets on each floor. A flexible hose of from 10 to 20 ft. in length may be attached to these inlets. Suction is applied to the floor or floor covering by means of an extension tube and a nozzle which is normally fitted with a universal joint for ease in handling. The dirt is separated from the air by means of a filter and either drops into a removable receptacle or is directed into a sewerage inlet.

(2) The portable electric type is now supplementing and supplanting many central installed systems. Two distinct types of portable electric vacuum cleaners are in use: the truck type and the light portable type. The truck type is placed on a truck platform which is mounted on three or four wheels. It employs motors of from $\frac{1}{4}$ to 1 h.p. which operate an exhaust fan or suction pump. A large flexible hose and nozzle is used similar to that of the

permanently installed systems. The light portable type is by far the most popular and represents 95% of all electric vacuum cleaners in use. Although of several distinct types, identified by varied cleaning principles, its main characteristics are lightness, from 10 to 20 lb. in weight, use of exhaust fan principles and use of floor nozzle. The latter is attached to a suction chamber, motor, exhaust fan and cloth bag to trap dust and sift air; and is mounted on small wheels guided by a handle, through which an electric cord runs to motor. The switch is usually in the handle These cleaners operate from house current at a cost which is generally less than 1 cent per hour. Motors are of from $\frac{1}{12}$ to $\frac{1}{4}$ horsepower. The attachments which are commonly sold at extra cost generally consist of a flexible hose about 8 ft in length, which may be connected to the intake of the suction chamber, various cleaning nozzles, a brush attachment and an extension tube which enables the operator to clean any type or contour of surface and without step-ladders reach any part of a room of normal height.

There are three main types of light portable electric vacuum cleaners. The first is the high vacuum type, characterized by simplicity and paucity of moving parts. Powerful suction is generated because the motor is used for producing suction only. High vacuum is effective in removing deeply embedded dirt. The broom action self-cleaning brush removes surface litter without injury to the nap of the floor covering The second is the carpet sweeper type which employs suction for removing embedded dirt and a revolving wheel driven brush for surface litter The revolutions of the brush are controlled by the speed at which the cleaner is moved across the surface of the floor covering The brush not being connected to the motor permits the full use of the power of the motor for generating suction The brush is removable for cleaning The third is the motor-driven brush and metal drum types which beat the floor covering and cause vibration to dislodge embedded dirt Surface litter is effectively removed by this type of cleaner and clinging dog or cat hairs or loose and cut nap are picked up by suction

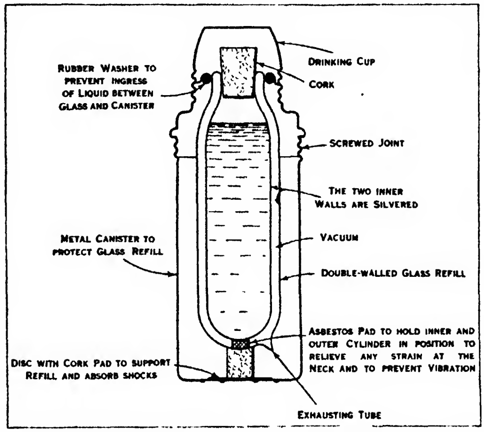
Small hand vacuum cleaners, frequently termed vacuum brushes, are sold in limited quantities. These are miniature electric cleaners and are of a pattern of all three types of portable electric cleaners explained above Larger portable electric cleaners which can be suspended by a strap from the shoulder of the operator or carried in one hand while he is using the cleaning nozzle, are designed and powered like the standard portable vacuum cleaners, but have no handle or large floor nozzle Non-electrical vacuum cleaners of current design are generally of the exhaust fan type A fly wheel weighing several pounds to which the fan is attached is actuated by a slip ratchet gear in mesh with one or two large driving wheels These wheels also support the cleaner. The speed at which the cleaner is moved determines the amount of suction generated which is never very great A carpet sweeper type revolving brush is generally used and is the chief cleaning agent. The dust is trapped in a cloth bag. These cleaners resemble electric vacuum cleaners in appearance.

History.—Hand power vacuum cleaners are the forerunners of all electric cleaners The "pump handle" portable tank type, using a set of two contracting diaphragms was first on the scene, followed by the suction carpet sweeper with a double bellows, operated by wheels in traction with the floor covering, which drew the dust into a cloth bag sifter

Large tank type vacuum cleaners mounted on horse-drawn wagons, or automobile trucks were the first power-driven vacuum cleaners to appear in America A motor supplied the power for both exhaust pump and fan types. This type employed flexible tubes, in sections, to reach from the street to the farthest corners of home, office building or hotel They are practically obsolete to-day. (F. War.)

VACUUM DISTILLATION: *see* Distillation.

VACUUM FLASK, a glass vessel with double walls, the space between which is evacuated. The only junction of the walls is at the neck of the vessel. It is also known as a Dewar vessel after its inventor Sir James Dewar (*q.v.*); "Thermos" flask is a proprietary name applied to a form protected by metal casing It was invented in the first place to preserve liquefied gases (*see* Liquefaction of Gases) by preventing the transference of heat from the surroundings to the liquid The approximate vacuum between the glass walls is practically a non-conductor of heat, and radiation is reduced to a minimum by silvering the glass The chief path by which heat can be communicated to the interior of the inner vessel is at the junction



BY COURTESY OF THERMOS (1925) LTD

VACUUM FLASK IN WHICH TRANSMISSION OF HEAT TO OR FROM THE CONTAINER IS PREVENTED BY THE VACUUM SPACE

of the walls at the vessel's neck, which is consequently made as small as possible. This thermal isolation applies equally in the opposite direction, a hot liquid remaining at a high temperature for several hours Where the flask is subjected to rough usage, metal has been substituted for glass, but the latter is the more efficient material

VACUUM-PUMP. This has an opposite effect to an air-compressor, that is, it withdraws air instead of forcing it in The smaller pumps are employed for scientific purposes, and for the exhaustion of incandescent lamp bulbs and Rontgen tubes. Large units serve factories carrying on certain chemical processes, and making foodstuffs, sauces, varnishes, etc A vacuum is largely used for boiling semi-liquids or liquids at a low temperature, the boiling point being determined by pressure. Condensed milk and milk powder are made by boiling off the water in a vacuum, while oil refining and sugar refining are also performed with the help of a vacuum.

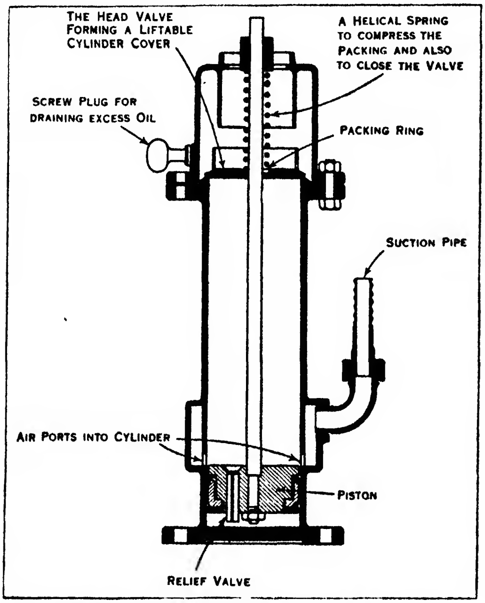
The large pumps are built similarly to air-compressors, and driven by belt, steam, electric motor, or internal-combustion engine, and ranging in power requirement to more than 200 horse-power Small types such as the well-known Sprengel mercury pump are composed of tubes and bulbs mounted against a vertical frame or board But a mechanical pump, the Geryk, patented by Fleuss (and made by The Pulsometer Engineering Co. Ltd.) is extremely simple to use, and gives a very high vacuum, whether on a small or a large scale The single-cylinder type will give a vacuum of $\frac{1}{50}$ of a millimetre off perfect, while in an elaborated type, and under favourable conditions, a vacuum of $\frac{1}{1,000,000}$ mm. can be obtained. The piston of the small pumps is reciprocated by a lever, or a lever worked from a handwheel, while larger units derive their power from an electric motor. Rotary pumps are also made on a modified principle.

In the diagram the top of the piston and the underface of the head valve are seen to be of the same form, so that when they are in contact no air space exists between them. As the piston reaches the top of its stroke it over-runs the cylinder bore slightly, and is therefore in close contact with the head valve, expelling all air. The piston in rising to this position comes into

contact with the oil. The main valve is oil sealed with a special oil of low vapour tension *See* also VACUUM (F. H)

VACUUM TUBE: *see* THERMIONIC VALVE.

VÁCZ, a town of Hungary, 20 m N of Budapest, straggles along the left bank of an arm of the Danube at the foot of the Cserhát mountains, where the river takes its southward course On the hills around are large vineyards and the exportation of grapes is an important industry There are also spirit, soap and shoe factories while the working of wool is carried on The town is the see of a bishop and has numerous architectural remains and a museum of the Roman and mediaeval antiquities in which the district is so rich Pop (1923), 19,395.



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THE GERYK OIL VACUUM PUMP, WHICH PRODUCES HIGH VACUA

VADE-MECUM, a Latin phrase meaning literally "come with me" (*vade,* imperative of *vadere,* to go or come; *cum,* with; *me,* abl of *ego,* I), and used in French, Spanish and English for something that a person is in the habit of constantly taking about with him.

VAGRANCY. The existing British law against vagrancy is the outcome of over three centuries of legislation. Stephen's *History of the Criminal Law,* dealing with vagrancy as a criminal offence, states that "when serfdom was breaking down and when the statutes of labourers provided what might be regarded as a kind of substitute for it, provisions as to vagrancy were practically punishments for desertion The labourer's wages were fixed, his place of residence was fixed; he must work where he happened to be. If he went elsewhere, he must be taken and sent back By degrees the order of ideas which this view of the subject represented died away The vagrant came to be regarded rather as a probable criminal than as a runaway slave."

The act of 1495 instructed local authorities to search for all "vagaboundes, idell and suspecte persones lyvyng suspeciously" and put them in the stocks for three days, giving them bread and water only, and then turn them out of the town In 1530 owing to the increase of vagrancy followed by crime and disorder whipping was allowed as an alternative to the stocks. In 1535 an even severer punishment for the sturdy vagabond was enacted. If brought a second time before a justice of the peace he might be marked by having the upper part of his right ear cut off and after this if convicted of wandering, loitering and idleness might be adjudged a felon and suffer death. Other drastic acts followed until 1597 when fortune tellers, tinkers, pedlars, jugglers, etc., were all treated as rogues and vagabonds and even players except such as "belonged to any baron of this realm or any other honourable person of greater degree." This law remained in force with amendments until orders in council in 1603 and 1662 empowered the authorities to transport sturdy beggars and idle and disorderly persons to English plantations beyond the seas. Branding ceased to be legal in 1713 In 1821 a select committee of the House of Commons dealing with the system of "passing" vagrants to their place of settlement recommended that the existing system should be abolished and long periods of imprisonment given instead.

As a result of the report, the existing legislation was in 1822 repealed "en bloc" and the new act to remain in force till 1824 reduced the powers of magistrates with regard to vagrants and also reduced the maximum term of detention from seven years transportation to two years imprisonment Finally the Vagrancy Act of 1824 repealed all former statutes and vagrancy offenders were liable to punishment either as "idle and disorderly persons" or as "rogues and vagabonds" or as "incorrigible rogues" Since 1824 legislation and regulations have both been based on reports made by the poor law commission, and under the poor law as reformed in 1834 it became the duty of the guardians to provide relief for destitute persons and to use a test to make sure that relief given from the public funds was not abused When workhouses were established vagrants applied for admission to them and in 1837 the poor law commissioners expressed the opinion that it was the intention of the Act of 1834 that all cases of destitution should be relieved irrespective of the fact that the applicant might belong to a distant parish

There have been many acts since that time, such for example, as the act of 1842 proscribing a task of work in return for food and lodging and the Poor Law Act of 1844 authorising the formation of districts in London and other large towns for the provision of temporary relief In 1848 when the poor law board took the place of the poor law commissioners the whole question of vagrancy was reported on by the inspectors to the new board and a minute of the poor law board urged uniformity in action, the refusal of relief to able bodied men not actually destitute, and the employment of police officers as assistant relieving officers for vagrants Under the act of 1864 every London union was required to provide casual wards

The "Casual."—Nearly all subsequent legislation deals with the treatment of the casual pauper and the regulations that should be enforced especially when the applicant for admission to a casual ward was an able bodied man A general order dated Dec 18 1882 prescribed the rules and regulations to be observed and pauper vagrancy decreased for two or three years, but increased again from 1885–1895 The number of vagrants in casual wards on Jan. 1, 1905 was 9,768 There followed the appointment of the departmental committee on vagrancy in 1906 Since then the number of vagrants has increased and it is estimated that there are no less than 12,000 many of them ex-service men who for one reason or another tramp from place to place and find temporary accommodation in the casual wards and lodging houses or sleep in the open. It is extremely difficult to say how many of these men are *bona fide* unemployed but not more than one-third could be placed in the class of "rogues and vagabonds." The recommendations of the committee on vagrancy of which the Rt Hon. J. L. Wharton was chairman were of a varied character some of which could not be carried into effect without legislation For example, it was suggested that the control of casual wards and the local relief of vagrants should be transferred to the police authority with a view to securing uniform treatment throughout the country. At present (1929) it is often necessary for tramps to apply for tickets at police stations before they can sleep in the casual ward, although the police have no final control Another recommendation was that of a detention colony and an indeterminate sentence, a detention colony, for example, such as Borstal for boys and the place of detention for an indefinite period instead of prison for a short term The committee recommended

that habitual vagrants should be sent to certified labour colonies for detention for not less than six months or more than three years. This recommendation would also require legislation The third recommendation which has passed into law is that of the establishment of labour exchanges the value of which for the unemployed tramp is that information can be obtained at a labour exchange as to where employment is likely to be found. The difficulty however which has not been overcome is that if a man is compelled without money to tramp the country he cannot stay long enough in one place to enable him to find employment. A considerable advance has been made in the direction of forming vagrancy committees for counties or larger areas, the object being to secure uniform treatment of tramps, to find work for those who are willing to work and to deal with the difficulty of women and children on the road Clearly what is required is a national system of dealing with the problem; and all boards of guardians, if still in existence, should be included in these committees. A number of counties have also adopted the suggestion of a way-ticket system. By a statutory order of Sept. 23, 1914 the supply of a midday meal for paupers discharged from the casual ward was legalised. The way-ticket system was by no means universally adopted and has not been a success.

The Metropolitan Asylums Board by unifying the London tramp wards has introduced uniformity in administration and generally speaking the London casual wards are clean and well kept. As a result of the report of the casual wards committee of the Metropolitan Asylums Board many helpable cases are now dealt with separately, the idea being to enable those who are really desirous of work to stay in a ward which is treated as a hostel A stay of a week or a fortnight often means that the man is able to find employment The implication is that the casual ward with its one or two nights detention does not assist the man to find employment, but that given a longer time a considerable number of men can be assisted to find work

Remedies.—The labour exchange should theoretically enable an unemployed man, likely to become a vagrant, to be transferred to some place where work is more abundant, but the labour exchanges are in many cases overworked and have a mass of local unemployment to deal with, most of it stagnant labour. If the occupants of casual wards could be given a chance there is no doubt that a percentage, small perhaps, but probably not less than 10% would be willing to work if suitable employment could be found. To obtain this fluidity of labour some arrangement is required to enable the man to travel from place to place and this entails the expenditure of money He also requires when he arrives at a new town some decent accommodation other than the casual ward. Vagrancy reform must be based upon effective individual dealing and proper classification since the vagrant may be either a genuine unemployed man, an ex-service man, an old and infirm person, a young boy, a married man with a wife and children or an habitual vagrant Various remedies might be suggested for the evil. In the first place it would be as well to set up another inter-departmental committee to consider what changes have taken place in the situation since the last committee of 1906 and what legislation is still required. Proper accommodation should be supplied in the shape of municipal lodging houses for genuine unemployed looking for work, and Labour Exchanges should supply the necessary information as to existing accommodation in their own districts. Every attempt should be made to induce the vagrant to call at the labour exchange for information and if he possessed a wayfarer's card it would be possible for the labour exchange to endorse it before he went "on the road." A training camp is required for the young man who has no real trade behind him. while for those who are seasonally unemployed some sort of a colony should be established in order that the man may not lose the habit of regular work.

On the punitive and deterrent side other remedies are required. If "sleeping out" and "loitering with intent" and begging for food or drink are treated as offences the vagrant can no longer be left to the poor law. He becomes a concern of the Home Office. Vagrancy offenders should then be subject to penal detention under an indeterminate sentence. Such men should not be allowed to become recidivists. Two things are quite obvious in dealing with this problem The first is that penal detention should not be resorted to where the only crime is poverty, the second, that where the social conduct of an individual calls for penal treatment he should not be allowed to contaminate others in the casual ward

Like all social problems vagrancy cannot be isolated from other important questions such as housing, poor law reform and unemployment. It is a symptom of a deeply rooted social evil which must be remedied by dealing with the other problems which lie at the root of the trouble (*See* also POOR LAW; CASUAL WARD, LABOUR COLONIES, UNEMPLOYMENT)

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The United States.—Vagrancy laws in the United States began to appear after the economic depression of 1873 (New Jersey, 1876, Delaware, 1879; New York, 1884) and after the even greater depression of 1893 Owing to the unique nature of the problem in the United States these laws attempted to differentiate between the vagrant or loafer about town, and the tramp who roved "about from place to place" Both were "idle persons without visible means of support" only the tramp was more of a romantic adventurer In other connections he is known as a migratory worker or hobo He was a conspicuous figure in the building of railroads, prospecting and clearing the land during the strenuous drive against the frontier. With the passing of the frontier he continued in his rôle as tramp and migratory worker, but he now functions in only the seasonal industries and transient occupations The migratory worker, thanks to his facility in using the railroads. is more mobile than any type of vagrant so far developed In the main he is self-sustaining, and when he is not, his problem is as much a matter of unemployment as of vagrancy His labour market is elusive, harvesting, sheep shearing, lumbering, ice cutting and the like, and his fortunes are no less elusive However legitimate his function may be in the country's industrial set-up, he still leads a precarious, hand-to-mouth existence, moving from job to job, from State to State at the beck and call of his opportunities, and not infrequently of his moods. Most of his life the hobo lives in the open, especially in summer when if he is not at work or travelling to the next job he is basking in the "jungles," his roadside camps In winter when work is scarce he is frequently forced into some city for food and shelter, and it is then that he gets his rating as a vagrant.

The life of the hobo, and he is at present typical of the American variant of the genus vagrant, is divided between train riding, the job, the "jungle" and the "main stem," or the street of the homeless found in most cities In most of his contacts he is relatively isolated from women, so hobo life becomes a man's game. A population recruiting its new membership from young men and boys, it has little of the culture traits, jargon and sign language that some observers attribute to vagrants of the Old World. Since so many boys and young men are attracted into the class and since the promise of adventure generally proves a delusion there is naturally considerable unrest, which may explain the zeal with which hobos often turn to syndicalism. Manifestations of unrest, songs of protest, and rapid movement, especially of younger hobos, about the country, have all appeared with the passing of the frontier and the swing of the country from a rural to an industrial, city-building civilization. The hobo of the old school who lived his life in the open, tramping and working by turns, and carrying his bed wherever he went, is vanishing. Whereas the old-type hobo used to avoid the city, the present species of the undomesticated American is essentially urban, and only when necessity forces him does he venture into the country.

Most attempts in the large cities to cope with the problem of vagrancy have been partial and palliative Small cities at one time opened their jails for winter lodging but that has practically ceased since the World War. Other cities drive tramps out of town, and others have established wood yards to give the work test Numerous cities have municipal lodging houses and in addition private agencies, as the Salvation Army, maintain industrial shops and transient hotels In every large city during hard times, and often the year through, bread lines and soup kitchens may be found None of these efforts meets the problem in any comprehensive fashion; in fact no American city has as yet attempted any comprehensive programme Quite a contrast is the treatment afforded tramps who have invaded the Southern States during winter months They frequently find their way into chain camps and often have been leased to contractors in the mines and turpentine camps The brutal treatment so characteristic of Southern prison camps has failed, however, to prevent the annual southward movement of large numbers.

Jacob S Coxey who led "Coxey's army" of unemployed to Washington in 1894 demanded that the Government should put them to work building roads That proposal has often been made but only with transient success One of the earliest instances was in New York city in 1808 during a riot of unemployed sailors Attempts have been made by the Federal and State Governments, as well as by municipalities to conduct employment bureaux These have been partially successful but perhaps more important still are the moves toward public regulation of private employment agencies These agencies frequently corner jobs during hard times and charge unreasonable prices Since the World War the automobile has had a profound influence on vagabondage in the United States The old-time hobo still rides the railroad but a younger class, out for sport, follow the highways and ride automobiles This promises to add women to the tramp population There is evidence too that the automobile is making possible a tramp family In many towns of the South and West these families constitute a serious burden for charity agencies

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(N A)

VAI, a people of the Mandinga group, on the Guinea coast in Liberia and Sierra Leone, who are remarkable for their use of a syllabic script consisting of more than 159 signs invented in the first half of the 19th century by Momolu Doalu Bukere

See Migeod, *The Languages of West Africa* (1911)

VAIDA-VOEVOD, ALEXANDRE (1871–), Rumanian statesman, was born at Olpret (Transylvania) in 1871. He studied medicine in Vienna and practised for many years at Karlsbad (Karlovy Vary) At the age of 28 he joined the National Rumanian Party of Transylvania and from 1906–18 sat in the Hungarian parliament at Budapest, where he waged a permanent fight in defence of the Rumanians in Transylvania. On the collapse of the Central Powers in the autumn of 1918, Vaida-Voevod was instructed by the newly formed "Rumanian national committee," to voice their claims in the Hungarian parliament. Invoking the right of self-determination he denied the right of the Hungarian Government to speak in the name of the Rumanians of Transylvania and claimed that the latter should have their own representative at the Peace Conference. Soon after, the Rumanian national committee took administrative control of Transylvania and delegated Vaida-Voevod to represent the Rumanians of Transylvania and the Banat at the Peace Conference in Paris.

In 1919 Dr Vaida-Voevod was appointed prime minister and minister for foreign affairs of Rumania and in the latter capacity went to Paris and London early in the following year to negotiate with the French and British Governments the recognition of the union of Bessarabia with Rumania This he succeeded in doing in March 1920 when the rights of Rumania over Bessarabia were recognized by the Supreme Economic Council, and afterwards ratified by the Treaty of London (Oct 28, 1920). Dr. Vaida-Voevod resigned in the same year and afterwards sat in parliament as one of the leaders of the National Rumanian Party, but left that institution when his party decided to boycott the Liberal Government as unconstitutional

VAIL, THEODORE NEWTON (1845–1920), American capitalist, was born in Carroll county (O), on July 16, 1845 He became interested in telegraphy, and in 1868 he became station agent and telegraph operator on the Union Pacific Then he was appointed clerk in the railway mail service, and in 1873 was made assistant superintendent of railway mail service, rising in 1875 to general superintendent In 1878 he was made general manager of the American Bell Telephone Company In 1885 he resigned and was elected president of the newly organized American Telephone and Telegraph Co, which in 1900 acquired the American Bell Telephone Company. In 1887, because of ill-health, Vail retired In 1896 he installed an electric railway system in Buenos Aires, and later introduced telephone systems in South American cities.

In 1907 he was again induced to accept the presidency of the American Telephone and Telegraph Company When this company in 1910 bought control of the Western Union Telegraph Co, Vail was made president of the latter also, and introduced many changes, including "night letters" at reduced rates When in 1914, as the result of a threatened suit by the Government, the Western Union was again segregated Vail remained president of his old company After the taking over of the wires in Aug 1918 by the Government as a war measure, he was appointed adviser by the postmaster-general When the wires were returned in 1919 to private ownership he was elected chairman of the board of directors of the American Telephone and Telegraph Company He died in Baltimore on April 16, 1920.

See A B. Paine, *In One Man's Life* (1921)

VAILLANT, EDOUARD MARIE (1840–1915), French politician, was born in Vierzon (Cher) on Jan 28, 1840 He studied science, residing in Heidelberg, Tubingen, Vienna On his return to Paris he took part in the republic and socialist battle against the Second Empire, becoming a disciple and friend of Blanqui On March 18, 1871 he took part in the Commune Insurrection, and, on the 26th, was elected a member of the Commune He was a delegate on the executive Commission, and his work for public instruction displays his revolutionary audacity and his scientific knowledge

After the defeat of the Commune he fled to England and became associated with Karl Marx But, after having been a member of the general committee of the First International, after having participated in 1872 in the Congress at The Hague, he induced his friends to abandon this association because it seemed to him to be insufficiently revolutionary. He founded "The Revolutionary Commune" which published the manifesto in which these disciples of Blanqui declared themselves to be atheists, republicans, communists, revolutionaries, and partisans of class conflict.

Condemned to death by the War Council in 1872, Vaillant only returned to France in 1880 under amnesty He was a founder of the Socialist Revolutionary Party, and in 1884, he became a Municipal Councillor of Paris, becoming deputy in 1893 Under his direction, the Blanquist party made itself noticeable among the other socialist parties In Boulangisme (1889), he separated from other blanquists, who, through nationalism, were inclined to accept a plebiscitary dictator

In 1899, and again in 1905, Vaillant made himself the apostle of socialist unity in France. When in 1905, all the socialist parties united, he became a very close friend of Jaurès, and secured with him the majority in all socialist congresses until 1914. He advocated the eight-hour day, security and hygiene for workers, remedies against stoppage of work, and a struggle against war.

In August 1914, he considered that France was attacked and that it was the duty of the socialists to defend it, as in 1870 and

1871. He resumed the formulae of blanquist socialism and declared himself unreservedly in favour of national defence.

VAIRAGI: *see* RAMATS.

VAISHNAVITES (Bengal). Chaitanya, the founder of the great Vaishnava sect of Bengal, was the son of a high-caste Brahman of Nadiya, the famous Bengal seat of Sanskrit learning, where he was born in 1485, two years after the birth of Martin Luther, the German reformer Having married in due time, and a second time after the death of his first wife, he lived as a "householder" (*grihastha*) till the age of 24, when he renounced his family ties and set out as a religious mendicant (*vairagin*), visiting during the next six years the principal places of pilgrimage in northern India, and preaching with remarkable success his doctrine of Bhakti, or passionate devotion to Krishna, as the Supreme Deity. He subsequently made over to his principal disciples the task of consolidating his community, and passed the last twelve years of his life at Puri in Orissa, the great centre of the worship of Vishnu as Jagannatha, or "lord of the world," which he remodelled in accordance with his doctrine, causing the mystic songs of Jayadeva to be recited before the images in the morning and evening as part of the daily service; and, seeking to humanize divine adoration by bringing it into accord with the experience of human love To this end, music, dancing, singing-parties (*sankirtan*), theatricals—in short anything calculated to produce the desired impression—would prove welcome to him His doctrine of Bhakti distinguishes five grades of devotional feeling in the Bhaktas, or faithful adherents: viz, (*santi*) calm contemplation of the deity; (*dasya*) active servitude; (*sakhya*) friendship or personal regard, (*vatsalya*) tender affection as between parents and children, (*madhurya*) love or passionate attachment, like that which the Gopis felt for Krishna. Chaitanya promoted the celebration on an imposing scale of the great Puri festival of the Ratha-yatra, or "car-procession," in the month of Ashadha, when, amidst multitudes of pilgrims, the image of Krishna, together with those of his brother Balarama and his sister Subhadra, is drawn along, in a huge car, by the devotees This festival was, and is, attended by people from all parts of India, without distinction of caste or sex All classes, even Mohammedans, were admitted by Chaitanya as members of his sect The ordinary form of worship is very simple, consisting mainly of the constant repetition of names of Krishna, or Krishna and Radha, which of itself is considered sufficient to ensure future bliss The partaking of flesh food and spirituous liquor is strictly prohibited By the followers of this sect, also, an extravagant degree of reverence is habitually paid to their *gurus* or spiritual heads Indeed, Chaitanya himself, as well as his immediate disciples, have come to be regarded as complete or partial incarnations of the deity to whom adoration is due, as to Krishna himself; and their modern successors, the Gosains, share to the fullest extent in the devout attentions of the worshippers. Chaitanya's movement was directed against the vile practices of the Saktas (*q v*) then very prevalent in Bengal, but his own doctrine of divine, though all too human, love was by no means free from corruptive tendencies. Whilst in Chaitanya's creed, Krishna, in his relations to Radha, remains at least theoretically the chief partner, an almost inevitable step was taken by some minor sects in attaching the greater importance to the female element, and in this way making Krishna's love for his mistress the guiding sentiment.

VAISON-LA-ROMAINE, a town of south-eastern France, in the department of Vaucluse, 26 m. N.N E. of Avignon by road. Pop. (1926) 1,860. Vaison, under the name of *Vasio*, was one of the principal towns of the *Vocontii;* the number of Roman finds, including a fine statue of an athlete (the Diadumenos) in the British museum, proves its importance in Roman times. The bishopric established in the 3rd century was suppressed in 1791. The temporal power of the bishops passed in the 12th century to the counts of Toulouse. Subsequently Vaison came, together with the rest of Comtat-Venaissin, under the power of the popes The Ouvèze, a tributary of the Rhône, divides Vaison into two quarters—the Roman and early mediaeval town on the right bank, and the mediaeval town on the left bank.

VALAIS, a canton of south Switzerland. The region is the old *Vallis Poenina* (Upper Rhone valley) The former spelling, "Vallais," was officially replaced (early 19th century) by "Valais"

The modern canton includes the entire basin above St Maurice, but below this point it consists of the western part only; its lower limits are in the Lake of Geneva The total area is 2,020·7 sq m (exceeded only by the Grisons and Berne), of which, however, only 55 9% is reckoned as "productive"; forests cover 282 6 sq m and vineyards 12 2 sq. miles Its unproductive area includes the most considerable stretch of glaciers in Switzerland (*c* 375 sq m), together with about 5 sq m of lakes Poor as the canton is, it would be poorer were it not for its excellent wines—the area under vineyards is second only to Vaud (*q v*) and is increasing—and for its well organized tourist traffic Hotels have been built in nearly every tributary glen, and on the majority of the high pastures The striking beauty of the scenery of its high glens, and the accessibility (*see* below) of the most characteristic features, have made the canton unusually popular, chiefly with summer visitors The Upper Rhone occupies a north-east to south-west gorge-like trench from Gletsch to Brig; below this the valley widens and runs east to west to Leuk, onwards it resumes its original course, ever widening until Martigny is reached, where the remarkably sharp bend carries the feature to the north-west; between St Maurice and the lake is the only low land in the canton The lowest commune is St Gingolph (1,266 ft alt) The loftiest point is the Dufourspitze summit (15,217 ft) of Monte Rosa, but the highest mountain wholly within the canton is the Dom (14,942 ft) (*See* SWITZERLAND *Relief*.)

The chief railway line (about 75 m) through the canton is from St Gingolph, on the Lake of Geneva, to Brig, at the north mouth of the Simplon tunnel (1895–1905—12½ m long), from St Maurice onwards it forms part of the main through line from Lausanne towards Milan There are also several mountain railways, *e g*, from Visp up to Zermatt (thence a branch up to the Gornergrat), from Vernayaz (near Martigny) past Salvan towards Chamonix, and from Leuk to Leukerbad, near the Gemmi pass and noted for its mineral springs A new tunnel (1906–12) beneath the Lotschen pass, connects Kandersteg, in the Bernese Oberland, with Brig, thus opening up a new direct route from Paris to Italy, via Berne The lofty alpine barriers of Valais are, as a rule, accessible only by footpaths or mule paths, but there are excellent roads over the Great St Bernard pass (8,111 ft) and the Simplon pass (6,590 ft) to Italy, while at the head of the Rhone valley other excellently engineered roads give access to Uri over the Furka pass (7,992 ft) and to Berne over the Grimsel pass (7,159 ft)

In general, the boundaries of the canton run along the summit ridges of the surrounding mountains, but from an early date it has held a valuable part of the southern slope of the Simplon pass to below Gondo, as well as the rich Alpine pastures on the northern slopes between the Gemmi pass (7,641 ft) and Schwarenbach.

The estimated population in 1926 was 134,200; at the 1920 census the total was 128,246, of whom 84,340 were French-speaking, 40,105 German-speaking and 3,479 Italian-speaking, the most marked change during the 20th century being a decrease in the last total The linguistic frontier has shown much oscillation; at present the inhabitants above Leuk generally speak a dialect of German, while below Leuk a Savoyard patois (French dialect) is the prevailing tongue In general, the history of Valais (from 1810 to 1814 the French department of the Simplon) is a struggle between French and German elements. It is one of the last three admissions to the Confederation In 1920 there were 122,976 Catholics, 4,242 Protestants and 44 Jews

The canton forms the 4th century diocese of Sion (created *c* 580) and has St Théodule as its patron saint. Since 1513, its bishop has had no superior except the pope. Valais contains the three famous religious houses (all now held by Austin canons) of St Maurice, of the Great St Bernard, and of the Simplon The abbey of St. Maurice (4th century and the oldest Christian foundation among the Alps) has, since 1128, belonged to the Augustinians Since 1840 its abbot has borne the title of bishop of Bethlehem *in partibus*

Good wines, especially Muscat and Vin du Glacier, are produced in the canton, but the chief activity of the main valley below Brig is agriculture, rendered rather precarious in former days by extensive Rhone inundations. In the higher valleys the inhabitants are employed in pastoral occupations. The number of mountain pastures is greater, and they are better stocked in the more congenial Lower Valais than in Upper Valais (the line of division passing near Leuk). The capital is Sion (pop 6,950). The canton has no large towns. The average density of the population in 1920, 63 per sq m, was but little above that of Uri (*q v*). Of the larger settlements, Monthey (4,700)—near St. Maurice—with an electric railway up the Val d'Illiez to Champéry, and Brig (3,130) are the most important. Naters, near the latter town, has a prosperous colony of Italian workmen.

Valais is divided into 13 administrative districts, which comprise 171 communes The Cantonal Constitution was entirely remodelled in 1907. The legislature (*Grand Conseil*) is composed of 109 members elected by the people in the proportion of one for every 1,100 Swiss residents. The executive (*Conseil d'État*) is composed of five members Both councils hold office for four years The "obligatory referendum" prevails for all laws and financial resolutions passed by the *Grand Conseil*, while 4,000 electors (6,000 in the case of a revision of the Cantonal Constitution) have the right of "initiative" as to legislative projects; the latter initiative dates back to 1848. The canton provides two members of the Federal *Standerat* and six members of the Federal *Nationalrat*, elected by a popular vote. The principles of proportional representation are employed in communal elections.

History.—The Vallis Poenina was won by the Romans after a great fight at Octodurus (Martigny) in 57 B C, and was so thoroughly Romanized that the Celtic aboriginal inhabitants and the Teutonic Burgundian invaders (5th century) became Romance-speaking peoples. Valais formed part of the kingdom of Transjurane Burgundy (888), which fell to the empire in 1032, and later of the duchy of Burgundia Minor, which was held from the emperors by the house of Zahringen (extinct 1218). In 999 Rudolph III of Burgundy gave all temporal rights and privileges to the bishop of Sion, who was later styled "praefect and count of the Valais." About the middle of the 13th century we find independent communities or "tithings" (*dizains* or *Zehnten*) growing up, these, though seven in number, taking their name most probably from a very ancient division of the bishop's manors for administrative and judicial purposes In the same century the upper part of the valley was colonized by Germans from Hasli (Bern), who Teutonized it, though many Romance local names still remain. In 1354 the liberties of several of the seven "tithings" (Sion, Sierre, Leuk, Raron, Visp, Brieg and Conches) were confirmed by the emperor, Charles IV. A little later the influence of Savoy became predominant, and the count secured to his family the bishopric of Sion, of which he was already the suzerain His progress was resisted by the tithings, which in 1375–76 crushed the power of the house of La Tour-Châtillon, and in 1388 utterly defeated the forces of the bishop, the count and the nobles at Visp, this being a victory of the Teutonic over the Romance element in the land From 1384 the Morge stream (a little below Sion) was recognized as the boundary between Savoyard or Lower Valais and episcopal or Upper Valais In 1416–17 the *Zehnten* of the upper valley made an alliance with Lucerne, Uri and Unterwalden, with a view partly to the conquest of the Val d'Ossola, which was finally lost in 1422, and partly to the successful crushing of the power of the lords of Raron (1420). By the election of Walther von Supersax of Conches as bishop in 1457 the Teutonic element finally won the supremacy. On the outbreak of the Burgundian War, the bishop of Sion and the tithings made a treaty with Bern In November of the same year (1475) they seized all Lower or Savoyard Valais up to Martigny, and in 1476 (March), after the victory of Grandson, won St Maurice, Evian, Thonon and Monthey. The last three districts were given up in 1477, but won again in 1536, though finally by the treaty of Thonon in 1569 Monthey, Val d'Illiez and Bouveret alone were permanently annexed to the Valais, these conquests being maintained with the help of their old allies, Uri, Schwyz and Unterwalden. These districts (or Lower Valais) were ruled as subject lands by the bishop and tithings of Upper Valais. In 1790–91 Lower Valais rose in revolt; but it was not finally freed till 1798, when the whole of Valais became one of the cantons of the Helvetic republic. Such prolonged resistance, however, was offered to French rule that in 1802 Bonaparte declared Valais an independent State under the name of the "Rhodanic Republic." In 1810, for strategic reasons, he incorporated it with France as the "department of the Simplon," and it was not freed till the Austrians came in 1813 In 1815 a local assembly was created, in which each of the seven tithings of Upper, and each of the six of Lower Valais elected four members, the bishop being given four votes. This constitution was approved by the Federal Swiss diet, and the Valais was received as a full member of the Swiss Confederation. By the constitution of 1839, the local assembly was to be elected according to population (one member for every 1,000 inhabitants), and the bishop was given a seat instead of his four votes, while the clergy elected one deputy. By the 1844 constitution the clergy elected a second deputy. In 1844 there was civil war, and the Valais became a member of the Sonderbund It was the last canton to submit in the Sonderbund War (1847) By the constitution of 1848 all ecclesiastical exemptions from taxation were swept away, and the bishop lost his seat in the assembly. New constitutions were framed in 1852, 1875 and 1907. (*See* SWITZERLAND. *History*)

VALDEMAR I., king of Denmark (1131–1182), the son of Canute Lavard and the Russian princess Ingeborg, was born a week after his father's murder, and was brought up in the religious and relatively enlightened household of Asser Rig, whose sons Absalon and Esbjörn Snare, or "the Swift," were his playmates On the death of King Eric Lam in 1147 Valdemar came forward as one of the three pretenders to the Danish crown, Jutland falling to his portion (compact of Roskilde [1157]) Narrowly escaping assassination, at a banquet a few days later, at the hands of his rival, King Sweyn III, he succeeded only with the utmost difficulty in escaping to Jutland, but on Oct 23 utterly routed Sweyn at the great battle of Grathe Heath, near Viborg, Sweyn perishing in his flight from the field

Valdemar had no longer a competitor He was the sole male survivor of the ancient royal line, his valour and ability were universally recognized, and in Absalon, elected bishop of Roskilde in 1158, he possessed a minister of equal genius and patriotism. The first efforts of the new monarch were directed against the Wendish pirates who infested the Baltic and made not merely the political but even the commercial development of the Danish state impossible What the Northmen were to the Western powers in the 8th and 9th the Wends were to the Scandinavian lands in the 11th and 12th centuries At the beginning of the reign of Valdemar the whole of the Danish eastern coast lay wasted and depopulated. Arkona, the chief sanctuary, and Garz, the political capital of the Wends, in the island of Rügen, were captured in 1169 by a great expedition under the command of Valdemar and Absalon; the hideous colossal idol of Rügievit was chopped into firewood for the Danish caldrons, and the Wends were christened at the point of the sword

This triumph was only obtained, however, after a fierce struggle of ten years, in which the Danes were much hampered by the uncertain and selfish co-operation of their German allies, chief among whom was Henry the Lion, duke of Saxony and Bavaria, who appropriated the lion's share of the spoil For at the beginning of his reign Valdemar leaned largely upon the Germans and even went the length, against the advice of Absalon, of acknowledging the overlordship of the Emperor Frederick Barbarossa at the diet of Dôle, 1162. Very different was Valdemar's second conference with Barbarossa, on the banks of the Eider, in 1182, when the two monarchs met as equals in the presence of their respective armies and a double marriage was arranged between two of Valdemar's daughters and two of the emperor's sons.

The only serious domestic trouble during Valdemar's reign was the rebellion of the Scanian provinces, which objected to the establishment of a strong monarchy inimical to local pretensions and disturbances, and especially to the heavy taxes and tithes

necessary to support the new reign of law and order. The rising was ultimately suppressed by Absalon at the battle of Dysiaa, 1181 In the following year King Valdemar died

See *Danmarks Riges Historie*, vol. i., pp. 570–670 (Copenhagen, 1897–1905); Saxo, *Gesta Danorum*, books 10–16 (Strasbourg, 1886); L. Gresebrecht, *Wendische Geschichte aus den Jahren 780–1182* (Leipzig, 1843); and article DENMARK: *history*. (R. N. B.; X)

VALDEMAR II., king of Denmark (1170–1241), was the second son of Valdemar I and brother of Canute VI, whom he succeeded on Nov 12, 1202. Already during his brother's lifetime, as duke of Schleswig, Valdemar had successfully defended Denmark against German aggression In 1201 he assumed the offensive, conquered Holstein, together with Hamburg, and compelled Count Henry of Schwerin to acknowledge the over-lordship of the Danish crown. Immediately after his coronation, he hastened to his newly won territories, and was acknowledged lord of Northalbingia (the district lying between the Eider and the Elbe) at Lübeck, Otto IV, then in difficulties, voluntarily relinquishing all German territory north of the Elbe to Valdemar, who in return recognized Otto as German emperor Thus the three bishoprics of Lübeck, Ratzeburg and Schwerin, which hitherto had been fief of the *Reich*, now passed under Danish suzerainty. In 1208, when the Emperor Otto felt more secure upon his unstable throne, he would have attempted the recovery of the lost German territory but for the interposition of Pope Innocent III., who threatened to excommunicate any German prince who should attack Valdemar, the equally pious and astute Danish king having undertaken, at the bidding of the holy see, to lead a crusade against the heathen Estonians. Valdemar's position was further strengthened by the accession of Frederick II, who formally renounced all the German lands north of the Elbe and Elde, as well as the Wendish lands on the Baltic, in favour of Valdemar

Valdemar henceforth turned to the extension of the Danish empire over the eastern Baltic shores Here, however, he had already been forestalled by German colonists established in Gotland and at Riga. In 1206 Valdemar, urged by Archbishop Anders Suneson, had occupied the isle of Oesel on the Estonian coast. In 1210 Valdemar led a second expedition eastwards, this time directed against heathen Prussia and Samland, the chief result of which was the subjection of Mestwin, duke of Pomerania, the leading chieftain in those parts

In 1218 the German Bishop Albert of Riga was driven to appeal for assistance to King Valdemar Valdemar cheerfully undertook a new crusade "for the honour of the Blessed Virgin and the remission of my own sins." In 1218 he set sail for Estonia with one of the largest fleets ever seen in northern waters, including a Wendish contingent led by Prince Vitslav. Landing at Lyndantse (the modern Reval) in north Estonia, Valdemar at once received the submission of the inhabitants, but three days later was treacherously attacked in his camp and only saved from utter destruction by his own personal valour and the descent from heaven, at the critical moment, of a red banner with a white cross on it, the Dannebrog (Danes' Cloth), of which we now hear for the first time, and which henceforth was to precede the Danish armies to victory till its capture by the Ditmarshers, three hundred years later. This victory was followed by the foundation of Reval and the occupation of Harrien and Wirland, the northern districts of Estonia, by the Danes.

King Valdemar II was now, after the king of England, the most powerful potentate in the north of Europe The southwestern Baltic was a Danish sea, and Danish territory extended from the Elbe to lake Peipus. But this scattered and heterogeneous empire required a large standing army and a strong central government to hold it together It is doubtful whether even the genius of Valdemar would have proved equal to such a stupendous task. He never had the opportunity of attempting it. In May 1223 he was seized at midnight in his tent on the isle of Lyö, whither he had come to hunt, by his vassal and guest Count Henry of Schwerin, and conveyed with his son and many other valuable hostages to the inaccessible castle of Dannenberg-on-Elbe. In this dungeon he languished for two and a half years, and, despite all the efforts of Pope Honorius III. on his behalf, was ultimately forced to pay a heavy ransom, and surrender Northalbingia and all his Wendish conquests except Rugen.

On his release he tried to retrieve his position by force, but was defeated at Bornhöved (July 22, 1227), which deserves a place among the decisive battles of history, for it destroyed at once and for ever the Danish dominion of the Baltic, and established the independence of Lubeck, to the immense detriment in the future of all the Scandinavian states On the other hand Valdemar, by prudent diplomacy, contrived to retain the greater portion of Danish Estonia (compact of Stensby, 1238). With rare resignation Valdemar devoted the remainder of his life to the great work of domestic reform His noblest achievement in this respect is the codification of the Danish laws known as the *Jydske Lov* (Jutland Code), which he lived to see completed a few days before his death at Vordingborg on March 21, 1241 Valdemar was twice married, his first consort being Dragomir (Dagmar) of Bohemia, his second Berengaria of Portugal. All his four sons, Valdemar, Eric, Abel and Christopher became kings of Denmark.

See *Danmarks Riges Historie*, vol. i., pp. 736–849 (Copenhagen, 1897–1905). (R. N. B.; X.)

VALDEMAR IV., king of Denmark (*c.* 1320–1375), was the youngest son of Christopher II of Denmark Valdemar was brought up at the court of the German emperor, Louis of Bavaria, during those miserable years when Denmark was partitioned among Holstein counts and German *Ritter*, while Scania, "the bread-basket" of the monarchy, sought deliverance from anarchy under the protection of Magnus of Sweden Even the Hansa Towns, the hereditary enemies of Denmark, regarded the situation with disquietude "One would gladly have seen a single king in Denmark if only for peace sake," says the contemporary Lubeck chronicle, "for peace was not to be had either at sea or on land" The assassination at Randers of the detested Holstein tyrant Count Gerhard III (1340), who for nine years had held Jutland and Funen and dominated the rest of Denmark, first opened Valdemar's way to the throne, and on midsummer day 1340 he was elected king at a *Landsting* held at Viborg, after consenting to espouse Helveg, the sister of his most important confederate, Valdemar, duke of Schleswig

Valdemar could not have been more than 20 when he became the nominal king of Denmark, though, as a matter of fact, his territory was limited to the northernmost county of Jutland His precocious maturity is strikingly evident from the first An energy which never slackened, a doggedness which no adversity could crush, a fiery ambition coupled with the coolest calculation, and a diplomatic unscrupulousness which looked always to the end and never to the means, these were the salient qualities of the reconstructor of the dismembered Danish state First Valdemar aimed at the recovery of Zealand, which was actually partitioned among a score of Holstein mortgagees who ruled their portions despotically from their strong castles, and sucked the people dry The oppressed clergy and peasantry regarded Valdemar as their natural deliverer, but the work of redemption proved painfully slow

In Nov 1343 Valdemar obtained the town and castle of Copenhagen from King Magnus Smek of Sweden, by reconfirming in still more stringent terms the previous surrender of the rich Scanian provinces, and by the end of the following year he had recovered the whole of North Zealand In 1347 the remainder of Zealand was redeemed, and the southern isles, Laaland, Falster and Mon, also fell into the king's strenuous hands By this time, too, the whole of Jutland (except the province of Ribe) had fallen to him, county by county, as their respective holders were paid off. In 1349, at the *Landsting* of Ringsted, Valdemar proudly rendered an account of his stewardship to the Estates of Zealand, and the bishop of Roskilde congratulated him on having so miraculously delivered his people from foreign thraldom. In August 1346, he prudently rid himself of the distant and useless province of Estonia by selling it very advantageously.

In north German politics Valdemar interfered to protect his brother-in-law the Margrave Louis of Brandenburg against the

lords of Mecklenburg and the dukes of Pomerania, with such success that the emperor, Charles IV., at the conference of Bautzen, was reconciled to the Brandenburger and allowed Valdemar an annual charge of 16,000 silver marks on the city of Lübeck (1349). Some years later Valdemar even contemplated a descent on England in alliance with the French king John, but the chronic state of rebellion in western Denmark, which, fomented by the discontented Jutish magnates, lasted with short intervals from 1350 to 1360, and compelled Valdemar to renounce this fantastic design But he proved more than a match for his domestic rebels, especially after his great victory at Brobjaerg in Funen (1357) Finally, the compact of Kalundborg restored peace to the kingdom.

Valdemar now turned his eyes to the "kingdom of Scania." Valdemar had indeed pledged it solemnly and irrevocably to King Magnus of Sweden, who had held it for 20 years; but profiting by the difficulties of Magnus with his Norwegian subjects, after skilfully securing his own position by negotiations with Albert of Mecklenburg and the Hanseatic League, Valdemar suddenly and irresistibly invaded Scania, and by the end of 1361 all the old Danish lands, except North Holland, were recovered

By the recovery of Scania Valdemar had become the lord of the great herring-fishery market held every autumn from St. Bartholomew's day (Aug. 24) to St Denis' day (Oct. 9) on the hammer-shaped peninsula projecting from the S W corner of Scania containing the towns of Skanor and Falsterbo. This flourishing industry, which fully occupied 40,000 boats and 300,000 fishers assembled from all parts of Europe to catch and salt the favourite Lenten fare of the whole continent, was the property of the Danish crown, and the innumerable tolls and taxes imposed by the king on the frequenters of the market was one of his most certain and lucrative sources of revenue Foreign chapmen eagerly competed for special privileges of Skanör and Falsterbo, and the Hanseatic merchants in particular aimed at obtaining a monopoly there But Valdemar was by no means disposed to submit to their dictation, and political conjunctures now brought about actual hostilities between Valdemar and the Hansa, or at least that portion of it known as the Wendish Towns[1], whose commercial interests lay principally in the Baltic.

From time immemorial the isle of Gotland had been the staple of the Baltic trade, and its capital, Visby, whose burgesses were more than half German, the commercial intermediary between east and west, was the wealthiest city in northern Europe In July 1361 Valdemar set sail from Denmark at the head of a great fleet, defeated a peasant army before Visby, and a few days later the burgesses of Visby made a breach in their walls through which the Danish monarch passed in triumph. The conquest of Gotland at once led to a war between Valdemar and Sweden allied with the Hanseatic towns; but in the spring of 1362 Valdemar repulsed from the fortress of Helsingborg a large Hanseatic fleet provided with "shooting engines" (cannon) and commanded by Johan Wittenburg, the burgomaster of Lubeck In Sweden proper he was equally successful, and the general pacification which ensued in April 1365, very greatly in his favour, was cemented by the marriage of his daughter Margaret with Haakon VI of Norway.

Valdemar was now at the height of his power Every political rival had been quelled. With the papal see, since his visit to Avignon in 1364, he had been on the best of terms. His ecclesiastic patronage was immense, and throughout the land he had planted strong castles surely held by the royal bailiffs. But in the winter of 1367–68 a hostile league against him of all his neighbours threatened to destroy the fruits of a long and strenuous lifetime. The impulse came from the Hansa At a *Hansetag* held at Cologne on Nov. 11, 1367, three groups of the towns, seventy in number, concerted to attack Denmark, and in Jan. 1368 Valdemar's numerous domestic enemies, especially the Jutlanders and the Holstein counts, acceded to the league, with the object of partitioning the realm among them.

And now an astounding and still inexplicable thing happened. At Easter-tide 1368, on the very eve of this general attack, Valdemar departed for three years to Germany, leaving his realm in the capable hands of the earl-marshal Henning Podbusk. Valdemar's skilful diplomacy, reinforced by golden arguments, did indeed induce the dukes of Brunswick, Brandenburg and Pomerania to attack the confederates in the rear; but fortune was persistently unfriendly to the Danish king, and peace was finally concluded with the towns by Podbusk and the Danish Council of State at the congress of Stralsund, 1370. The conditions of peace were naturally humiliating for Valdemar, though, ultimately, he contrived to render illusory many of the inordinate privileges he was obliged to concede. He was also able, shortly before his death on Oct 24, 1375, to recover the greater part of Holstein from the rebels

See *Danmarks Riges Historie*, vol. ii., pp. 275–356 (Copenhagen, 1897–1905). (R. N. B.)

[1]Rostock, Greifswald, Wismar and Stralsund.

VALDES, JUAN DE (*c.* 1500–1541), Spanish religious writer, younger of twin sons of Fernando de Valdes, hereditary regidor of Cuenca in Castile, was born about 1500 at Cuenca He has been confused with his twin-brother Alphonso (in the suite of Charles V. at his coronation in Aix-la-Chapelle, 1520; Latin secretary of state from 1524, died in 1532 at Vienna) Juan, who probably studied at the University of Alcala, first appears as the anonymous author of a politico-religious *Diálogo de Mercurio y Caron*, written and published about 1528 A passage in this work may have suggested Don Quixote's advice to Sancho Panza on appointment to his governorship. The *Diálogo* attacked the corruptions of the Roman Church; hence Valdes, in fear of the Spanish Inquisition, left Spain for Naples in 1530 In 1531 he removed to Rome, where his criticisms of papal policy were condoned, since in his *Diálogo* he had upheld the validity of Henry VIII's marriage with Catherine of Aragon. From the autumn of 1533 he made Naples his permanent residence, his name being Italianized as Valdesso and Val d'Esso

Valdes' house on the Chiaja was the centre of a literary and religious circle; his conversations and writings (circulated in manuscript) stimulated the desire for a spiritual reformation of the church His first production at Naples was a philological treatise, *Diálogo de la Lengua* (1533) His works entitle him to a foremost place among Spanish prose writers His friends urged him to seek distinction as a humanist, but his bent was towards problems of Biblical interpretation in their bearing on the devout life Vermigli (Peter Martyr) and Marcantonio Flaminio were leading spirits in his côterie, which included Vittoria Colonna and her sister-in-law, Giulia Gonzaga On Ochino, for whose sermons he furnished themes, his influence was great Carnesecchi, who had known Valdes at Rome as "a modest and well-bred courtier," found him at Naples (1540) "wholly intent upon the study of Holy Scripture," translating portions into Spanish from Hebrew and Greek, with comments and introductions To him Carnesecchi ascribes his own adoption of the Evangelical doctrine of justification by faith, and at the same time his rejection of the policy of the Lutheran schism Valdes died at Naples in May 1541.

His death scattered his band of associates Abandoning the hope of a regenerated Catholicism, Ochino and Vermigli left Italy Some of Valdes's writings were by degrees published, in Italian translations. They combine a delicate vein of semi-mystical spirituality with the personal charm attributed to their author in all contemporary notices. Llorente traces in Valdes the influence of Tauler; any such influence must have been at second hand The *Aviso* on the interpretation of Scripture, based on Tauler, was probably the work of Alphonso. Valdes was in relations with Fra Benedetto of Mantua, the anonymous author of *Del Benefizio di Gesù Cristo Crocefisso*, revised by Flaminio (reprinted by Babington, Cambridge, 1855). The suggestion that Valdes was unsound on the Trinity was first made in 1567 by the Transylvanian bishop, Francis Dávid (*see* article SOCINUS); it has been adopted by Sand (1684), Wallace (1850) and other anti-Trinitarian writers, and is countenanced by Bayle. But Valdes never treats of the Trinity (even when commenting on Matt. xxviii. 19), reserving it (in his *Latte Spirituale*) as a topic for advanced Christians; yet he explicitly affirms the consubstantiality of the Son, whom he unites in doxologies with the

Father and the Holy Spirit (*Opusc.* p. 145). Practical theology interested him more than speculative; his aim being the promotion of a healthy and personal piety.

The following is a list of his writings:—*Diálogo de Mercurio y Caron* (no date or place; 1528?); *Diálogo de la Lengua* (written, 1533; first printed, Madrid, 1737, reprinted, 1860, 1873); *Qual Maniera si devrebbe tenere a informare . . gli figliuoli de Christiani delle Cose della Religione* (no date or place; before 1545, as it was used by the Italian translator of Calvin's catechism, 1545), Eng trans. by J. T. Betts, 1882; *Trataditos* (Bonn, 1881, from a manuscript in the Palatine Library, Vienna; in English, by J. T. Betts, in *XVII. Opuscules*, 1882); *Alfabeto Christiano* (written about 1537, in Italian, Venice, 1545, in English, by B B. Wiffen, 1861), *Ciento i Diez Conçideraçiones;* all copies of the original edition suppressed by the Spanish Inquisition; in English, by Nicholas Ferrar (at the instance of George Herbert), Oxford, 1638 (another version by J. T Betts, 1865); *Seven Doctrinal Letters* (original published with the *Trataditos* from Vienna mss. in English, by J. T Betts, with the *Opuscules*); *Comentario Breve . . sobre la Epistola de San Pablo a los Romanos* (Venice, 1556; in English, by J T. Betts, 1883); *Comentario Breve . . . sobre la Primera Epistola de san Pablo a los Corintios*, Venice, 1557 (No 8), *El Evangelio de San Mateo* (1881, from Vienna ms, in English, by J T Betts, 1883), *El Salterio* (the Psalms from Hebrew into Spanish published with the *Trataditos* from Vienna manuscript).

Notices of Valdes in Sand (*Biblioth Antitrinitar*, 1684), Bayle and Wallace (*Antitrin Biog*, 1850) are inadequate Revival of interest in him is due to McCrie (*Hist Ref in Italy*, 1827, *Hist Ref in Spain*, 1829) *See* B. Wiffen's *Life* of Valdes prefixed to Betts's translation of the *Considerations*, 1865. E Boehmer, *Span. Reformers of Two Centuries* (1874), *Lives of J and A. de Valdes* (1882), and article in *Realencyklopadie fur prot Theol und Kirche* (1885) *See* also M. Young, *Aonio Paleario* (1860), K Benrath. *Bernardino Ochino* (1875), Menendez Pelayo, *Los Heterodoxos Españoles* (1880); G. Bonet-Maury, *Early Sources of Eng Unit. Chrst.* (trans E P. Hall, 1884). (A. Go ; X.)

VALDEZ, a town of Alaska, the terminus of the wagon road, and farthest north all year open port in North America, situated 61° 07′ N, 146° 16′ W Selected in 1898 by the U S War Department as a base for exploration, it became the terminus of the military telegraph, connecting with the cable to the United States A military post, Ft Liscum, was built nearby, where troops were stationed until 1922, when they were withdrawn. There was also the Valdez-Fairbanks road, used for mails With the building of the Copper river railroad from Cordova, and later the Government railroad from Seward, and diversion of traffic, the population dwindled from 1.500 to 466 in 1920.

VALDIVIA, a southern province of Chile Area, 11.843 sq m Pop (1920) was 237,538, including that of the additions made to its territory in 1928. The province is roughly mountainous in the E, is heavily forested and is traversed by numerous rivers There is a chain of lakes across its eastern side near the Andes, the largest of which are Villarica, Rinihue and Ranco The rivers are the Toltén on the northern boundary, the Valdivia or Calle-Calle, with its large tributaries in the central part of the province, and the Bueno The Valdivia (about 100 m. long) has its sources in the Andes and flows west to the Pacific Its largest tributary on the north is the Río Cruces. The Valdivia is the outlet for Lake Rinihue and is navigable for a long distance. Valdivia is one of the most recently settled provinces and has a large immigrant element, chiefly German. Its most important industry is that of clearing away the heavy forests and marketing the timber Stock-raising is an important industry, and wheat is grown on the cleared lands. Lumber, cattle, leather, flour and beer are exported. The capital is Valdivia, a flourishing city on the Valdivia river, 12 m above its port, Corral, near the mouth of the river. Pop. (1920) 26.854 It is a roughly built pioneer town, in which wood is the principal building material. The mean annual temperature is 52·6° F and its annual rainfall is 105 inches

VALDOSTA, a city of southern Georgia, U.S A., the capital of Lowndes county. Pop 10.783 in 1920 (51% negroes); estimated locally at over 17,000 in 1928. Valdosta is the seat of the Georgia State Woman's college (opened 1913) and a junior college for men, established in 1928 by Emory university (Atlanta). It has four large tobacco warehouses. Its wholesale business amounts to $15,000,000 annually; its retail trade to $22,500,000; and its manufacturing plants (including cotton, feed and lumber mills) have an output of $15,750,000. Valdosta was settled in 1859 and was chartered in 1901.

VALENCE, a town of France, on the Rhône. Pop. (1926) 26,414. *Valentia* was the capital of the Segalauni, and the seat of a celebrated school before the Roman conquest, a colony under Augustus, and an important town of *Viennensis Prima* under Valentinian. Its bishopric dates probably from the 4th century It was ravaged by the Alani and other barbarians, and fell successively under the power of the Burgundians, the Franks, the sovereigns of Arles, the emperors of Germany, the dukes of Valentinois, the counts of Toulouse and its own bishops To strengthen the hands of the bishops against the dukes of Valentinois the pope in 1275 united their bishopric with that of Die The citizens put themselves under the protection of the dauphin, and in 1456 had their rights and privileges confirmed by Louis XI, the bishops consenting to recognize the suzerainty of the dauphin Valence became the capital of the Protestants of the province in 1563 The town was fortified by Francis I It had become the seat of a celebrated university in the 15th century; but the revocation of the edict of Nantes crippled the prosperity of the town

The cathedral of St Apollinaris, with an interesting apse, was rebuilt in the 11th century in the Romanesque style of Auvergne and consecrated in 1095 by Urban II It was injured in the wars of religion, but restored in the 17th century. A curious 16th century house (Maison des Têtes) has a sculptured front with heads of Homer, Hippocrates, Aristotle, Pythagoras, etc

VALENCIA, the name of a maritime province of eastern Spain, and anciently of a kingdom Pop. (1920) 926,442; area, 4,150 sq miles. When the ancient kingdom of Valencia was incorporated into Aragon in 1238, it included the provinces of Castellon de la Plana (*q v*) and Alicante (*q.v*). It was bounded inland on the north by Catalonia, west by Aragon and New Castile, and south by Murcia. This region has an area of 8,830 sq m; its present population is about 2,000,000 For its history *see* VALENCIA (city) The inhabitants are of very mixed race, owing to the successive occupation of the country by Iberians, Greeks, Carthaginians, Romans, Visigoths and Moors. Their dialect resembles Catalan but is softer, and contains a larger percentage of Arabic words The elaborate irrigation-works and the system of intensive agriculture which have rendered the *huertas* or gardens of Valencia celebrated were initiated by the Moors, the fame of the Elche date-groves, the Alicante vineyards and the Valencia orange plantations, was also originally due to them With the decline of the caliphate of Cordova early in the 11th century, Valencia became an independent kingdom, which passed successively into the power of the Almoravides and Almohades In 1609, 200,000 Moriscos, or Moors who outwardly professed Christianity, were banished from the country In 1833 Valencia was divided into the three provinces already named

The coast is skirted by considerable stretches of sand-dune, and by a series of these the lagoon called the Albufera (*q v*) de Valencia is separated from the Mediterranean The principal rivers are the Guadalaviar or Turia and the Jucar (*q v*) Irrigation disputes are settled by the peasants' Tribunal de las Aguas which meets weekly in front of Valencia cathedral

The *vegas* (cultivated plains) have an exceptionally fine, almost sub-tropical climate. In their low-lying portions rice is the favourite crop; elsewhere wheat, maize and all kinds of fruit; the mulberry is cultivated for silk; and wine and oil are produced Esparto grass is grown in the less fertile areas The fishing industry is considerable, and there are manufactures of silk, carpets and tapestry, woollen, hemp and linen fabrics, glass, pottery and leather; there are also iron foundries, distilleries, cooperages and oil refineries. The coast railway from Barcelona traverses the province. Valencia, the capital and principal seaport, and the towns of Alcira, Requena, Sueca, Játiva, Carcagente, Cullera, Utiel, Onteniente, Sagunto and Gandía, are described in separate articles. Other towns of more than 7,000 inhabitants are Algemesí (11,590), Catarroja (8,308), Oliva (8,995), Liria (9,557), Tabernes de Valldigna (9,563), and Torrente (9,952).

VALENCIA, capital of the Spanish province of Valencia, on the Guadalaviar or Turia, 3 m. from the Mediterranean sea, and 304 m by rail E S E of Madrid Pop. (1877) 143 856;

(1920) 251,258. The earliest mention of Valencia (*Valentia*) is by Livy (*Epit* lv), according to whom Junius Brutus settled the soldiers of Viriathus here in 138 B C., and invested the town with the *jus Latinum*. It sided with Sertorius (*c* 77 B C.), and was accordingly taken and partially destroyed by Pompey in 75 B.C.; but it must have recovered speedily, as it is mentioned by Pliny (iii. 4) as a colony in the region of the Edetani, and by Mela as an important place. It was taken by the Visigoths in A.D 413, and by the Moors in 714 An independent Moorish kingdom of Valencia was established in 1021, and extended from Almería to the Ebro estuary The Almoravides occupied the city in 1094, but it was retaken within a few months by the Christians under the Cid (*q v.*), from whom it is sometimes called Valencia del Cid The Moors recovered possession in 1101 and the kingdom was re-established in 1146. After 1172 it became tributary to Aragon, and in 1238 James I of Aragon added it to his dominions The first Spanish printing-press is said to have been set up here in 1474 Towards the close of the 15th century Valencia was annexed to Castile. In the 16th and 17th centuries it became the seat of a considerable school of painting In the War of Succession Valencia sided with the house of Austria In 1808 an abortive attempt to capture it was made by the French; they succeeded, however, in 1812, and held it till 1813

Valencia is the seat of an archbishop, a court of appeal, a university, a captain-general and an army corps. All round it stretches Huerta de Valencia, an alluvial plain with groves of oranges, lemons and mulberries The climate is mild and very dry; rain hardly ever falls. The white houses, often Moorish in architecture, and the multitude of domes and towers give to Valencia an oriental appearance. Until 1871 it was enclosed by a Roman wall rebuilt in 1356 by Pedro IV , two picturesque gateways with machicolated towers still remain The cathedral (La Seo), begun in 1262, possesses examples of 15th century sculpture and metal-work, as well as of the Valencian school of painting. The campanile (el Miguelete), an isolated octagonal Gothic tower, is 152 ft in height

Valencia university was formed about 1500 It began to decline in 1600 but was reorganized after 1848, and resumed its place as one of the leading universities. There is a provincial museum, with paintings by Velazquez, Ribera, Dürer; Juanes, Bosco, Goya and many modern artists

The principal manufacture is silk The town is also celebrated for its coloured tiles or "azulejos," its oranges and onions Linen, woollen and esparto fabrics, hats, fans, leather, paper, cigars, glass and pottery are also manufactured, and there are foundries and printing-works Corn, rice, silk, saffron, oranges, raisins, almonds, figs and other fruits are exported, and iron, hardware, timber, manure, grain and colonial produce are imported

The port of Villanueva del Grao is 3 m. E. by N. of Valencia. Spanish and British coasters chiefly call here.

BY COURTESY OF LEE

A CHARACTERISTIC HOME OF THE LOWER CLASS OF VENEZUELA, NEAR VALENCIA, SHOWING A CRUDE RICE HULLER IN THE CENTRE

VALENCIA, a city of Venezuela. Pop. (1927), 36,800. There are railway communications and also a steamboat service on Lake Valencia The lake is 1,348 ft. above the sea, is about 30 m. long and has an area of 216 sq m The city is beautifully situated in a large fertile valley between parallel ranges of the Maritime Andes, about 1,625 ft above sea-level, and in the midst of rich plantations and luxuriant tropical vegetation.

Valencia was founded in 1555 by Alonzo Diaz Moreno, being 12 years older than Caracas. It was occupied for a time in 1561 by Aguirre and his band of outlaws. At the beginning of the War of Independence it was made the capital of Venezuela, and the patriot congress was in session there on March 26, 1812, when Caracas was destroyed by an earthquake. In 1830 Valencia was the scene of the Constituent Congress, again in 1856 it was the meeting place of the celebrated National Convention and served the same purpose in 1870.

VALENCIA or **VALENTIA,** an island, county Kerry, Ireland, forming the southern horn of Dingle Bay. It is 7 m. long and 3 broad. It forms with the mainland a fine natural harbour, land-locked with narrow entrances, and a depth of about 40 ft. at low tide. At its north end is the Valencia Harbour station, while across the strait is Knightstown, on the island. The harbour is used by fishing vessels From Valencia the "Great Eastern" laid the cable to Newfoundland in 1866. On the island is a meteorological station. Its name is Spanish; the Irish called it Dairbhre, the oak forest.

VALENCIA DE ALCÁNTARA, a town of western Spain, in the province of Cáceres Pop (1920), 12,024 From the 16th century to the 18th Valencia was a celebrated border fortress; it was captured by the Portuguese in 1664 and 1698. Valencia de Alcántara is an important custom-house between Spain and Portugal, and has a flourishing trade in farm produce, and in phosphates from the mines. A Roman aqueduct still brings water to the main street; the courtyards and windows of many houses are Moorish in style.

VALENCIENNES, a town of northern France. Pop. (1926) 35,969. Valenciennes is said to owe its name and foundation to one of the three Roman emperors named Valentinian In the middle ages it was the seat of a countship which in the 11th century was united to that of Hainaut. In the 16th century Valenciennes became the stronghold of Protestantism in Hainaut, but was conquered by the Spaniards. In 1656 the Spaniards under Condé made a successful defence against the French under Turenne, but in 1677 Louis XIV. took the town and Vauban constructed the citadel. Valenciennes, which then became the capital of Hainaut, has since always belonged to France In 1793, after 43 days' bombardment, the garrison surrendered to the allied forces In 1815 it defended itself successfully The Scheldt here divides into two branches, one of which flows through the town, while the other, canalized and forming a port, skirts it on the west The Tour de la Dodenne (13th and 15th centuries) and the citadel (17th century) are the chief remains of the old fortifications. The town hall is early 17th century, with a 19th century façade The museum contains a good collection of paintings.

Valenciennes is the centre of the rich Anzin coal-field. There are important foundries, forges, rolling-mills, wire-works and machine shops. There is also an extensive beetroot cultivation, with attendant sugar-works and distilleries, and glass, starch, chemicals and soap are produced Hosiery, trimmings and handkerchiefs are manufactured and cotton weaving and printing are carried on, though little of the famous lace is now made.

VALENCY, in chemistry, is the power which atoms possess of combining with a definite number of other atoms, and is usually expressed numerically by the number of hydrogen atoms which an atom can combine with or replace.

When towards the middle of the 19th century the relative weights of atoms and molecules became accurately known, especially through the reintroduction by Cannizzaro in 1858 of Avogadro's principle (1811) of the relation between the molecular weight and the density of a gas, it was clear that the number of atoms with which a given atom could combine varied with the nature of that atom: that, for example, a chlorine atom could combine with one hydrogen atom, an oxygen atom with two, a nitrogen atom with three, and a carbon atom with four, as in the compounds HCl, H_2O, H_3N, H_4C. These characteristic combining powers were shown to extend to more complicated compounds: two of the four hydrogen atoms in methane, CH_4, could be replaced by one oxygen atom, or all four by two, or three by one nitrogen atom, as in H_2CO, CO_2, HCN. Thus it appeared that every atom could combine with or replace a definite number of other atoms of a specified kind, and hydrogen, as it was the lightest atom, and was never found to combine with more than one atom of another element, was selected as the standard. The term,

valency, introduced in 1868, is now adopted to express both the power of combination in general, and its numerical value.

As the examination of the valency of elements was extended, there was much dispute as to whether or not it was constant in value for any one element. It soon became evident that the valency of many elements was variable: for a time it was maintained that the variations were always by two units, so that elements could be divided into those of odd and those of even valency; but before long it was recognised that while this was true of many elements, there were others of which the valency must be admitted to vary by single units at a time, unless very improbable assumptions were made as to the structure of some of their compounds.

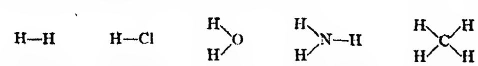
The discovery of the periodic classification of the elements through the work of Newlands, Mendeleyev and Lothar Meyer (1864–1869) brought to light a new regularity in the valencies of the elements (*see* PERIODIC LAW) Mendeleyev pointed out that all the elements of a periodic group had the same valency, and that this changed by one unit as we pass from one group to the next. In particular, the highest valency of an element, as shown in its highest oxide, is equal to the ordinal number of the group to which it belongs. On the other hand, the valency in the hydrides seems to rise with that in the oxides from one to four, and then to fall by steps of one unit to unity again This is illustrated by the following table, giving the two "short periods" of the periodic classification

Periodic Group	I	II	III	IV	V	VI	VII
	Li Na	Be Mg	B Al	C Si	N P	O S	F Cl
Highest oxide	Li_2O Na_2O	BeO MgO	B_2O_3 Al_2O_3	CO_2 SiO_2	N_2O_5 P_2O_5	SO_3	Cl_2O_7
Hydride	NaH	MgH_2		CH_4	NH_3	OH_2	ClH
Valency in oxide	1	2	3	4	5	6	7
Valency in hydride	1	2	3	4	3	2	1

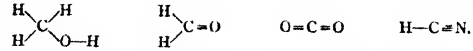
Thus the mysterious periodicity of properties revealed by the table was most clearly exemplified in the valency

Earlier Theories.—All discussions of valency in the 19th century were handicapped by the absence of any satisfactory theory of its cause Berzelius, in the earlier part of the century, had assumed that atoms were electrically charged, and were held together in the molecule by the attraction of opposite charges This view was supported by the phenomena of electrolysis, and especially by the work of Davy and Faraday Its validity as a general theory of valency was, however, destroyed about 1840 by the discovery that under some conditions "electropositive" could be replaced by "electronegative" atoms without any fundamental modification of the properties of the molecule; thus part of the hydrogen in acetic acid can be replaced by chlorine, and the product resembles the original acid in many ways, and obviously must have a similar structure. The attempts of Berzelius to stretch his theory to explain such phenomena led to its falling into discredit, and it was replaced by what ultimately became the theory of structural chemistry.

In this new theory no assumptions were made as to the nature of the forces connecting the atoms in a molecule, and hence no opposition in character between the atoms was required. Every atom was regarded as having a certain number of units of combining power, and every atomic link as involving the utilization of one of these units by each of the atoms concerned. Double and triple links, in which each of two atoms used up two or three of these units in combining with one another, were also recognized. The valency of an atom in the numerical sense was the number of such units which it possessed. On paper, the links were represented by lines, giving such formulae as



Hydrogen Hydrogen chloride Water Ammonia Methane



Methyl alcohol Formaldehyde Carbon dioxide Prussic acid

This theory had an astounding success in its application to organic chemistry. It was found possible to determine from the reactions of a substance the order in which the constituent atoms were linked in the molecule, and thus to assign to the vast hordes of organic compounds "structural formulae" which accounted for their existence and to a large extent also for their properties For an account of further extensions of this theory. which made it possible to determine the actual positions in space of the various atoms and groups in a molecule, *see* STEREOCHEMISTRY In consequence of these triumphs the older theory was disregarded, and chemists failed to realise that the views of Berzelius were quite satisfactory if their application was limited to the oppositely charged radicals in a salt.

The electrical theory again became prominent in and after 1887, with the rise of the Arrhenius theory of salt solutions which showed that when a salt is dissolved in water it is very largely broken up into oppositely charged ions (sodium chloride, for example, into positive sodium and negative chlorine ions) which have to a great extent the properties of free molecules. On the other hand atoms forming part of a complex radical do not separate in this way; thus potassium chlorate, $KClO_3$, breaks up in solution into potassium, K^+, and chlorate, ClO_3^-, ions, but the latter do not dissociate further into chlorine and oxygen. This made it clear that two kinds of links can be formed between atoms in a molecule, one of which is broken on solution in water (and other similar solvents) with the formation of ions, while the other is not To the first kind the theory of Berzelius, that the atoms are held together by their electrical charges, obviously applies: the work of Faraday and of Arrhenius shows that such atoms actually exist in solution with electrical charges, and further support is given by the observation that solvents of high dielectric capacity promote ionization, since such solvents would weaken the attraction between charged atoms The final confirmation of the theory has been given in recent years through the investigation of crystal structure, mainly by W. H. and W L Bragg and by Rubens, who have shown that with many salts (including sodium chloride itself), the ions are present as such in the solid crystal

It still remained to explain the second kind of linkage (non-ionized), and especially two of its peculiarities: (1) the fact that in many compounds the valency of an element is the same whether it is expressed in ionized or in non-ionized links, and (2) the relation between this numerical value and the position of the element in the periodic table This was the state of opinion towards the end of the 19th century.

Werner's Theory.—In 1893, an entirely new theory of valency was put forward by Alfred Werner, which was subject to quite different laws, and dealt primarily with a different—and previously somewhat neglected—class of compounds It had already become recognised that there were many substances, some of them quite stable, the structure of which could not be explained on the current theory of valency Most of these were formed by the combination of molecules which appeared to be already saturated, and so to have used up all their combining power; and often, though not always, the component molecules could easily be separated again Such substances were known as "molecular compounds" and were disregarded in the current theories of molecular structure, it being supposed that molecules retained the power of combining loosely with one another, in virtue of some force inferior to true valency. The most conspicuous examples are the compounds which many salts form with "water of crystallization," and those which many substances form with ammonia (*see* AMMINES). All attempts to formulate these on the accepted theories of valency had proved unsatisfactory. Werner collected an immense number of examples of such compounds, and showed that it was possible to formulate them on a new principle, to which he gave the name of co-ordination. The essence of this principle was that the combining powers of an atom depended not on the nature but on the number of the atoms or groups to which

it was attached. This number, which he called the co-ordination number, and which determined the formula of the compound and, in the new sense, the valency of the central atom, did not, as did the ordinary valencies, change from one atom to the next, but was most frequently six, sometimes four, and less often had other values. Thus platinic chloride, $PtCl_4$, forms a series of addition compounds with ammonia, and also with potassium chloride. Werner showed that in all of these the platinum has six groups—chlorine atoms or ammonia molecules—attached to it by links which are not ionized in solution, while any further atoms in the molecule are ionized, and are presumably attached by weaker links in the "outer sphere" of the platinum, outside the co-ordination complex. This is shown by the following formulae, in which the atoms enclosed in square brackets are those which are found not to ionize:

$[Pt(NH_3)_6]Cl_4$ $\quad$ $[Pt(NH_3)_5Cl]Cl_3$ $\quad$ $[Pt(NH_3)_2Cl_4]$ $\quad$ $K_2[PtCl_6]$

It will be seen that in the series of transformations the platinum atom always retains a group of six atoms or molecules attached to it by non-ionized links In its application to addition compounds of this kind, Werner was able to show that his theory was quite satisfactory. He subsequently extended it to the whole of chemistry; but in this he was not followed by the majority of chemists. In particular the complicated relations of the great mass of compounds of carbon—some hundreds of thousands of substances—were found to be adequately explained by the older structural theory Indeed Werner's theory, even in its application to inorganic compounds, was not regarded very seriously by chemists until, in 1911, he was able by its means to predict the occurrence of optical activity (*see* STEREOCHEMISTRY) in certain structures, and to verify his predictions by experiment It then became recognised that the theory in its original sphere—that of inorganic chemistry—had strong claims to be accepted

The doctrine of atomic linkage was thus brought into the very unsatisfactory state that two apparently incompatible theories held the field. Each was successful in explaining the behaviour of one class of compounds, but neither could be extended to cover the whole ground It was evident that the true theory still remained to be discovered, and that when it was discovered the structural theory and the theory of co-ordination would be seen to be two imperfect aspects of one truth

The position which chemistry had reached at the beginning of the present century was therefore this. It appeared that the links which hold together the atoms in a molecule can be of three kinds. (1) Polar or ionized links, between the oppositely charged ions of a salt (2) Non-polar non-ionized links, which can exist between atoms of a similar or even identical character, and are peculiarly common among the compounds of carbon. (3) The co-ordinated links of Werner, which are not ionized, are capable of uniting apparently saturated atoms, and occur mainly in inorganic compounds

There was the further peculiarity that an atom was found to be in general capable of forming the same number of links of the first and of the second kind, and that this number depended on its position in the periodic table The number of links of the third kind which it could form had no relation to its periodic group, and was usually six, sometimes four, while other numbers were comparatively rare

Atomic Structure and Valency.—These important, but obviously not final, conclusions were the result of the chemical investigation of the structures of molecules. Their further development, and their combination into one uniform system, were rendered possible only by the increase of our knowledge of the physical structure of the atom (*q.v.*). Of this it is enough to say here that mainly through the work of J. J. Thomson, Rutherford, Moseley, and Bohr, it was shown that every atom consists of a minute positively charged nucleus, surrounded by a number of negative electrons which are arranged in groups, revolving at greater or smaller distances from the nucleus. The number of electrons (which is also the number of positive charges on the nucleus) is also the ordinal number (from 1 for hydrogen to 92 for uranium) of the element in the natural series (the periodic classification) which agrees in almost every case with the order of the atomic weights; this is known as the atomic number (*q v.*).

As it thus appears that every atom contains one electron more than that of the preceding element, the periodic table acquires a new meaning. The regular recurrence of a definite set of properties after a definite number of places suggests that the number of electrons so added form a new and complete group, and that, for example, lithium (3) and sodium (11) resemble one another because the eight extra electrons of the latter are grouped together, leaving a similar arrangement of the chemically active electrons in both atoms. It may further be assumed that since certain elements—the inert gases such as helium and argon—have practically no power of chemical combination, the stability of the electronic groups in the atoms of these gases is already so great that it cannot be improved by interaction with other atoms; and that other elements combine to form molecules because by so doing they can rearrange their electrons in a more stable manner The atomic numbers of the inert gases (helium 2, neon 10, argon 18, krypton 36, xenon 54, radon 86) will thus give the total number of electrons in a series of stable groups, and their differences (2, 8, 8, 18, 18, 32) the sizes of individual groups We may suppose that other elements tend by combination to acquire electronic groups of these or similar sizes

The first attempts to work out a theory of valency along these lines were published in 1916 by Kossel in Germany and by G N Lewis in America Kossel dealt with polar or ionized links and Lewis with non-ionized

Kossel's Theory.—Kossel pointed out that the element next after an inert gas (and so with one electron more) is always a strong univalent metal, forming an ion with one positive charge, whilst the element one place before an inert gas forms an ion with one negative charge In the same way an element two places after an inert gas gives an ion with two positive, and that two places before it an ion with two negative charges If we write down for a series of elements the atomic number, the charge on the ion, and the number of electrons in the ion (obtained by subtracting the positive or adding the negative charges), we find the same resultant number for an inert gas and for its neighbours on both sides, thus

Element	O	Cl	Ne	Na	Mg	Al
Atomic number	8	9	10	11	12	13
Ion	O^{--}	Cl	Ne	Na^{+}	Mg^{++}	Al^{+++}
Electrons in ion	10	10	10	10	10	10

It is evident that the guiding principle is the stability of the $10(=2+8)$ electrons If an atom has a few more than this, it loses the excess. if a few less, it makes up the defect The force holding the atoms together in the resulting molecule is the electrostatic attraction of the oppositely charged atoms, and when the compound is dissolved in a medium of high dielectric constant such as water, this force is weakened, and the thermal agitation is sufficient to separate the charged atoms or ions from one another The valency is the number of electrons which the atom gains or loses in forming the ion, and is (at any rate in such elements as these) the difference between its atomic number and that of the neighbouring inert gas Since the inert gases form Group O in the periodic table, this gives us the relation between the periodic group and the valency which, as was pointed out above, is found to hold for the hydrides of the elements.

It is an essential characteristic of the compounds with which Kossel's theory deals that the two combining atoms should be of opposite character: that they should stand in the series on opposite sides of an inert gas, so that one has an excess and the other a defect of electrons. But, as we have seen, there are many compounds in which we do not find this opposition, and cannot say which of the atoms is positive and which negative; as in the compounds of carbon with hydrogen and oxygen, or more striking still, in the compounds of the elements with themselves which occur in the polyatomic molecules of the free elements, as H_2, N_2, O_2, P_4, etc. Such compounds are further distinguished by the fact that they do not ionize in solution It is evident that the linkage

in such molecules must be due to some different physical mechanism from that established by Kossel in ionized molecules.

Theory of Lewis.—The solution of this problem was given by Lewis in the same year in which Kossel's paper appeared. He suggested that it was possible for electrons to be shared between two atoms in such a way that they formed part of the constitution of both. As he accepted the static atom, he did not discuss how the sharing took place. Even now, though we know that the electrons are in motion, and have some knowledge of how they move round the nucleus of an isolated atom, very little has been discovered about the dynamics of the shared electron; we may, however, assume that as in the isolated atom the electron moves round one nucleus, so an electron which is shared between two atoms revolves round the nuclei of both. But for our present purpose it is enough to assume that the sharing is in some way possible, without inquiring more closely into its mechanism. This assumption makes possible a kind of link which is not broken in solution by ionization, and does not involve any opposition of character between the linked atoms; it further explains why this form of link is peculiarly common amongst atoms a few places before an inert gas, since they can remedy their defect of electrons by using some of them twice over. We can also explain by its means the remarkable fact that the valency of an atom has normally the same value in its non-ionized compounds as in its salts. For example, chlorine forms a univalent negative ion, because it is one electron short of the stable number of argon. This defect also enables it to form a single covalency (non-ionized link) as in methyl chloride, $CH_3—Cl$, because by sharing a single electron belonging to the carbon it can complete its stable number. Both the covalency and the electrovalency of such a negative atom are equal to the number of electrons needed to make up the inert-gas number, and hence equal to the number of places in the periodic table by which the element is removed from the next following inert gas. On the other hand, a metal like aluminium, as it has three loosely attached electrons, can lose these by ionization and form a trivalent positive ion Al^{+++}. . . For the same reason it can share three electrons with other atoms or groups, as in $Al(CH_3)_3$, but it cannot share more without disturbing the arrangements of its inner electrons (the core of the atom). The covalency of such a metal is, like its electrovalency, the number of electrons which it has in excess of an inert gas.

One other point is to be noticed about the covalency. A fundamental principle in all theories of valency other than that of co-ordination is that when two atoms form a link, whether covalent or electrovalent, each of the two uses up a unit of combining power. Thus sodium has one such unit, and so has chlorine. When they combine, neither has any power of further combination. So too, hydrogen has one unit, and carbon four: when four atoms of hydrogen combine with one of carbon to form methane, the hydrogen loses its power of further combination as well as the carbon, and a saturated molecule is produced. When the linkage is ionized the explanation is simple. Every such link involves the migration of an electron from one atom to the other, so that the metal loses one loosely attached electron, and at the same time the other atom fills up one of its gaps. If the same is to hold for the covalent link, we must suppose that when atom A combines with atom B, not only does A share one of B's electrons, but at the same time B shares one of A's: the covalent link must consist of two shared electrons, so that its formation involves the addition of one electron to each of the atoms concerned. This was pointed out by Lewis in 1916, as a necessary result of the simple laws of valency. Later work has shown that an unstable linking of hydrogen to another atom by means of a single shared electron is possible in a few compounds; but it is clear that the two-electron link is the almost invariable form of the covalency.

Co-ordinate Valency.—Thus the physical theory of atomic structure has provided an explanation of the mechanism both of electrovalencies and of covalencies. The explanation of the third form of attachment, the co-ordinate link, is almost equally simple: it was suggested by Lewis in 1916, although he did not develop the idea in detail. It is clear from the behaviour of Werner's compounds that the co-ordinate link is of the nature of a covalency. As we have seen, the units of the co-ordination complex do not ionize, while other groups in the molecule outside the complex do so. The occurrence of optical activity (*see* STEREOCHEMISTRY) dependent on the position of the groups composing the complex, and independent of the ionized groups outside it, is further evidence of the same thing. We may therefore conclude that the co-ordinated atoms or radicals are attached to the central atom by covalencies, that is, by pairs of shared electrons. Where these groups have a valency of one in the ordinary sense (univalent radicals or groups such as chlorine or NO_2) this needs no further explanation: the difficulty is to explain the replacement of such radicals by complete molecules like water or ammonia. In ammonia the nitrogen has increased its valency electrons from the original five to eight by combining with three hydrogen atoms. It thus has a complete valency group of eight electrons ("octet"), of which six are shared with the three hydrogen atoms, while the other two are not shared, and form what is called (in America) a "lone pair." All that is necessary to explain the co-ordination is to suppose that the nitrogen shares this lone pair with the platinum, thus forming a covalency differing from that previously discussed only in this, that the two shared electrons both come from the same atom. This explanation of the co-ordinate link of Werner satisfies all requirements. It explains why the link is not ionized, since it is in fact a covalency. It explains why it is often more easily broken than an ordinary covalency, since the nitrogen or other atom forming it can recall the two electrons which it has lent. It explains why the co-ordination number of an element can remain constant through a whole series of compounds, in spite of variations in the electrovalency, that is, in the electrical charge of the complex, for the co-ordination number is the number of pairs of shared electrons required to make up a stable valency group for the central atom. It accounts for the fact that while the valency in the ordinary sense changes by one unit as we go from one atom to the next, the co-ordination number is usually six or four independently of the periodic group to which the element belongs: the ordinary valency depends on the number of electrons which the atom originally had (the atomic number), whilst the co-ordination number depends only on the stable size of the valency group, which for most atoms is 12 or 8. We can also account on this theory for the remarkable change in the electrovalency which, as we have seen, accompanies the replacement of, say, an ammonia molecule in the complex by a chlorine atom, the electrovalency increasing by one if it is negative, and diminishing by one if it is positive, as is shown in the change from $[Pt(NH_3)_6]Cl_4$ to $[Pt(NH_3)_5Cl]Cl_3$. For when the ammonia molecule is removed, it takes with it the pair of electrons which formed its co-ordinate link to the central atom, when a neutral chlorine atom takes its place, it only offers one electron for the link, and so another electron must be introduced from outside, which gives the complex a negative charge; or, to put it in another way, if the chlorine is to take the place of the nitrogen and provide both electrons for the link, it must already have a complete octet, and so must be not a neutral chlorine atom (which has only seven valency electrons), but a negatively charged chlorine ion.

In this way we can now see that the theory of Werner is only one aspect of a physical process of which the older structural theory is another. The co-ordinate link and the ordinary covalency are of the same kind, consisting of pairs of shared electrons, but the manner in which they arise is different.

The electronic theory thus accounts for all the various kinds of linkage which can arise between atoms by the redistribution of their valency electrons. The cause of this redistribution is the possibility of producing a more stable arrangement of the electrons.

Octet Theory.—So far, it has been assumed that the stable forms attained are in general those which occur in the inert gases. The physicists have shown (*see* ATOMIC STRUCTURE) that the electrons of an isolated atom arrange themselves in groups or shells, and the outermost group contains eight electrons in all the inert gases except helium, which has a single group of two. Hence in the majority of molecules, and in nearly all those hitherto discussed, the result of the combination is to give an outer group

of eight electrons to all the atoms concerned except those of hydrogen, which have two. This is the basis of the octet theory, originally proposed by Lewis, and developed in great detail by Irving Langmuir. But if the largest valency group possible is eight, and every covalency consists of two electrons, the highest covalency possible for any atom must be four. The existence of such bodies as sulphur hexafluoride SF_6, a very stable gas, and of the co-ordination compounds already mentioned, shows that a covalency of six is possible, and hence a valency group of twelve; and we know of atoms which exert a covalency of eight, and so must have a valency group of 16 electrons, such as osmium in the octafluoride OsF_8 This seems to open up almost infinite possibilities of combination; but it is found that it is not every atom which can form these large groups The size of the valency group of an element is limited according to the position which it occupies in the periodic table, but the limitation does not depend on the (vertical) periodic group to which it belongs, as does that of the ordinary valency, it is determined by the (horizontal) period For hydrogen it is four (covalency two; one of the two links must of course be co-ordinate); for the elements of the first short period (lithium to fluorine) it is eight (covalency, four); for those of the second short and the first long periods (sodium to chlorine, and potassium to bromine) it is 12 (covalency, six), whilst for the heavier elements it is 16, corresponding to a covalency of eight This refers to the maximum size possible, which is not always reached

The electrons surrounding an atom in a molecule can thus be divided into two parts, the valency group, including the shared electrons, and the inner groups, the electrons of which are all unshared, and which may be called the core; and changes of valency may either be due to changes in the size or the utilization (extent of sharing) of the valency group, or to changes in the size of the core In many elements, including all those of the first two periods, the core cannot be changed by chemical means: it consists of a series of complete electronic groups, which are too stable to be affected by chemical forces. (These are the elements included in the Abridged Classification in the article PERIODIC LAW) With these, a change of valency can only occur through the valency group being completed, or, if it is already complete, being more fully shared Thus boron, with three valency electrons, can form three covalencies as in the fluoride BF_3, sharing each of its electrons with a fluorine atom, and receiving one electron in return from each Though this only gives it six valency electrons, it cannot combine with a fourth (neutral) fluorine atom, because it has no more valency electrons to offer But with a fluorine ion (which has a complete octet) it can form a co-ordinate link, if the ion shares a pair of its electrons with the boron:

$$\begin{array}{c} F \\ \ddot{} \\ F{:}\,B \\ \ddot{F} \end{array} \quad + \quad F' \quad = \left[\begin{array}{c} F \\ \ddot{} \\ F{:}\,B.\,F \\ \ddot{F} \end{array}\right]$$

We thus get the four-covalent complex BF_4^- which, however, necessarily has the negative charge given it by the fluorine ion, and so appears as the anion of a salt such as $K[BF_4]$. In this way the boron changes its valency from three to five (four covalencies and one electrovalency). In the same way the nitrogen of ammonia, though it has a complete octet, only shares six of these electrons. It can, however, increase its valency by sharing the other pair with a hydrogen ion·

$$\begin{array}{c} H \\ \ddot{} \\ H{:}\,N{:} \\ \ddot{H} \end{array} \quad + \quad H^+ \; = \left[\begin{array}{c} H \\ \ddot{} \\ H{:}\,N{:}\,H \\ \ddot{H} \end{array}\right]^+$$

The complex now has the positive charge of the hydrogen ion, and so forms the ammonium cation, as in $[NH_4]Cl$. In this way a trivalent element can increase its valency to five, its covalency rising to four, while the complex acquires one unit of charge, that is, one electrovalency. Further changes of the same kind are possible with the heavier elements, the valency group of which is not limited to eight Thus silicon, with four valency electrons, can form the tetrafluoride SiF_4, with a complete and fully shared octet It is, however, able to hold a valency group of twelve, and can obtain this by forming two co-ordinate links with two fluorine ions:

$$\begin{array}{c} F \\ \ddot{} \\ F{:}\,Si\,{:}F \\ \ddot{F} \end{array} \; + \; 2F^- \; \longrightarrow \left[\begin{array}{c} F \\ \ddot{} \\ F{:}\,Si\,{:}F \\ F{:} \quad\; {:}F \\ \ddot{F} \end{array}\right]$$

acquiring at the same time two negative charges. We thus get the anion of the silicofluorides (such as $K_2[SiF_6]$) in which the valency of the silicon has risen from four to eight (six covalencies and two electrovalencies) The same thing can happen without the production of an electrovalency, if an atom shares a lone pair of its electrons with, say, an oxygen atom, which needs two to make up its octet. For example, chlorine completes its octet by combining with a hydroxyl (H–O–) group in hypochlorous acid H–O–Cl In this molecule the chlorine has three lone pairs, so that it can form co-ordinate links with as many as three oxygen atoms, giving the series

$HClO$	$HClO_2$	$HClO_3$	$HClO_4$
Hypochlorous acid	Chlorous acid	Chloric acid	Perchloric acid

If, as is commonly done, we regard this link to the oxygen as equivalent to two valencies (in the older structural formulae it was necessarily written as a double link), the chlorine here appears with the valencies of 1, 3, 5 and 7.

It will be observed that all these changes of valency in which the core of the atom is unaffected, occur by two units at a time; and this is the main cause of the belief held in the early days of the theory of valency that the various valencies of an atom were either all even or all odd

Transitional Elements.—The elements commonly called transitional, those which are enclosed in frames in the Bohr classification (*see* ATOMIC STRUCTURE) and are relegated to table 2 in the article PERIODIC LAW, have in the outermost (valency) group of the isolated atom one or two electrons, and in the next group, which forms the outermost group of the core, not the stable numbers 2, 8 or 18, but some number intermediate between 8 and 18 A group of this size does not hold its electrons very firmly, and one or two of them can be detached by chemical action. Thus iron (26), in which the successive groups of the free atom are 2, 8, 14, 2, can lose its two outermost electrons in the usual way to form the bivalent cation Fe^{++}=2, 8, 14. But by more energetic treatment a third electron can be detached from this ferrous ion leaving the trivalent ferric ion Fe^{+++}=2, 8, 13 In this particular element the process in nearly all the compounds stops here, but with others it goes further· thus manganese [(25)=2, 8, 13, 2] can have valencies of 2, 3, 4, 5, 6 and 7. In the last of these states the core is reduced to 18=2, 8, 8, the stable arrangement of argon. Thus the transitional elements show valencies varying by single units, often over a wide range, the limit being that in which the core is reduced to the size of the preceding inert gas, or in other words, the highest valency being that corresponding to the periodic group to which the element belongs.

Copper and gold, though not strictly transitional elements, have many of the properties of such elements. They have the outer electronic groups 18, 1. The single electron of the outermost group is readily detached to give the univalent cuprous and aurous ions. But the 18 group, though it is normally very stable, is less so when the positive charge on the nucleus is barely sufficient to neutralize it, or in other words when its electrons are moving in a very weak electric field. Hence, in copper one, and in gold two, of these 18 electrons can be detached from the group, giving the cupric and auric compounds, such as $CuCl_2$ and $AuCl_3$, with the respective groups 17 and 16. Silver, which has a similar structure, might be expected to behave in the same way; but for some reason which is not understood the 18 group in silver is more stable and cannot be broken down; hence silver is almost invariably univalent. In the elements following these three in the table, from zinc, cadmium and mercury onwards, the increased charge on the nucleus holds the 18 group so firmly that its electrons cannot be removed. (N. V. S.)

VALENS, East Roman emperor from 364 to 378, owed his elevation in the 36th year of his age to his brother, Valentinian, who chose him to be his associate in the empire. Valens had been attached to Julian's bodyguard, but he did not inherit the military ability of his father, Gratian of Pannonia. A revolt headed by Procopius in the second year of his reign was quelled by the ability of his generals. In the year 366 Valens at one stroke reduced the taxes of the empire by one-fourth, a very popular measure, though one of questionable policy in the face of the threatening attitude of the Goths on the lower Danube Before venturing on a campaign against them, Valens received baptism from Eudoxus, the Arian bishop of Constantinople. After some small successes over the Goths, won by his generals (367–369), Valens concluded a peace with them, which lasted six years, on a general understanding that the Danube was to be the boundary between Goths and Romans On his return to Constantinople in 369–370 Valens began to persecute his orthodox and Catholic subjects, but he lacked the energy to carry out his edicts.

In the years 371 to 377 Valens was in Asia Minor, most of the time at the Syrian Antioch Though anxious to avoid an Eastern war, because of danger nearer home from the Goths, he was compelled to take the field against Shapur II Valens crossed the Euphrates in 373, and drove back the king of Persia to the farther bank of the Tigris But the Roman success was by no means decisive, and no definite understanding as to boundaries was come to with Persia. Valens returned to Antioch, where in the winter of 373–374 he instituted a persecution of magicians. Between 374 and 377 we read of grievous complaints of injustice and extortion perpetrated under legal forms Although preparations were made for following up the war with Persia and securing the frontier, a truce was patched up, rather to the disadvantage of the empire, Armenia and the adjacent country being half conquered and annexed by Shapur The armies of Rome, in fact, were wanted in another quarter The Huns, of whom we now hear for the first time, were beginning in 376 to press the Goths from the north, and the latter asked leave of the emperor to cross the Danube into Roman territory. This they were allowed to do, on the condition that they came unarmed, and their children were transported to Asia as hostages The conditions, however, were not observed by the imperial generals Accordingly, the enraged Goths, under their chief Fritigern, streamed across the Balkans into Thrace and the country round Adrianople, plundering, burning and slaughtering as they went They were driven back for a time, but returned in the spring of 378 in greater force, with a contingent of Huns and Alans; and penetrated to the neighbourhood of Adrianople Valens left Constantinople in May 378 with a strong and well-officered army Without awaiting the arrival of his nephew Gratian, emperor of the West, who had just won a great victory over the Alamanni, Valens attacked the enemy at once The battle, which was fought on confined ground in a valley, was decided by a cavalry charge of the Alans and Sarmatians, which threw the Roman infantry into confusion and hemmed it in so closely that the men could scarcely draw their swords. The slaughter, which continued till the complete destruction of the Roman army, was one of the greatest recorded in antiquity. Valens perished either on the field or, as some said, in a cottage fired by the enemy From the battle of Adrianople the Goths permanently established themselves south of the Danube

See Ammianus Marcellinus, bks. 26–31; E Gibbon, *The Decline and Fall of the Roman Empire* (ed Bury, London, 1909), chs 25–26; Hodgkin, *Italy and Her Invaders* (1880; 2nd ed, 1892–99), vol. i; F. Runkel, *Die Schlacht bei Adrianopel* (Berlin, 1903).

VALENTINE or VALENTINUS, the name of a considerable number of saints. The most celebrated are the two martyrs whose festivals fall on Feb. 14, the one, a Roman priest, the other, bishop of Terni (Interamna). The *Passion* of the former is part of the legend of SS Marius and Martha and their companions; that of the latter has no better historical foundation; so that no argument can be drawn from either account to establish the differentiation of the two saints. It would appear from the two accounts that both belonged to the same period, *i.e.,* to the reign of the emperor Claudius (Gothicus); that both died on the same day; and that both were buried on the Via Flaminia, but at different distances from Rome The *Martyrologium Hieronymianum* mentions only one Valentinus: "Interamnae miliario LXIIII. via Flaminia natale Valentini." The St Valentinus who is spoken of as the apostle of Rhaetia, and venerated in Passau as its first bishop, flourished in the 5th century. For the observances connected with St. Valentine's Eve and Day, *see* John Brand's *Popular Antiquities* (edited by W. C. Hazlitt, vol ii. pp. 606–11, London, 1905), W. Hone's *Every-Day Book,* and Chamber's *Book of Days* The association of the lovers' festival with St. Valentine seems to arise from the fact that the feast of the saint falls in early spring, and is purely accidental

See *Acta Sanctorum,* February, ii. 753, 756, and January, i. 1094, G B de Rossi, *Bullettino di archeologia cristiana* (1871), p 101 and (1878), p. 59.

VALENTINE AND ORSON, a romance attached to the Carolingian cycle It is the story of twin brothers, abandoned in the woods in infancy Valentine is brought up as a knight at the court of Pippin, while Orson grows up in a bear's den to be a wild man of the woods, until he is overcome and tamed by Valentine, whose servant and comrade he becomes The two eventually rescue their mother Bellisant from the power of a giant There are versions of the tale, which appears to rest on a lost French original, in French, English, German, Icelandic, Dutch and Italian. In the older versions Orson is described as the "nameless" one

The French romance was printed at Lyons in 1489. *The Historye of the two Valyannte Brethren· Valentyne and Orson* . . . by Henry Watson (*c.* 1550) is the earliest known English version A ballad on the subject was printed in Percy's *Reliques* For a detailed bibliography of the English, French, German, Dutch and Italian forms of the tale, *see* W Seelman, "Valentin und Namelos" (Norden and Leipzig, 1884), in vol. iv of *Niederdeutsche Denkmaler.*

VALENTINIAN I., Roman emperor of the West from A D. 364 to 375, was born at Cibalis, in Pannonia He had been an officer of the guard under Julian and Jovian, and had risen high in the imperial service He was chosen emperor in his forty-third year by the officers of the army at Nicaea in Bithynia in 364, and shortly afterwards named his brother Valens (*q v*) colleague with him in the empire. As emperor of the West, Valentinian took Italy, Illyricum, Spain, the Gauls, Britain and Africa, leaving to Valens the eastern half of the Balkan Peninsula, Greece, Egypt, Syria and Asia Minor as far as Persia During the short reign of Valentinian there were wars in Africa, in Germany and in Britain, and Rome came into collision with the Burgundians, Saxons and Alamanni The emperor's chief work was guarding the frontiers and establishing military positions Milan was at first his headquarters for settling the affairs of northern Italy; next year (365) he was at Paris, and then at Reims, to direct the operations of his generals against the Alamanni who were driven back to the German bank of the Rhine, and checked for a while by a chain of military posts and fortresses At the close of 367, however, they suddenly crossed the Rhine, and sacked Moguntiacum (Mainz) Valentinian attacked them at Solicinium (Sulz in the Neckar valley or Schwetzingen) with a large army, and defeated them with considerable loss on his own part. Later, in 374, he made peace with their king, Macrianus The next three years he spent at Trier, which he chiefly made his headquarters, organizing the defence of the Rhine frontier

During his reign the coasts of Gaul were harassed by the Saxon pirates, with whom the Picts and Scots of northern Britain joined hands, and ravaged the island from the wall of Antoninus to the shores of Kent. In 368 Theodosius was sent to drive back the invaders, in this he was completely successful, and established a new British province, called Valentia In Africa the Moorish prince, Firmus, raised the standard of revolt against Count Romanus, the military governor The services of Theodosius were again requisitioned He landed in Africa with a small band of veterans, and Firmus, to avoid being taken prisoner, committed suicide. In 374 the Quadi, a German tribe in what is now Moravia and Hungary, resenting the erection of Roman forts to the north of the Danube, and further exasperated by the treacherous murder of their king, Gabinius, crossed the river and laid waste the province of Pannonia. The emperor, in April of the following year,

entered Illyricum with a powerful army, but during an audience to an embassy from the Quadi at Brigetio on the Danube (near Pressburg) died in a fit of apoplexy.

Valentinian's general administration seems to have been thoroughly honest and able, in some respects beneficent If he was hard and exacting in the matter of taxes, he spent them in the defence and improvement of his dominions. Though himself a plain and almost illiterate soldier, he was a founder of schools, and he also provided medical attendance for the poor of Rome, by appointing a physician for each of the fourteen districts of the city He was an orthodox Catholic, but he permitted absolute religious freedom to all his subjects The great blot on his memory is his cruelty, which at times was frightful

See Ammianus Marcellinus xxv–xxx; Gibbon, *Decline and Fall*, chap 25; T. Hodgkin, *Italy and her Invaders*, bk 1 chap 3, H Richter, *Das westromische Reich* (1865), pp 240–268

VALENTINIAN II., son of the above, an infant of four in 375 with his half-brother Gratian (*q.v.*) a lad of about seventeen, became the emperors of the West They made Milan their home; and the empire was nominally divided between them, Gratian taking the trans-Alpine provinces, whilst Italy, Illyricum in part, and Africa were to be under the rule of Valentinian, or rather of his mother, Justina In 387 Magnus Maximus (*q v.*), who had in 383 overthrown Gratian and made himself master of the northern provinces, crossed the Alps and threatened Milan The emperor and his mother fled to Theodosius, the emperor of the East Valentinian was restored in 388 by Theodosius Four years later he was murdered at Vienne in Gaul, probably at the instigation of his Frankish general Arbogast

See Gibbon, *Decline and Fall*, chap. 27, H Richter, *Das weströmische Reich unter den Kaisern Gratian, Valentinian II. und Maximus* (1865), pp 577–650, and O Seek, *Untergang des antiken Welt*, Vol 5 (1897–1921).

VALENTINIAN III., emperor of the West from 425 to 455, the son of Constantius and Placidia He was only six years of age when he ascended the throne, and during his minority the conduct of affairs was in the hands of his mother His reign is marked by the dismemberment of the Western Empire, the conquest of the province of Africa by the Vandals in 439; the loss of great portions of Spain and Gaul, in which the barbarians had established themselves, and the ravaging of Sicily and of the western coasts of the Mediterranean by the fleets of Genseric As a set-off against these calamities there was the great victory of Aetius over Attila in 451 near Châlons, and his successful campaigns against the Visigoths in southern Gaul (426, 429, 436), and against various invaders on the Rhine and Danube (428–31) Ravenna was Valentinian's usual residence; but he fled to Rome on the approach of Attila, who ravaged North Italy in 452 In 454 Aetius was treacherously murdered by Valentinian. Next year, however, the emperor himself was assassinated by two of the barbarian followers of Aëtius He was self-indulgent, incompetent, and vindictive.

Our chief original sources for the reign of Valentinian III are Jordanes, Prosper's *Chronicles*, written in the 6th century, and the poet Apollinaris Sidonius *See* also Gibbon, *Decline and Fall*, chaps 33–35 and pp. 24 and 25 (ed London, 1909); J. B Bury, *Later Roman Empire*, bk. ii. chaps 6–8, E A Freeman, "Tyrants of Britain, Gaul and Spain" (*Eng Hist. Review*, January 1886), and "Aetius and Boniface" (*ibid*, July 1887).

VALENTINUS, pope for thirty or forty days in 827, in succession to Eugenius II. (824–27) He was a Roman by birth, and, according to the *Liber Pontificalis*, was first made a deacon by Paschal I. (817–24). Nothing further is known of his history. His successor was Gregory IV (827–44)

VALENTINUS and **THE VALENTINIANS.** Valentinus, the most prominent leader of the Gnostic movement, was born, according to Epiphanius (*Haer.* 31, 2), near the coast in Lower Egypt, and was brought up and educated in Alexandria Valentinus came to Rome (*c.* 135–160) during the episcopate of Hyginus, flourished under Pius and stayed till the time of Anicetus. According to Irenaeus iii. 3, 4, Polycarp, during his sojourn in Rome under the episcopate of Anicetus, converted a few adherents of the Valentinian sect. Tertullian (*Adv. Valentin.* cap. 4) declares that Valentinus came to Rome as an adherent of the orthodox Church, and was a candidate for the bishopric of Rome, but he abandoned the Church because a confessor was preferred to him for this office. The credibility of this statement may be questioned Great uncertainty attaches to the residence of Valentinus in Cyprus, recorded by Epiphanius (*loc. cit.*), who places it after his stay in Rome, adding that it was here that he definitely accomplished his secession from the Church. But it seems to be clear that Valentinus did not, like Marcion, break with the Church from the very beginning, but endeavoured to maintain his standing within it.

Justin's *Syntagma*, which treats of Valentinus, is unfortunately lost. Irenaeus, *Adversus Haereses*, i. 11, 1–3, as in every other article where named, has preserved what is obviously an older document, possibly from Justin, dealing with Valentinus's own teaching and that of two of his disciples The sketch which he gives is the best guide for the original form of Valentinianism For Valentinus himself we have also to consider the fragments of his writings preserved by Clement of Alexandria The best edition of and commentary on them is Hilgenfeld's *Ketzergeschichte des Urchristentums* (pp. 293–307). Irenaeus also gives a detailed account of the two chief schools following Valentinus, the school of Ptolemaeus (i. 1–10), and Marcus and the Marcosians (i 13–21). For his account of the Ptolemaeans, Irenaeus seems to have used various writings and expositions of the school, especially prominent being a collection of Scripture proofs which may have once had a separate literary existence (i. 1, 3; 3, 1–5 [6]; 8, 2–4). To this is appended in a somewhat disconnected fashion a commentary on the prologue to the fourth Gospel (i 8, 5) Irenaeus himself twice prefaces his remarks by saying he is indebted to other authorities for his exposition (i. 2, 3–4, 7, 2–5) *Excerpta ex Theodoto* which are to be found in the works of Clement and may be looked upon as a collection made by the author with a view to the unfinished eighth book of his *Stromateis*. The lost *Syntagma* of Hippolytus, which can be partially reconstructed from Philaster (*Haereses*) and from pseudo-Tertullian (*Adversus Valentinianos*), seems to furnish us with valuable information as to the earlier doctrines of the sect, and in his second treatise against heretics, the so-called *Philosophumena* (6, 29 *seq*), Hippolytus gives a homogeneous and continuous exposition of a later Valentinian system, possibly connected with the school of Ptolemaeus Important, too, are Hippolytus' references to an Italic and an Anatolian branch of the Valentinian sect (6, 35) Tertullian gives at the beginning of his treatise against the Valentinians a few separate notices of the life and disciples of Valentinus, but his further argument is closely dependent upon Irenaeus' exposition of the Ptolemaean system, which he embellishes in his usual fashion with bitterly sarcastic comments Epiphanius deals with Valentinus and his school in sections 31–36 of his work. He has preserved a valuable letter of Ptolemaeus to Flora, which is of the highest importance for the understanding of Gnosticism

Valentinus is the only one of the Gnostics who had a whole series of disciples who are known by name—indeed, in the accounts of the Church Fathers his own system and views are almost entirely obscured by the accounts of those of his disciples The most important disciples are the two dealt with at length by Irenaeus, Ptolemaeus and Marcus, who both seem to have had a numerous following. Also, there was Herakleon, of whose commentary on the gospel of St. John extensive fragments are preserved by Origen. Ptolemaeus and Herakleon are counted by Hippolytus (6, 35) among the Italic branch of Valentinianism. There was also the Anatolian branch, as representative of which Hippolytus mentions Axionicus, who is also referred to by Tertullian as having actually been taught in Antioch. The *Excerpta ex Theodoto* in Clement are also, according to the superscription, fragments from the Anatolian Gnosticism. It is, however, an error when Hippolytus speaks of Bardesanes as representative of this branch, for he had an entirely distinct position. Valentinianism was based on primitive gnosticism (*q v.*), with the doctrines of which Valentinus may have become acquainted in Egypt. The mother goddess stands at the centre of the system. The main doctrines are outlined below.

(1) Valentinus has a system of thirty aeons, but the quite shadowy plurality of ten and twelve aeons (the *Dekas* and the *Dodekas*) of the Valentinian system we may at once set aside as mere fantastical accretions We have left only a group of eight celestial beings, the so-called Ogdoas, and of these eight figures four again are peculiar to this system.

(2) The first pair of aeons, *Bythos* and *Sige*, is an original innovation of the Valentinian school, and clearly betrays a monistic tendency. According to Irenaeus's account of the "Gnostics" (i 29), their theory was that *Sophia* casts herself into the primal substratum of matter (*Bythos*) to be found outside the celestial world of aeons But in the Valentinian system matter is not originally and irretrievably separated from the higher celestial world but the latter originally exists for itself alone; the fall or disturbance is accomplished within the celestial world, and the material world first comes into existence through the fall

(3) There remain a double pair of aeons, the Father and Truth, the *Anthropos* and the *Ekklesia* With the celestial Primal Man—of whom the myth originally relates that he has sunk into matter and then raised himself up from it again—is associated the community of the faithful and the redeemed who are to share the same fate with him

(4) In the true Valentinian system the so-called *Christos* is the son of the fallen Aeon, who is thus conceived as an individual *Sophia*, who in a frenzy of love had sought to draw near to the unattainable *Bythos*, brings forth, through her longing for that higher being, an aeon who is higher and purer than herself, and at once rises into the celestial worlds Among the Gnostics of Irenaeus we find a kindred conception but with a slight difference. Here *Christos* and *Sophia* appear as brother and sister, *Christos* representing the higher and *Sophia* the lower element In the enigmatic figure of *Christos* we again find hidden the original conception of the Primal Man, who sinks down into matter but rises again (In the later Valentinian systems this origin of the *Christos* is entirely obscured, and Christ, together with the Holy Spirit, becomes a later offspring of the celestial world of aeons, this may be looked upon as an approximation to the Christian dogma)

(5) A figure entirely peculiar to Valentinian Gnosticism is that of *Horos* (the Limiter) The name is perhaps an echo of the Egyptian *Horus* The peculiar task of *Horos* is to separate the fallen aeons from the upper world of aeons He becomes a kind of world-creative power, who in this capacity helps to construct an ordered world out of *Sophia* and her passions He is also called, curiously enough, *Stauros* (cross), and we frequently meet with references to the figure of *Stauros* But we must not be in too great a hurry to assume that this is a Christian figure. A Platonic conception may have been at work here The cross can also stand for the wondrous aeon on whom depends the ordering and life of the world, and thus *Horos-Stauros* appears here as the first redeemer of *Sophia* from her passions, and as the orderer of the creation of the world which now begins The figure of *Horos-Stauros* was often assimilated to that of the Christian Redeemer.

(6) The dualism of the two separate worlds of light and darkness was thus overcome This derivation of the material world from the passions of the fallen *Sophia* is, however, affected by an older theory according to which the son of *Sophia*, whom she forms on the model of the *Christos* who has disappeared in the higher heavens, becomes the *Demiourgos*, who with his angels now appears as the real world-creative power These two conceptions had now to be combined at all costs And it is interesting to observe here what efforts were made to give the *Demiourgos* a better position. According to the older conception, he was an imperfect, ignorant, half-evil and malicious offspring of his mother, who has already been deprived of any particle of light (Irenaeus i 29, 30) In the Valentinian systems he appears as the fruit of *Sophia's* repentance and conversion He is no longer called *Jaldabaoth*, but has been assigned the better name, drawn from the philosophy of Plato, of *Demiourgos* The *Demiourgos* of the Gnostic corresponded to the God of the Old Testament, which again suggests a compromise with the Christian faith

(7) With the doctrine of the creation of the world is connected the subject of the creation of man. We fortunately know, from a fragment preserved by Clement, that Valentinus here preserved the old Gnostic myth practically unaltered in his system According to it, the world-creating angels—not one, but many—create man, but the seed of the spirit comes into their creature without their knowledge, by the agency of a higher celestial aeon, and they are then terrified by the faculty of speech by which their creature rises above them, and try to destroy him A definite Valentinian idea is here added in that of the threefold nature of man, who is represented as at once spiritual, psychical and material. In accordance with this there also arise three classes of men, the *pneumatici*, the *psychici* and the *hylici* (ὕλη, matter) All the other Gnostic systems recognize only a dual division, the children of light and the children of darkness That the Valentinians should have placed the *psychici* between the *pneumatici* and *hylici* signifies a certain recognition of the Christian Church and its adherents who are not treated as outcasts.

(8) At the centre of the whole Valentinian system naturally stands the idea of redemption, and so we find here developed particularly clearly the myth of the heavenly marriage already known from Irenaeus i 30 to be Gnostic Redemption is essentially accomplished through the union of the heavenly *Soter* with the fallen *Sophia* This myth of the redeemer is of significance for the practical piety of the Valentinian Gnostics It is the chief idea of their pious practices mystically to repeat the experience of this celestial union of the *Soter* with *Sophia* In this respect, consequently, the myth underwent yet wider development Just as the *Soter* is the bridegroom of *Sophia*, so the heavenly angels, who sometimes appear as the sons of the *Soter* and *Sophia*, sometimes as the escort of the *Soter*, are the males betrothed to the souls of the Gnostics which are looked upon as feminine Thus every Gnostic had his angel standing in the presence of God and the object of a pious life was to bring about and experience this inner union with the celestial abstract personage This leads us straight to the sacramental ideas of this branch of Gnosticism

(9) With this celestial *Soter* of the Valentinians and the redemption of *Sophia* is connected the figure of Jesus of Nazareth and the historical redemption connected with his name The *Soter*, the bridegroom of Sophia, and the earthly Jesus answer to each other as in some way identical Here again we recognize the artificial compromise between Gnosticism and Christianity

(10) The Valentinians laid down that even the Redeemer has a threefold nature, from his mother, Sophia, he derived his nature as a *pneumaticos*, in the world of the Demiourgos he was united with the Christos, and finally a wonderful bodily nature was formed for him from celestial elements, which was yet not of earthly material As such he was miraculously born of the Virgin The compromises with the Catholic Church are here obvious Also, there was the idea that upon this Jesus, so constituted, yet another celestial nature, the Christos or the Soter, has descended at his baptism

The first survey of these confused speculations, these myths gathered together and preserved from the ancient world, this marshalling together of the most varied traditions, and above all, these artificial attempts at compromise, makes us inclined to doubt whether it was possible for any true piety to coexist with all this Yet such piety existed, indeed we have here a set of regular mystics It is not, indeed, a purely spiritual and mystical piety, but a mysticism much distorted and over-grown with sacramental additions and a mysterious cult But all this is not without an inner value and an attractive atmosphere. In a letter in Clement ii 20, 114, Valentinus sets forth that the soul of man is like an inn, which is inhabited by many evil spirits "But when the Father, who alone is good, looks down and around him, then the soul is hallowed and lies in full light, and so he who has such a heart as this is to be called happy, for he shall behold God "

But with this mysticism is connected the mystery and cult of the sacrament The lofty spirituality of the Gnostic degenerates over and over again into a distinctly material and sensual attitude, in which all kinds of efforts are made actually to assimilate to oneself the divine through external means

The chief sacrament of the Valentinians seems to have been that of the bridal chamber. Just as the apostle Paul represented his Christianity as a living, dying and rising again with Christ, so the first concern of the pious Valentinian was the experience of the divine marriage feast of Sophia. As Sophia was united with the Soter, her bridegroom, so the faithful would experience a union with their angel in heaven Through a fortunate chance, a liturgical formula which was used at this sacrament appears to be preserved It runs. "I will confer my favour upon thee, for the father of all sees thine angel ever before his face . . we must now become as one, receive now this grace from me and through me, deck thyself as a bride who awaits her bridegroom, that thou mayest become as I am, and I as thou art Let the seed of light descend into thy bridal chamber; receive the bridegroom and give place to him, and open thine arms to embrace him Behold, grace has descended upon thee"

Besides this the Gnostics already practised baptism, using the same form in all essentials as that of the Christian Church The name given to baptism was *apolytrosis* (liberation) In one of the formulae occur the words. "I would enjoy thy name, Saviour of Truth" The concluding formula of the baptismal ceremony is "Peace over all upon whom the Name rests" (Irenaeus i 21, 3) This name pronounced at baptism over the faithful has above all the significance that the name will protect the soul in its ascent through the heavens, conduct it safely through all hostile powers to the lower heavens, and procure it access to Horos, who frightens back the lower souls by his magic word

Here and there a reaction took place against the absurdity of this sacramental superstition Thus Irenaeus (i 21, 4) tells us of certain Gnostics who would admit no external holy practices as efficacious A pure piety breathes in the words of the Gnostics preserved in *excerpta ex Theodoto*, 78, 2 "But not baptism alone sets us free, but knowledge (*gnosis*) who we were, what we have become, where we were, whither we have sunk, whither we hasten, whence we are redeemed, what is birth and what rebirth"

We have seen that Valentinian Gnosticism affected the nearest approach of all the Gnostic sects to the Catholic Church Valentinus's own life indicates that he for a long time sought to remain within the official Church, and had at first no idea of founding a community of his own

And yet this reconciliation of Gnosticism was a fruitless and henceforward a purposeless undertaking Oriental dualism and wildly intemperate Oriental mythology had grown into so radical and essential a part of Gnosticism that they could not be separated from it to make way for a purer and more spiritual view of religion. And at a time when the prevailing tendency of Christianity was a struggle out of the darkness of Oriental mythology and eschatology into clearness, and an effort towards union with the lucid simplicity of the Hellenic spirit, these Gnostics, for all their efforts, and even the most noble of them, had come too late They are not the men of a forward movement, but they are, and remain, in spite of all clearer insight, the rear-guard of piety

See Bibliography to article GNOSTICISM Also E F. Scott, art "Valentinianism" in Hastings *Encyclopaedia of Religion and Ethics*, vol. xii , R A Lipsius, art "Valentinus" in Smith's *Dictionary of Christian Biography; Pauly-Wissowa, Realencyklopadie des klassischen Altertums*, s v *Gnosticismus, Gnostiker*; G Heinrici, *Die Valentinianische Gnosis und die heiligen Schriften* (1871) ; and A Harnack, "Brief des Ptolomaeus und die Flora," *Sitzungsber. der Berl. Akademie* (1909).

VALENZUELA, FERNANDO DE (1630–1692), Spanish royal favourite and minister, was born at Naples on Jan 19, 1630 He obtained a footing in the palace by his marriage with Maria de Uceda, lady-in-waiting to Mariana, Philip IV.'s second wife. When he was appointed introducer of ambassadors (Oct. 12, 1671), it became notorious that whoever had a petition to present must apply to him He became popularly known as the *duende*, the fairy or brownie of the palace, and was believed to be the lover of the queen Dismissed (1675) from court by intrigue, he was made marquis of Villa Sierra by the queen and ambassador to Venice He exchanged the embassy for the governorship of Granada, organized a counter-intrigue and returned to court. The queen-regent appointed him prime-minister and made him a grandee, to the profound indignation of the other grandees At the palace revolution of Jan 1678, Valenzuela fled to the Escorial, was captured, degraded from the grandeeship, exiled to the Philippines and his property confiscated. He died in Mexico on Feb 7, 1692.

See *Documentos inéditos para la Historia de España*, vol. lxvii. (1842, etc.).

VALERA Y ALCALÁ GALIANO, JUAN (1824–1905), Spanish novelist, entered diplomacy in 1847 and became unpaid attaché to the Spanish embassy at Naples under the famous duke de Rivas. He held various other diplomatic posts until 1858 when he returned to Spain and entered the House of Deputies, taking his place with the Liberal opposition On the flight of Isabella II in 1868 he was elected deputy for Montilla in the province of Cordova, became under-secretary of state for foreign affairs, and was one of the deputation who offered the crown to Amadeus of Savoy in the Pitti Palace at Florence Though he always called himself a Moderate Liberal, Valera invariably voted for what are considered Radical measures in Spain, and a speech delivered by him in Feb. 1863 against the temporal power of the pope created a profound sensation However, though a member of the revolutionary party, he steadily opposed organic constitutional changes, and therefore he retired from public life during the period of republican government After the Bourbon restoration he acted as minister at Lisbon (1881–83), at Washington (1885), at Brussels (1886) and as ambassador at Vienna (1893–95), retiring from the diplomatic service on March 5, 1896 During his last ten years he took no active part in politics

Valera's *Poesías* (1858) are imitative exercises rather than original poetry His criticism in the *Estudios críticos sobre literatura* (1864), in the *Disertaciones y juicios literarios* (1878) and in the *Nuevos estudios críticos* (1888) show penetration and taste, but also an excessive amiability He said a hundred incisive, wise, witty, subtle and suggestive things concerning the mysticism of St Theresa, the art of novel-writing, *Faust*, the Inquisition, *Don Quixote*, Shakespeare, the psychology of love in literature; but, to do himself justice, it was an almost indispensable condition that he should deal with the past In the presence of a living author Valera was disarmed

When in his 50th year, he published *Pepita Jiménez* (1874) a recital of the fall of Luis de Vargas, a seminarist who conceived himself to be a mystic and a potential saint, and whose aspirations dissolve at the first contact with reality It is easy to point out blemishes: the story is not well constructed, and it has pauses during which the writer's fantasy plays at pleasure over a hundred subjects not very germane to the matter; but its characters are as real as any in fiction, the love story is told with the most refined subtlety and malicious truth, while page upon page is written in such Spanish as would do credit to the best writers of the 16th and 17th centuries A second novel, *Las ilusiones del Doctor Faustino* (1875), was received with marked disfavour, and has the faults of over-refinement and of cruelty; yet in keen analysis and in humour it surpasses *Pepita Jiménez*. The *Comendador Mendoza* (1877) is more pathetic and of a profounder significance, and if *Doña Luz* (1879) repeats the situation and the general idea already used in *Pepita Jiménez* it strikes a deeper and more tragic note, which came as a surprise to those familiar only with the lighter side of Valera's genius Besides these elaborate psychological studies, Valera issued a volume of *Cuentos* (1887), some of these short tales and dialogues being marvels of art and of insight.

At the close of the 19th century Valera was recognized as the most eminent man of letters in Spain. He had not Pereda's force nor his energetic realism; he had not the copious invention nor the reforming purpose of Pérez Galdós; yet he was as realistic as the former and as innovating as the latter. And, for all his cosmopolitan spirit, he fortunately remained intensely and incorrigibly Spanish. His aristocratic scepticism, his strange elusiveness, his incomparable charm are his own; his humour, his flashing irony, his urbanity are eminently the gifts of his land and race. He is by no means an impersonal artist; in almost every story there is at least one character who talks and thinks

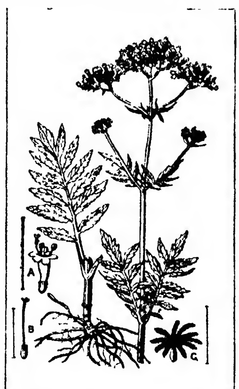
and subtilizes and refines as Valera himself wrote in his most brilliant essays. This may be a fault in art, but, if so, it is a fault which many great artists have committed (J F-K)

VALERIA, VIA, an ancient highroad of Italy, the continuation north-eastwards of the Via Tiburtina (*q.v.*) It probably owed its origin to M Valerius Messalla, censor in 154 B C It ran first up the Anio valley past Varia (*q v.*), and then, abandoning it at the 36th mile, where the Via Sublacensis diverged, ascended to Carsioli (*q.v.*), and then again to the lofty pass of Monte Bove (4,003 ft), whence it descended again to the valley occupied by the Lago di Fucino (*q v*) The difficult route from Cerfennia, the easternmost point of Marsian territory, to the valley of the Aternus (mod. Pescara)—a drop of nearly 1,000 ft , involving too the crossing of the main ridge of the Apennines (3,675 ft) by the Mons Imeus (mod Forca Caruso)—was not made into a highroad until the reign of Claudius, who also constructed a road, the Via Claudia Nova, connecting the Via Salaria which it left at Foruli (mod. Civitatomassa, near Amiternum) with the Via Valeria near the modern Popoli This road was continued south to Aesernia From Popoli the road followed the valley of the Aternus to its mouth, and there joined the coast-road at Pescara The modern railway from Rome to Castellammare Adriatico follows closely the line of the Via Valeria

See R. Gardner in *Papers of the British School at Rome*, ix , 75–106

VALERIAN, a genus of herbaceous perennial plants of the natural order Valerianaceae. Two species—*Valeriana officinalis* and *V dioica*—are indigenous in Britain, while a third, *V pyrenaica*, is naturalized in some parts The valerians have opposite leaves and small flowers, usually white or reddish, and arranged in terminal cymes The limb of the calyx is remarkable for being at first inrolled and afterwards expanding in the form of a feathery pappus which aids in the dissemination of the fruit. The genus comprises about 150 species, which are widely distributed in the temperate parts of the world In medicine the root of *V officinalis* is intended when valerian is mentioned

Valerian is cultivated in England, but to a much greater extent in Saxony, in Holland and in the United States The dried root or rhizome consists of a short central erect portion, about the thickness of the little finger, surrounded by numerous rootlets about $\frac{1}{10}$ of an inch in diameter, the whole being of a dull brown colour. When first taken from the ground it has no distinctive smell; but on drying it acquires a powerful odour of valerianic acid This odour, now regarded as intolerable, was in the 16th century considered to be fragrant, the root being placed among clothes as a perfume (Turner, *Herbal*, 1568, part iii p 76), just as *V. celtica* and other species are still used in the East



VALERIAN (VALERIANA OFFICINALIS), ONE-THIRD NATURAL SIZE
A. flower; B. flower after removal of corolla; C. fruit crowned by the feathery pappus (A, B, & C enlarged)

The red valerian of gardens is *Centranthus ruber*, also belonging to the Valerianaceae; but Greek valerian is *Polemonium coeruleum*, belonging to the family Polemoniaceae. Cats are nearly as fond of the smell of this plant as of the true valerian, and will frequently roll on the plant and injure it.

The chief constituent of valerian is a volatile oil, which is present in the dried root to the extent of 1–2%, plants growing on dry or stony soil being said to yield the largest quantity. The oil is of complex composition, containing valerianic (valeric), formic and acetic acids combined with a terpene, $C_{10}H_{16}$; the alcohol known as borneol; and pinene Valerian acts medicinally entirely in virtue of its volatile oil, which exerts the actions typical of its class. The special use of this drug, like that of others which contain an offensive volatile oil—such as asafoetida—is in hysteria

VALERIANUS, PUBLIUS LICINIUS, Roman emperor from A D. 253 to 260. He was of noble family, and in 238 was *princeps senatus* In 251, when Decius revived the censorship with practically supreme civil authority, Valerian filled the post Gallus, the successor of Decius, summoned him from the upper Rhine in 253 when threatened by the rebellion of Aemilianus The soldiers, however, proclaimed Valerian emperor, and marching slowly towards Rome he found both his rivals dead, slain by their own soldiers Trouble on the frontiers east and west was complicated by something near national bankruptcy Valerian left his son, Gallienus in charge of the wars in Europe; and took the offensive against the Goths, recaptured Antioch and marched to relieve Edessa He was defeated and taken prisoner, and disappears from history (258)

See Trebellius Pollio, *Life of Valerian* (frags); Aurelius Victor. *Caesares*, 32 , Eutropius ix 6; Ammianus Marcellinus xxiii 5; Zosimus i. 27; Gibbon, *Decline and Fall*, chap 10, H Schiller, *Geschichte der romischen Kaiserzeit* (1883–86) 1 pt 2

VALERIC ACID or **VALERIANIC ACID,** an organic acid belonging to the fatty acid series ($C_nH_{2n+1}\cdot CO_2H$) It exists in four different forms, all having the same formula, $C_4H_9\,CO_2H$ (*See* ISOMERISM.) One of these contains an asymmetric carbon atom and consequently occurs in two optically active modifications and one optically inactive modification. Ordinary valeric acid (baldrianic acid) is a mixture of *iso*valeric acid or *iso*propylacetic acid $(CH_3)_2CH\cdot CH_2\,CO_2H$, and optically active methylethylacetic acid $(CH_3)(C_2H_5)CH\,CO_2H$, both of which occur free or as esters in the vegetable and animal kingdoms, chiefly in the roots of *Angelica archangelica* and *Valeriana officinalis* It may be extracted by boiling with water or soda A similar product is obtained by oxidizing fermentation amyl alcohol with chromic acid Isovaleric acid is an oily liquid having the odour of stale cheese and boiling at 174° C, its salts are usually greasy to the touch Potassium permanganate oxidizes it to β hydroxisovaleric acid $(CH_3)_2\,C(OH)\,CH_2\cdot CO_2H$, whilst nitric acid gives, among other products, dinitropropane, $(CH_3)_2C(NO_2)_2$ The acid has been synthesized as has also the inactive form of methylethylacetic acid; this modification is split into its optical antipodes by crystallization of its brucine salt Normal valeric acid or propylacetic acid, $CH_3\,CH_2\cdot CH_2\,CO_2H$, is a liquid boiling at 186° The remaining isomeride, pivalic or trimethylacetic acid, $(CH_3)_3C\,CO_2H$, melts at 35° and boils at 163°; it is prepared by oxidizing pinacolin (*See* KETONES)

VALERIUS FLACCUS, GAIUS, Roman poet, flourished under Vespasian and Titus He has been identified on insufficient grounds with a poet friend of Martial (i 61 76), a native of Padua His work, the *Argonautica*, dedicated to Vespasian on his setting out for Britain, was written during the siege, or shortly after the capture of Jerusalem by Titus (70) It is an epic in eight books on the Quest of the Golden Fleece and is not wholly extant Part is borrowed from Apollonius of Rhodes

The *Argonautica* was unknown till the first four and a half books were discovered by Poggio at St Gall in 1417. The *editio princeps* was published at Bologna (1474) Recent editions by G Thilo (1863), with critical notes; C Schenkl (1871), with bibliography, E Bahrens (1875), with critical introduction; P Langen (1896), with Latin notes, and short introductions on the style and language, Caesar Giarratano (1904) , *see* also J Peters, *De V F. Vita et Carmine* (1890); W C. Summers, *Study of the Argonautica* (1894).

VALERIUS MAXIMUS, Latin writer, flourished in the reign of Tiberius His family was poor, and he owed everything to Sextus Pompeius (consul A D 14), proconsul of Asia and a kind of minor Maecenas, whom he accompanied to the East in 27. He intimates that his work is intended as a commonplace book of historical anecdotes for use in the schools of rhetoric The stories are loosely and irregularly arranged, and are from Roman history, but each section includes extracts from the annals of other peoples, principally the Greeks The work reproduces the general feeling of the empire, that the Romans of the day are degenerate compared with their ancestors, but still vastly superior to the rest of the world

The author's chief sources are Cicero, Livy, Sallust and Pom-

peius Trogus. In spite of his confusions, contradictions and anachronisms, the excerpts are apt illustrations. Valerius often used sources now lost, and affords us some glimpses of the much debated and very imperfectly recorded reign of Tiberius Modern criticism will hardly regard as flattery his description of Tiberius, once so misunderstood, as *salutaris princeps.* He reveals the transition from classical to silver Latin It is an instructive lesson to compare minutely a passage of Valerius with its counterpart in Cicero or Livy The tenth book of the ms, the *Liber de Praenominibus,* is much later The collection was used as a schoolbook, and was very popular in the middle ages

One complete epitome, probably of the 4th or 5th century, bearing the name of Julius Paris, has come down to us; also a portion of another by Januarius Nepotianus Editions by C Halm (1865) and C Kempf (1888), contain the epitomes of Paris and Nepotianus

VALÉRY, PAUL (1871–), French poet, was born at Cette on Oct 30, 1871 He first became known as the author of several apocalyptic poems of remarkable beauty and form, which appeared in such reviews as *L'Ermitage, Le Centaure,* etc., and were issued later in a collection entitled *Album de Vers anciens* (1920). From 1900 to 1917 Valéry lived in strict retirement and published nothing During this period, however, his ideas matured, and he accumulated material later given to the public in *Cahier B, Rhumbs* and *Analecta* It was not until 1917 that he published his first great poem *La Jeune Parque,* dedicated to André Gide. Then came *Aurore* (1917), *Le Cimitière marin* (1920), *Le Platane, L'Ebauche d'un Serpent,* etc., which appeared in a collection entitled *Les Charmes* (1922). Valéry has also written critical essays (on Stendhal, Poe, etc) and philosophical treatises (*Introduction à la méthode de Léonard de Vinci, Soirée avec M. Teste*) of which some have been collected under the title *Variétés* (1924), *Eupalinos* and *Ame et la Danse* (1923), two Platonic dialogues.

Valéry initiated a new movement in French poetry. Influenced by Mallarmé, especially in his sense of verbal music, he believes with the symbolists that pure poetry must have value in itself apart from any reference to the accidents of being Interested in philosophy and mathematics he is a poet-mathematician trying to set his subtle analysis to music Valéry has been a member of the Académie française since 1926

See H A. L. Fisher, *Paul Valéry* (1927), R Fernandat, *P Valéry* (1927), P Soudav, *P. Valery* (1927), *Hommys des Louvain étrangers à Paul Valéry* (Maestricht, 1928), containing appreciations by R M. Rilke, R Kayser, T. Shuge Moon, P. Ziffer, E. Cecchi, and others

VALHALLA, according to the heathen Scandinavians the abode where the souls of those who had fallen in battle (Old Norse *Valholl, i e,* "hall of the slain") are received by the god Odin, and fight and feast in his service. (*See* TEUTONIC PEOPLES.)

VALJEVO, a town in western Serbia, Yugoslavia, lying in a pine clad valley 627 ft above sea level Pop (1921) 9,768 Valjevo is a prosperous little town, lit by electricity. It forms the headquarters of the western division of the Serbian army and is the most important strategic point in this part of the country. Besides being the centre of the plum growing and distillery industries, Valjevo has a considerable trade in cattle, the pastures watered by the Kolubra being famous The best nut trees in Serbia flourish here. It was at Valjevo that the standard of revolt against the Turks was raised in 1804, and during the second rising in 1815 Prince Milosh captured the town.

VALKYRIES, generally represented in Northern mythology as divine maidens who, sent by Odin, ride through the air to determine the course of battles and to select brave warriors for Valhalla (*q.v*). Beings with the same name (*waelcyrgean*) were in England associated with witches

(*See* TEUTONIC PEOPLES)

VALLA, LORENZO or **LAURENTIUS** (*c.* 1406–1457), Italian humanist, was born at Rome about 1406, his father, Luca delle Vallea, being an advocate. He was educated at Rome, became a priest in 1431, and wandered from one university to another lecturing. About 1435 he became private secretary to Alphonso V of Aragon, who ever afterwards protected him, and later helped him to open a school at Naples Valla by now had achieved a great reputation by the *De Voluptate* and the *De Elegantiis Linguae Latinae* The first is a remarkable dialogue presenting in turn the Stoic, Epicurean and Christian ethical systems Christianity is allowed to prevail, but Epicurus is very favourably treated. The *De Elegantiis* is a scientific analysis of the rules of Latin grammar and style In 1439 appeared his famous exposure of the Donation of Constantine (*q.v*), followed by other attacks on spurious documents He was compelled to appear before an inquisitory tribunal composed of his enemies, and he escaped only by the special intervention of Alphonso He was not, however, silenced; he ridiculed the Latin of the Vulgate and accused St. Augustine of heresy In 1444 he visited Rome, but in this city also his enemies were numerous and powerful, and he saved his life only by flying in disguise to Barcelona, whence he returned to Naples After the death of Eugenius IV in 1447 he went again to Rome, where he was welcomed by the new pope, Nicholas V., who made him an apostolic secretary, and this entrance of Valla into the Roman Curia has been justly called "the triumph of humanism over orthodoxy and tradition" Valla also enjoyed the favour of Pope Calixtus III His most famous dispute was with Poggio (*q v.*) He died in Rome on Aug 1, 1457.

Over Valla's private life, the most obscene language was employed He appears as a vain, jealous and quarrelsome man, but an elegant humanist, an acute critic and a venomous writer, who had committed himself to a violent polemic against the temporal power of Rome In him posterity honours the man who initiated a bold criticism, which he applied to language, to historical documents and to ethical opinions Luther had a high opinion of him, and Cardinal Bellarmine calls him *praecursor Lutheri,* while Sir Richard Jebb says that his *De Elegantiis* "marked the highest level that had yet been reached in the critical study of Latin"

Collected, but not quite complete, editions of Valla's works were published at Basle in 1540 and at Venice in 1592 *seq*, and *De Elegantiis* was reprinted nearly 60 times between 1471 and 1536 For detailed accounts of Valla's life and work *see* G Voigt, *Die Wiederbelebung des classischen Alterthums* (1880–81), J A Symonds, *Renaissance in Italy* (1897–99), G Mancini, *Vita di Lorenzo Valla* (Florence, 1891), M. von Wolff, *Lorenzo Valla* (Leipzig, 1893), J Burckhardt, *Kultur der Renaissance* (1860), J Vahlen, *Laurentius Valla* (1870), L. Pastor, *Geschichte der Päpste*, Band ii Eng trans by F I Antrobus (1892), the article in Herzog-Hauck's *Realencyklopadie,* Band xx. (Leipzig, 1908), and J E Sandys, *Hist of Class Schol* ii (1908), pp 66–70

VALLABHACHARS, a numerous sect in western and central India in which the emotional and erotic elements are allowed free scope, aided by vernacular dialects in prayers and hymns of praise

Vallabha, the son of a Telinga Brahman, lived at Gokula near Mathura, and set up a shrine with an image of Krishna Gopala Vallabha went subsequently to reside at Benares, where he died In the doctrine of this Vaishnava prophet, if the human soul is identical with God, the practice of austerities must be discarded as directed against God, and it is rather by a free indulgence of the natural appetites and the pleasures of life that man's love for God will best be shown The followers of this creed direct their worship chiefly to Gopal Lal, the boyish Krishna of Vrindavana, whose image is sedulously attended like a revered living person eight times a day—from its early rising from its couch to its retiring to repose at night The sectarial mark of the adherents consists of two red perpendicular lines, meeting in a semicircle at the root of the nose, and having a round red spot painted between them Their principal doctrinal authority is the Bhagavata-purana, as commented upon by Vallabha himself, the author of several other Sanskrit works highly esteemed by his followers Children are solemnly admitted to full membership at the early age of four, and even two years, when a rosary, or necklace, of 108 beads of basil (tulsi) wood is passed round their necks, and they are taught the use of the octo-syllabic formula *Sri-Krishnah saranam mama,* "Holy Krishna is my refuge." Their spiritual heads, the Gosains, also called Maharajas, adorn themselves in splendid garments, and allow themselves to be habitually regaled by their adherents with choice kinds of food; and as the living representatives of the "lord of the Gopis" himself, claim and receive in their own persons all acts of attachment

and worship due to the deity, even, it is alleged, to the extent of complete self-surrender. In the final judgment of the famous libel case of the Bombay Maharajas, before the Supreme Court of Bombay, in January 1862, these improprieties were severely commented upon.

A modern offshoot of Vallabha's creed, formed with the avowed object of purging it of its objectionable features, was started, in the early years of the 19th century, by Sahajananda, a Brahman of the Oudh country, who subsequently assumed the name of Svami Narayana. Having entered on his missionary labours at Ahmadabad, and afterwards removed to Jetalpur, where he had a meeting with Bishop Heber, he subsequently settled at the village of Wartal, to the north-west of Baroda, and erected a temple to Lakshmi-Narayana, which, with another at Ahmadabad, form the two chief centres of the sect, each being presided over by a Maharaja

VALLADOLID, a Mexican town Pop (1920) 6,840 It is situated in a healthy and fertile part of Yucatan, and is a resort for invalids. It has old churches, a Jesuits' college, town hall, hospital and aqueduct It was founded in 1544, soon after the conquest, as a great ecclesiastical centre, but these plans were not realized and its fine buildings have fallen into decay The inhabitants, chiefly Mayas, have frequently revolted against their rulers

VALLADOLID, an inland province of Spain, one of the eight into which Old Castile was divided in 1833 Pop. (1920) 280,931, area, 2,922 sq miles

The province belongs to the basin of the river Duero (Douro) It is for the most part flat and exceedingly fertile, the only part that can be called hilly being in the north-west, where the low Montes de Torozos occur Valladolid shares with the Tierra de Campos in Palencia the title of granary of the Peninsula

Besides wheat, maize, barley and oats, the province produces hemp, flax, various fruits, red and white wine, oil and madder Honey, wax and silk are also produced The woollen fabrics of Valladolid were once highly esteemed, but this industry has now greatly declined, although in the larger towns there are still linen and cloth factories, besides iron foundries, tanneries, saw-mills and flour-mills Trade is facilitated by the Canal de Castilla, which connects Valladolid, on the Pisuerga, with Alar del Rey, in Palencia, also on that river *See* PALENCIA (province) Valladolid is traversed from north to south by the northern railway from Madrid to France Apart from the capital Valladolid (*q v*), Medina del Campo (9,624) and Nava del Rey (5,221) are the only towns with more than 5,000 inhabitants

VALLADOLID, the capital of the Spanish province of Valladolid, 2,228 ft above sea-level, at the confluence of the river Pisuerga with the Esgueva Pop (1920) 76,791 Valladolid is sometimes identified with the ancient Pintia of Ptolemy Its Roman origin is uncertain The present name is undoubtedly Moorish. Valladolid was recovered from the Moors in the 10th century, but is first named by Sancho II of Leon in 1072 The cortes of Castile frequently met here in the following centuries, and in the beginning of the 15th century John II made it his principal residence After the removal of the capital to Madrid by Philip II. in 1560 it began rapidly to decay Columbus died (1506) and Philip II was born (1527) at Valladolid

Valladolid is an archbishopric, and the seat of an army corps, a court of appeal and a university. It is connected by numerous railways with every province of Spain The granite cathedral was begun in 1585 by Juan de Herrera in the Renaissance style The interior contains pictures by Luca Giordano (1632–1705) and the celebrated silver monstrance wrought by Juan de Arphe Other buildings are the church of Santa Maria la Antigua (1200); the church of San Pablo (1286); San Gregorio (15th century); and San Benito (end of the 14th century). The Plateresque college of Santa Cruz, built by Enrique de Egas in 1479–92, contains three pictures by Rubens, and some remarkable wooden statues by Alonso Berruguete (d. 1581), Gregorio Hernandez (1566–1636) and others. The university, originally founded at Palencia early in the 13th century, was transferred to Valladolid before 1250. The house in which Cervantes lived (1603–6) has been preserved by the Hispanic Society of America The principal industries are the manufacture of linen, silk and woollen fabrics, pottery, gold and silver work, flour, wine, beer, chocolate, leather, ironware

VALLANDIGHAM, CLEMENT LAIRD (1820–1871), American politician, was born in New Lisbon, Ohio, on July 29, 1820. He was duly admitted to the bar in 1842 Elected to the Ohio house of representatives in 1845, he became one of the extremists of the state rights Democrats of his section From 1858 to 1863 he was in the lower house of Congress, where he was noted for his strong opposition to the principles and policies of the growing Republican party, his belief that the South had been grievously wronged by the North, his leadership of the peace democrats or "copperheads," who were opposed to the prosecution of the war, and his bitter attacks upon the Lincoln administration, which, he said, was destroying the Constitution and would end by destroying civil liberty in the North In 1863 he made violent speeches in Ohio against the administration, and for these he was arrested by the military authorities, tried by military commission and sentenced to imprisonment President Lincoln commuted this sentence to banishment, and Vallandigham was sent into the Confederate lines, whence he made his way to Canada While in exile he was elected supreme commander of the Knights of the Golden Circle in Ohio and received the Democratic nomination for governor of Ohio, but was defeated In 1864 he returned to Ohio, took active part in the campaign of that year, wrote part of the national Democratic platform at Chicago, and assisted to nominate McClellan for the presidency After the war he denounced the reconstruction policy of the Republicans as unconstitutional and tyrannical, but in 1870, seeing the uselessness of further opposition, he advised his party to accept the situation and adopt new issues Vallandigham was an able lawyer and a popular politician He died in Lebanon, Ohio, on June 17, 1871

See J. L. Vallandigham, *Life of Clement L Vallandigham* (Baltimore, 1872), J F Rhodes, *History of the United States from the Compromise of 1850* (1839–1906); H van Fossan, "Clement L. Vallandigham," in *Ohio Archaeological and Historical Quarterly*, vol. xxiii, p. 256–267 (1914).

VALLE, PIETRO DELLA (1586–1652), Italian traveller in the East, came of a noble Roman family, and was born on April 11, 1586, in the family palace built by Cardinal Andrea. He served against the Moors of Barbary, but also became a member of the Roman academy of the Umoristi, and acquired some reputation as a versifier and rhetorician The idea of travelling in the East was suggested by a disappointment in love, as an alternative to suicide, and was ripened to a fixed purpose by a visit to the learned Mario Schipano, professor of medicine in Naples, to whom the record of Pietro's travels was addressed in the form of very elaborate letters, based on a full diary Before leaving Naples he took a vow of pilgrimage to the Holy Land, and, sailing from Venice in 1614, reached Constantinople, where he remained for more than a year, and acquired a good knowledge of Turkish and a little Arabic In September 1615 he sailed for Alexandria with a suite of nine persons From Alexandria he went on to Cairo, and, after an excursion to Mount Sinai, left Cairo for the Holy Land in March 1616, in time to assist at the Easter celebrations at Jerusalem Having visited the holy sites, he journeyed by Damascus to Aleppo, and thence to Baghdad, where he married a Syrian Christian named Maani, a native of Mardin, who died in 1621 He now desired to visit Persia; but, as that country was then at war with Turkey, he had to leave Baghdad by stealth in Jan 1617 Accompanied by his wife he proceeded by Hamadan to Isfahan, and joined Shah Abbas in a campaign in northern Persia, in the summer of 1618 Here he was well received at court On his return to Isfahan he began to think of returning by India rather than Turkey, but the state of his health, and the war between Persia and the Portuguese at Ormuz, created difficulties

In Oct. 1621 he started from Isfahan, and visiting Persepolis and Shiraz, made his way to the coast; but it was not till Jan 1623, that he found passage for Surat on the English ship "Whale" In India he remained till Nov. 1624, his headquarters being Surat and Goa. He was at Muscat in Jan. 1625, and at Basra in March In May he started by the desert route for Aleppo, and took ship at Alexandretta on a French vessel Touching at Cyprus he reached Rome on March 28, 1626 and was received with much

honour by Pope Urban VIII., who appointed him a gentleman of his bedchamber. He died at Rome on April 21, 1652.

In Pietro della Valle's lifetime there were printed—(1) a *Funeral Oration on his Wife Maani*, whose remains he brought with him to Rome and buried there (1627); (2) an *Account of Shah Abbas*, printed at Venice in 1628, but not published, (3) the first part of the letter describing his *Travels* (Turkey, 1650). The *Travels* in Persia (2 parts) were published by his sons in 1658, and the third part (India) in 1663 An English translation appeared in 1665 (fol.). Of the Italian text the edition of Brighton, 1843 (2 vols 8vo.), is more esteemed than the other reprints. It contains a sketch of the prolix, with a tendency to the rhetorical; but he is exact, and very instructive, so that his work still possesses high value.

VALLE-INCLÁN, RAMON DEL (1869–), Spanish novelist and poet, was born at Puebla de Caramiñal (Pontevedra) A subtle artificer in his verse—*Aromas de legenda* (1907), *Cuento de Abril* (1910), *Cara de plata* (1923)—he writes a refined and delicate prose in the *Memorias del marqués de Bradomín* (*Sonatas de primavera, de estio, de otoño* and *de invierno* [1902–1907]), while his *Guerra Carlista* is an impressive historical work.

VALLEJO, a city of Solano county, California, U S.A., on San Pablo bay at the mouth of the Napa river, 25 m. N E. of San Francisco. It is served by the Southern Pacific and electric railways, by steamboats to points on San Francisco bay, and for freight by ocean-going vessels. Pop. (1920) 21,107 (83% native white); (1928 local estimate) 28,000. The city has a large trade in agricultural products. There are flour mills and other industries, with an aggregate output valued at $22,000,000 annually. The harbour can accommodate the largest ocean-going ships. Opposite the city is Mare island, headquarters of the Pacific Squadron of the United States navy, with a navy yard (established 1854), two stone drydocks and a lighthouse, a total enlisted personnel of about 3,000, and employing 4,000 workmen. Vallejo was settled about 1849. It was named after Gen. Mariano Guadalupe Vallejo, a prominent Mexican leader. Through his efforts it became the State capital for a brief period, the legislature meeting here in 1851, 1852 and 1853. In the struggle for the terminus of the Central Pacific railway (1869–72) it was a formidable, though unsuccessful, rival of Oakland. In 1900 the population was 7,965; in 1920, 11,340; and in the next decade it increased 86%.

VALLÈS, JULES (1832–1885), French journalist, and author, was born at Puys, France, on June 10, 1832. Coming to Paris, he joined the staff of the *Figaro,* and became a constant contributor to the other leading journals. He was in Paris during the siege of 1870, and after the capitulation was a member of the Commune and founded *Le Cri du Peuple*. He took a conspicuous part in the fighting in the Paris streets, but finally made his escape to London, whence he contributed anonymously to the French press. In 1878 he began in the *Siècle* the serial publication of his principal work, *Jacques Vingtras,* a long autobiographical romance. He died in Paris on Feb. 14, 1885.

VALLETTA or VALETTA, the capital of Malta (since 1570). Pop. (1921) 48,240. The nucleus of the city is built on a ridge of rock (Mount Sceberras) which runs like a tongue into the middle of a bay, which it thus divides into two harbours, the Grand Harbour to the east and the Marsamuschetto to the west, which are subdivided again by three other peninsulas into creeks. On two of these peninsulas on the east side of the Grand Harbour, and at their base, are built the aggregate of towns called the Three Cities—Vittoriosa, Conspicua and Senglea. (*See* MALTA.) On the main promontory, with Valletta, stands the suburb Floriana; Fort St Elmo, with a lighthouse, stands on the extremity of the promontory; the suburb Sliema lies on the point which encloses the Marsamuschetto harbour; Fort Ricasoli is on the opposite point enclosing the east, Grand, or Great Harbour. The streets of Valletta, paved with stone, run along and across the ridge, and end on each side towards the water in steep flights of steps. There are several fine public buildings, as the governor's palace, the new opera-house, the public library and museum of Maltese antiquities, and the *auberges* or lodges of the Knights of Malta (especially the Auberge de Castile) which are now used for military offices, club-rooms, and other purposes. Roman Catholic churches in Valletta are very numerous; the cathedral of S. Giovanni, dating from 1576, is famous for its rich inlaid marbles, its Brussels tapestries, its roof painted by Matteo Preti (1661–1699), the picture by Michael Angelo da Caravaggio of the beheading of John the Baptist, numerous memorials of the knights and other relics.

The governor's palace was formerly that of the grand master of the Maltese Order, and it also contains relics of the knights, tapestries, armour, etc. The British government built here a naval hospital, military prison and other necessary institutions. Since the British occupation Valletta has been a naval and military station of the first importance. The dock and victualling yards are spread over the shores on both sides of those arms of the great harbour known as "Dockyard" and "French" creeks, the dockyard being partly on the former, but principally on the latter creek. The large transit trade and the local trade of the island centre in Valletta. The influx of winter visitors adds to the wealth of the city.

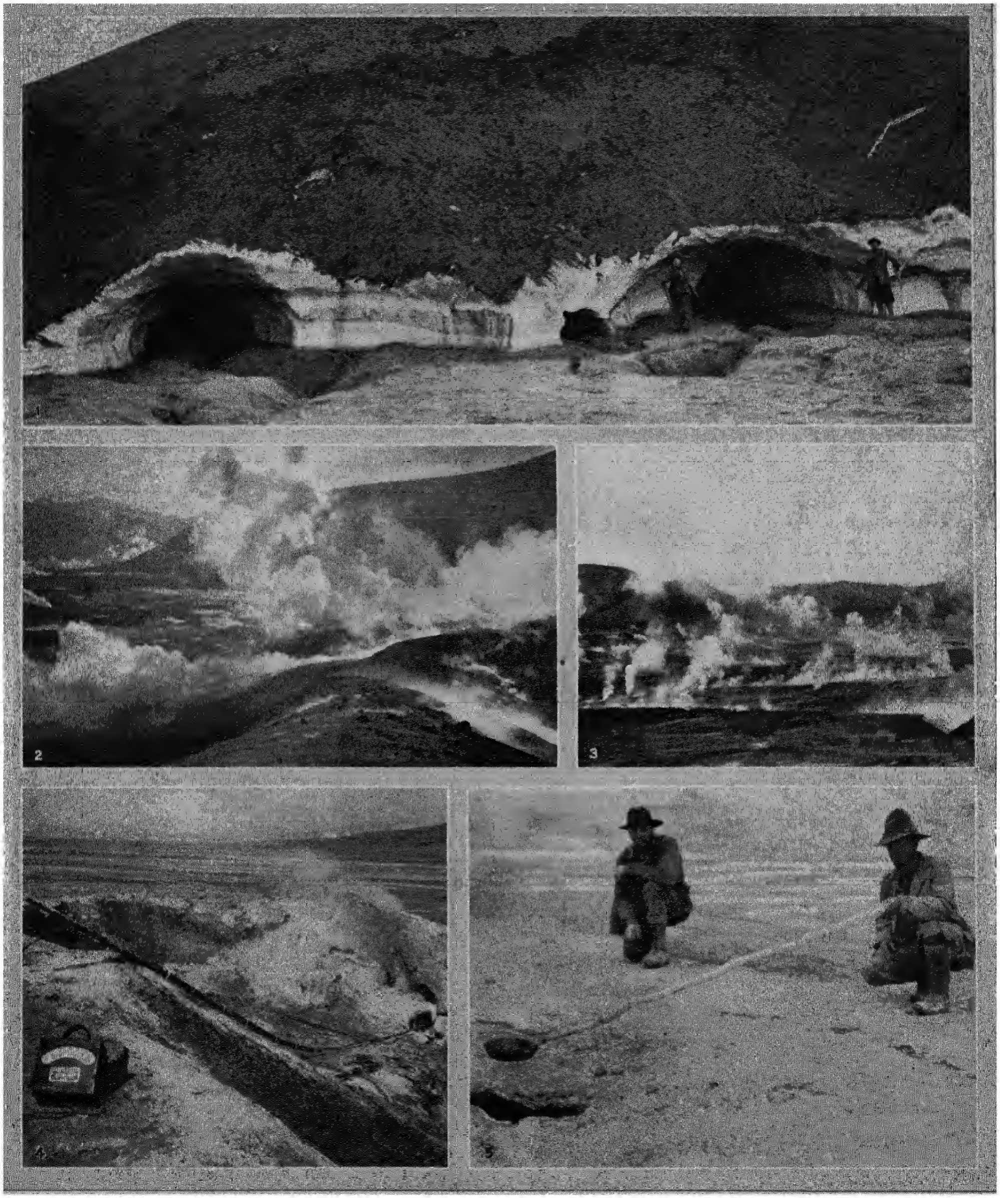
VALLEY CITY, a city of North Dakota, U S.A., on Federal highway 10. Pop. 4,695 in 1925 (State census). It is the seat of a State teachers' college (established 1890). The city was incorporated in 1881.

VALLEYFIELD, town and port of entry, Beauharnais county, Quebec, Canada, 25 m. S.W. of Montreal, at the foot of Lake St. Francis—an expansion of the river St. Lawrence—and at the head of the Beauharnais canal. Pop (1921) 9,215. It is the see of a Roman Catholic bishop, and contains a college.

VALLEY FORGE, a valley about 20 m north-west of Philadelphia, Pa., U S A., where the Revolutionary Army of about 10,000 men under George Washington spent the winter of 1777–78 Their sufferings there from cold, starvation and sickness made the place one of hallowed historic associations for Americans. The army received little food or clothing, and erected its own crude huts. On Dec. 23, 1777, Washington wrote: "We have this day no less than 2,873 men in camp unfit for duty because they are barefooted and otherwise naked. . . . Numbers are still obliged to sit all night by fires" There were many desertions and occasional symptoms of mutiny, but for the most part the soldiers bore their sufferings with heroic fortitude In Feb. 1778, Baron Steuben reached camp and began the drilling and reorganization of the army which resulted in a marked improvement in its efficiency. Parts of the grounds, including Washington's headquarters, are preserved in Valley Forge Park of 475 acres. The state has also erected a fine equestrian statue of General Anthony Wayne, and a number of granite markers which indicate the situation of the camps of the different brigades.

VALLEY OF TEN THOUSAND SMOKES, a volcanic region in Alaska, which came into being at the time of the eruption of Mt. Katmai on the Alaskan peninsula on June 6, 1912. An ancient trail led through the valley, so that it was well-known to have been rich in plant and animal life, a favourite hunting-ground of the natives. One of the first events in the Katmai eruption was the bursting forth of a new volcano, Nova Rupta, in the floor of one arm of the valley. Probably from this vent, and other smaller ones, issued the great flow of incandescent sand which filled the floor of the valley, 17m. in length and 4m. in width, utterly consuming everything in its path until it reached the lower end of the valley, where the trees were merely turned to charcoal. At the time of its discovery not ten thousand but millions of jets of steam were issuing from the floor of the valley from vents ranging in size from a tiny crack to pits or craters 150ft. in diameter. In temperature they ranged up to 1,200° F., hot enough to melt zinc and to set ablaze a stick held in the steam. Immediately following the hot sand flow Mt. Katmai exploded. Its three-peaked snow-covered crown was blown to atoms, leaving a crater 3m. wide, containing a lake 3,700ft below the crater rim. Five cu.m. of ash were thrown out, covering Kodiak island, 100m. away, with a blanket a foot deep. Acid rains fell in Cordova, 360m. distant, while the fumes tarnished brass in Victoria, B.C., 1,500m. away. The haze was noted in Virginia and at the Bureau of Standards in Washington, D.C. The dust from Katmai thrown into the higher layers of atmosphere robbed the North Temperate Zone of 10% of the sun's heat in the summer of 1912. Because Katmai

VALLEY OF TEN THOUSAND SMOKES



VARIED SCENERY IN VALLEY OF TEN THOUSAND SMOKES

1. Ash covered snowdrift near intense heat of fumaroles (crevice in volcanic cone) making an ideal temporary refrigerator
2. Looking across a corner of the Valley of Ten Thousand Smokes from the rim of Novarupta
3. Lines of fumaroles across the valley, illustrating that the smokes spring largely from fissures traversing the floor
4. Apparatus for measuring temperature of a fumarole. This one was found to be 572°F.
5. Frying bacon over a fumarole. Clear steam rushes forth with sufficient pressure to lift frying pan into the air

is located in a region almost uninhabited, not a human being lost his life, though this eruption was one of the largest ever known.

The Valley of Ten Thousand Smokes and its neighbouring wonders were discovered by Robert F. Griggs, director of the National Geographic Society's expeditions of 1915–16–17–18–19. This region proved to be so stupendous a volcanic laboratory as well as so rich in scenic value that in Sept. 1918 President Wilson set aside the whole district, comprising more than a million acres as the Katmai National Monument. (L. T. G.)

VALLOMBROSA, a summer resort of Tuscany, Italy, in the province of Florence, reached by road (9 m.) from the station of S. Ellero (which is 16 m. S.E. of Florence) and 328 ft. above sea-level, on the north-west slope of the Prato Magno chain. The former monastery was suppressed in 1866. A number of hotels have been built. Similar summer resorts are situated among the woods above the Casentino or upper valley of the Arno to the east, such as Camaldoli, Badia di Prataglia, etc. Camaldoli was the original headquarters of the Camaldulensian order, now partly occupied by an hotel. Five hours' journey to the south of the last on foot and 7½ m. to the east of Bibbiena by road is the monastery of La Verna, 3,660 ft. above sea-level, founded by St. Francis in 1215 on an isolated limestone peak. Here he received the stigmata in 1224. The small Church of the Angels, erected by him, and the Chiesa Maggiore (begun in 1348) contain some fine terra-cotta reliefs by the della Robbia family.

VALLOMBROSIANS, an order of monks under the Benedictine rule, founded by St. John Gualbert, who, about 1030, withdrew to Vallombrosa, a shady dale on the side of a mountain in the Apennines, 10 m. from Florence, and for some years led a completely solitary life. Disciples, however, gathered around him, and he formed them into an order in which the cenobitical and the eremitical lives should be combined. The Benedictine rule was the basis of the life, but every element of Benedictine life was eliminated that could interrupt the attention of the mind to God—even manual labour. The Vallombrosians spread in Italy and France, but they never had more than sixty houses.

See the *Catholic Encyclopaedia,* art. "Vallombrosians"; and Max Heimbucher, *Orden u. Kongregationen* (1907), I. § 44.

VALMY, a small village on the main road between Verdun and Paris, just west of Ste Menehould, famous for the French victory of Sept. 20, 1792. Eastward of Valmy lies, roughly north and south, the long barrier of the forest of Argonne. Dumouriez, with the belated assistance of Kellermann, was attempting to hold this in September against the advance of the duke of Brunswick's German troops. Heavy and continuous rains had made the chalky and clayey soil a greater obstacle even than the thick undergrowth and wild country, but the French revolutionary troops were unable to hold the forest. In their previous conflicts with Austrian or Prussian troops they had met continuous, immediate and shameful defeat; and their morale was going from bad to worse. The duke's forces broke through easily, not by the main road it is true, but to the north by a pass known as the Cross in the Woods. In great haste, on the 19th, Dumouriez was able to withdraw under the cover of darkness the forces guarding the northern portions of the Argonne, which would otherwise have been cut off, and to complete his junction with Kellermann. By the morning of Sept. 20 his army was on the flank of Brunswick's advance and was facing towards Paris, with its back to the Argonne. It consisted chiefly of troops of the *ancien régime,* disorganized by the defection of their officers, and young and wholly untrained volunteers.

Dysentery, the long detour necessitated by his holding a northern pass, and the general badness of the Prussian communications forced Brunswick to attempt immediately to clear Dumouriez's force off his flank and make safe his sources of supplies. As soon as the heavy mist lifted on the morning of Sept. 20, therefore, he commenced an attack on the French by heavy artillery preparation. The French line was drawn up on a slight elevation, of which the most prominent feature was the famous mill of Valmy. Between them and the Prussians was a shallow depression of about a half to three-quarters of a mile in breadth; the Prussians were drawn up on the opposite undulation. The French artillery, which was less heavy in metal than the German, was the sole important arm which had not been disorganized, and was able to reply effectively to the Prussian cannonade. Early in the afternoon, however, the Prussian guns did tremendous damage by a lucky shot which struck the French ammunition reserves near the mill, blowing them up with a tremendous report and great damage. A German mercenary brigade in the French service broke, and the effect on the whole sorely-tried French line was such that Brunswick decided that the right moment had come for a general attack, and gave the signal.

The Prussians advanced *en échelon* under a severe fire, but steadily, some two-thirds of the intervening distance. The shaky ranks of the French were rallied by Kellermann, and were more or less prepared to meet the attack, when the Prussians hesitated, and, still apparently without disorder, retreated to their original position. Some mystery surrounds this, the central event of the battle: it seems probable that the Prussian advance was impeded by unsuspected thick mud at the foot of the hill, as well as by the accurate French gunnery—the support of their own guns necessarily ceasing as they approached the French lines. The cannonade continued till nightfall. Brunswick, having failed to defeat his enemy, realized that his position was strategically untenable and, after a few days, retreated. (*See* FRENCH REVOLUTIONARY WARS.)

VALOIS, COUNTS AND DUKES OF. The French countship of Valois (*pagus Vadensis*) takes its name from Vez (Latin *Vadum*), its early capital, a town in the department of the Oise. From the 10th to the 12th century it was owned by the counts of Vermandois and of Vexin, but on the death of Eleanor, sister and heiress of Count Raoul V. (d. 1167), it was united to the crown by King Philip Augustus. Soon detached from the royal domain, Valois was the property of Blanche of Castile, widow of Louis VIII., from 1240 to 1252, and of Jean Tristan, a younger son of Louis IX., from 1268 to 1270. In 1285 Philip III. gave the county to his son Charles (d. 1325), whose son and successor, Philip, count of Valois, became king of France as Philip VI. in 1328. Sixteen years later Valois was granted to Philip's son, Philip, duke of Orleans; then passing with the duchy of Orleans in 1392 to Louis (d. 1407), a son of Charles V., it was erected into a duchy in 1406, and remained the property of the dukes of Orleans until Duke Louis became king of France as Louis XII. in 1498, when it was united with the royal domain. After this the duchy of Valois was held by Jeanne, countess of Taillebourg (d. 1520), from 1516 to 1517, and by Marie, countess of Vendôme, from 1530 until her death in 1546; it was given to Catherine de' Medici, the widow of Henry II., in 1562, and in 1582 to her daughter, Margaret of Valois, the wife of Henry of Navarre. In 1630 Louis XIII. granted Valois to his brother Gaston, duke of Orleans, and the duchy formed part of the lands and titles of the dukes of Orleans until the Revolution.

The house of Valois, a branch of the great Capetian family, is thus descended from Charles, a son of Philip III., and has been divided into several lines, three of which have reigned in France. These are: (1) the direct line (reigned 1328–1498) beginning with Philip VI.; (2) the Orleans branch (reigned 1498–1515), descended from Louis, duke of Orleans, a son of Charles V.; (3) the Angoulême branch (reigned 1515–1589) descendants of John, another son of the same duke.

VALOIS, CHARLES DE (1671–1747), son of Adrien de Valois, was a distinguished numismatist, and formed a fine collection of medals, chiefly Roman. He became a pupil (1705), and associate (1714), and finally a *pensionnaire* (1722) of the Académie des Inscriptions et Belles Lettres. He published *Histoire des Amphictyons,* and collected a number of critical observations, anecdotes, and Latin poems of his father in *Velesiana* (1694). His *Éloge* by Fréret is in the *Mémoires de l'Académie des Inscriptions,* vol. xxi. p. 234 (1747).

VALOIS, anciently a district of Picardy, part of the government of the Ile de France, bounded on the north by Soissonnais, on the east by Champagne, on the south by the Ile de France proper, and on the west by Beauvaisis. It included the towns of Crépy (capital), Morienval, Pierrefonds, Compiègne, Verberie, Pont-Sainte-Maxence, Senlis, Chantilly, Villers-Cotterets. Under

the Roman domination it belonged to the Suessiones but it is now a small area in the departments of the Oise and the Aisne

At first governed by its own independent counts, Valois, in 1214, was joined to the kingdom of France by Philip Augustus. It has given its name to three lines of the second branch of the Capetian kings (*See* VALOIS, COUNTS AND DUKES OF.)

For history see A Poilleux, *Le Duché de Valois, pendant le XVe et XVIe siècle* (1843)

VALONA (Albanian, *Vliona*), a seaport of Albania Pop. (1924) about 10,000, of whom 65% are Muslims, 30% Orthodox, and 5% Roman Catholics Valona occupies an eminence near the gulf of Valona and is almost surrounded by mountains The port is the best on the Albanian coast, with good anchorage and shelter, being protected by the island of Saseno (the ancient *Saso*) It is a port of call for steamers, and the cable and telegraph line to Otranto, in Italy, has an important station here The town is about 1½ m from the sea, and has a pleasant appearance with its minarets and its palace, surrounded by gardens and olive groves, but there are malarial marshes along the coast.

Valonia, a material largely used by tanners, is the pericarp of an acorn obtained in the neighbouring oak woods, and derives its name from Valona The surrounding district is mainly agricultural and pastoral, producing oats, maize, cotton a little rice, olives, cattle sheep, hides, skins and butter, all of which are exported, together with bitumen from the mine at Selenitsa At Smoktina there are steam saw mills, while in the town itself there are motor repairing works, and an oil refinery

Valona played an important part in the wars between the Normans and the Byzantines during the 11th and 12th centuries In 1464 it was taken by the Turks captured by the Venetians in 1690 but restored to Turkey in 1691 In 1851 it suffered severely from an earthquake During the Balkan Wars (1912–13) Valona was bombarded by the Greek fleet in 1912 and in the same year Ismail Bey and 83 Albanian notables met at Valona, and hoisting the old flag of Skanderbeg (*q v*), proclaimed the independence of Albania In the following year the International Commission of Control sat at Valona and appointed Prince William of Wied king of Albania After his flight, a few months later, Valona was seized by the insurgents At the outbreak of the World War in 1914 the Italians seized Saseno, which had been ceded to Albania, and occupied the town itself, which they held until 1920

VALPARAISO, formerly a province of Chile, now a *departamento* in the province of Aconcagua, on the Pacific coast The valleys, when irrigated are fertile That of the Aconcagua, to the north is sometimes called the "garden of Chile" The largest city is Valparaiso, and the principal other town is Quillota

VALPARAISO, a city and seaport of Chile, capital of the province of Aconcagua, on a broad open bay of the Pacific in lat 33° 0′ 2″ S, long 71° 41′ 15″ W, about 70m N W of Santiago Pop. (1902), 142,282, (1920 census) 182 422 The almost semicircular Bay of Valparaiso is slightly over 3m across from Punta Angeles to Punta Gruesa, and the city stands on the south side, on the slopes of a spur of barren hills projecting into the Pacific and forming a rocky peninsula terminating in Punta Angeles This point affords good shelter from southerly and westerly storms, but the bay is open to those from the north The extreme points of the bay are strongly fortified The city occupies a narrow strip of beach around the head of the bay, and extends up the steep slopes and valleys of the enclosing hills, which have an altitude of 1,000 to 1,400ft The city's civic improvements are striking and beautiful The Chilean naval academy buildings and fine residences are located on heights overlooking the bay. Improved roads connect the upper and lower city There are numerous inclined passenger elevators The suburban resort, Viña del Mar, is noted for its buildings, amusements, and society.

Valparaiso is pre-eminently commercial Its trade, which is the largest and most important on the Pacific coast of South America, makes it a terminal and port of call for several regular lines of steamers, affording frequent communication with Europe and the United States. The transcontinental railway line between Valparaiso and Buenos Aires (the Andean tunnel was opened in April 1910) adds to the traffic of the port, through the transhipment of passengers and freight to escape the long and dangerous voyage by way of the Straits of Magellan. A railway of 117m. to Santiago, electrified in 1924–25, relieves port congestion Harbour improvements. begun in 1912, represent an outlay of several million pounds The great depth of the water retards progress, but two breakwaters, in process of construction, from opposite shores of the bay, have attained sufficient length to protect shipping Eventually 220 ac of water space will offer protection In 1923 vessels began to dock at modern piers; a mile of semi-circular stone sea-wall, scores of new warehouses and modern cargo-handling machinery serve annual imports of 700,000 and exports of 400 000 tons

Two cable lines give telegraphic communication with Europe and the United States—a west coast line running to Panama, and a land line across the Andes to Buenos Aires in connection with the cable to Europe from that port There are a wireless telegraph station in regular communication with the islands of Juan Fernandez, State telegraph lines communicating with all parts of the republic, and an efficient telephone service From Valparaiso good highways are gradually extending inland and to the capital.

Valparaiso was founded in 1536 by Juan de Saavedra, who named it after his birthplace near Cuenca, Spain The port and town were of but little note during the colonial period, for free commercial intercourse with the colony was forbidden In 1819, near the end of the war with Spain, its population barely reached 5,000 In 1578 it was captured by Sir Francis Drake, and in 1596 by Sir John Hawkins In 1600 it was sacked by the Dutch under Van Noort On March 31, 1866, it was bombarded by a Spanish fleet under the command of Admiral Nuñez, when a large part of the town was laid in ruins, and on Aug 28, 1891, after the victory of the congressional troops over Balmaceda's forces in the vicinity, it was partially sacked by the Chileans themselves Valparaiso suffered much from the earthquakes of 1731, 1822, 1839, 1873 and 1908 That of 1908 caused the destruction of a large part of the city. Its modernization may be said to date from the earthquakes of 1906–07 From ashes and débris streets were widened and paved, better business structures arose and modern sewerage was provided

VALPARAISO, a city of Indiana, U S A, 40 m S E of Chicago It is served by the Grand Trunk, the Nickel Plate and the Pennsylvania railways. Pop (1920) 6,518 (91% native white), estimated locally at nearly 12 000 in 1928 It is the seat of Valparaiso university, established in 1873 as a revival of a Methodist college (1859–69), and since 1925 under Lutheran auspices It was settled about 1835 and chartered as a city in 1865

VALS (Vals-les-Bains), a town of south-western France Pop (1926) 2,867 Vals is situated on the Volane amongst volcanic mountains It is celebrated for its numerous cold mineral springs impregnated in most cases with sodium bicarbonate They are used chiefly for drinking but also as baths, and are efficacious in maladies of the digestion, liver and kidneys, and for gravel and gout Great quantities of bottles are exported

VALTELLINA (Ger *Veltlin*; the name comes from the former capital, Teglio, near Tresenda), properly the name of the upper valley of Adda, in north Italy Historically and officially, it also comprises the Italian Liro or San Giacomo valley.

Pop (1921) 131,184 To-day the whole valley belongs to the kingdom of Italy, except the side valley of Poschiavo (Puschlav), which belongs to the Swiss canton of the Grisons (Graubunden). The chief town is Sondrio (7,172), other important places being Tirano (5,870), Chiavenna (4,592) and Morbegno (3,603). Near Bormio there are some frequented mineral springs (sulphur and lime), known in Pliny's time, and efficacious in diseases of the skin. There are several other baths in the side valleys, such as Santa Caterina (chalybeate), Masino and Le Prese (sulphur).

The highest points in the ranges enclosing the valley are the Piz Zupo (13,131 ft.) in the Bernina group and the Grau Zebru (Konigsspitze) (12,655 ft.) in the Ortler district; the Monte della Disgrazia (12,067 ft) is the highest peak comprised entirely within the water-basin of the valley. Four well-marked Alpine passes are traversed by good roads—the Stelvio pass (9,055 ft., the highest carriage-road in Europe) from Bormio to Spondigna

in the Adige valley; the Bernina pass (7,645 ft.) from Tirano to Samaden in the Upper Engadine; and the Aprica pass (3,875 ft) from Tirano to the Val Camonica and the Lake of Iseo; while from near the top of the Stelvio a fourth road leads over the Umbrail pass (8,242 ft, the highest in Switzerland) to the Swiss valley of Münster, which is reached at the village of Santa Maria The main valley is traversed from end to end by a magnificent carriage-road constructed by the Austrian Government in 1820–25 A railway runs from Colico, on the Lake of Como, past Sondrio to Tirano, a distance of 42 m, while there is another from Colico to Chiavenna (16½ m).

The population is wholly Italian-speaking and Roman Catholic, the valley being in the diocese of Como The shrine of the Madonna of Tirano (founded 1520) attracts large numbers of pilgrims. The valley, particularly in its lower portion, is extremely fertile; and of late years vigorous measures have been taken to prevent the damage caused by the frequent inundations of the Adda. Chestnuts, vines, mulberry trees and fig trees abound; and there are many picturesquely situated churches, castles and villages The chief articles exported are wine and honey. Large quantities of honey are annually sent abroad The Valtellina has now become important for its hydroelectric plants

History.—After the defeat of the Lombards (774) the Valtellina was given (775) by Charlemagne to the abbey of St Denis near Paris, which never seems to have exercised its rights In 824 Lothair I, confirming an earlier donation (803) made by Charlemagne, gave the churches of Poschiavo and Bormio to the bishop of Como Bormio was in 1205 won by the men of Como, who in 1006 had received one-half of Valtellina from the emperor, and by 1214 they were masters of the entire valley They retained Bormio till 1300, when it freed itself, but in 1336 it belonged to the bishop of Chur In 1335 the Visconti of Milan became lords of Como, and therefore of Valtellina As early as 1360 the men of Rhaetia made incursions into Valtellina on the pretext that it had formed part of ancient Rhaetia This idea was confirmed in 1404, when, in return for kind treatment received during his exile, Mastino Visconti (son of Barnabò) gave to the bishop of Chur his share of the Milanese, including Poschiavo, Bormio and Valtellina Relying on this donation, the men of the Three Leagues of Rhaetia (best known by the name of Graubunden) invaded the valley in 1486–87, Poschiavo becoming in 1486 permanently a member (not a subject land) of the *Gotteshausbund* In 1512 Chiavenna, Bormio and Valtellina were also seized and harshly ruled Mastino Visconti's donation was solemnly confirmed in 1516 by the emperor Maximilian I In 1530 the bishop of Chur was forced to sell to the Three Leagues his title to these two districts At the time of the Reformation Poschiavo became Protestant. The other two districts clung to the old faith and came under the influence of Carlo Borromeo Valtellina was extremely important to the Habsburgs as affording the direct route between their possessions of the Milanese and Tirol Hence a great struggle took place between Austria and Spain on one side and France and Venice on the other The religious conflicts in Graubünden led to reprisals in the "subject land" of Valtellina In 1620 (July 19–Aug 4) the Spanish and Catholic faction (headed by the Planta family) massacred from 350 to 600 Protestants in the valley, according to different accounts (*Veltliner Mord* or *Sacro Macello*). For the next 20 years the valley was the scene of great strife, being held by the Spaniards (1621–23, 1629–31, 1637–39), by the French (1624–27, 1635–37) and by the pope (1623, 1627) At length George Jenatsch, a former pastor, who had been the active and unscrupulous leader of the Protestant party, became a Catholic (1635) in order to free the land from the French by aid of the Spaniards (1637), who finally (1639) gave it back to its old masters on condition that the Protestants were excluded from the valley In this way the local struggles of Valtellina came to be mixed up with the Thirty Years' War In 1797 Bormio and Valtellina were annexed to the Cisalpine republic, in 1805 to the Napoleonic kingdom of Italy and in 1815 (despite the remonstrances of the Rhetian leagues) to the kingdom of Lombardo-Venetia, held by the emperor of Austria In 1859 they became, like the rest of Lombardy, part of the kingdom of united Italy Poschiavo followed the fortunes of the "Gotteshausbund" It became (after 1798) part of the canton Rhetia of the Helvetic republic, and in 1803 of the canton of the Graubunden or Grisons, which was then first received a full member of the Swiss Confederation (*See* SWITZERLAND)

VALUATION AND VALUERS. A valuation or appraisement, under English law, need not be stamped where it is made (1) for, and for the information of, one party only, and is not obligatory as between parties, (2) in pursuance of the order of a court of admiralty or on appeal therefrom, (3) of property of a deceased person for the information of an executor, or other person required to deliver an affidavit of the estate of such deceased person, or (4) of any property for the purpose of ascertaining the legacy or succession or account duty payable in respect thereof Any other valuation or appraisement must be stamped Who makes an appraisement or valuation chargeable with stamp duty must, within 14 days after, write it out in words and figures showing the full amount upon duly stamped material If he omits to do so, or in any other manner discloses the amount, he becomes liable to a fine Any person who receives from an appraiser, or who pays for the making of, any such appraisement or valuation not so written out and stamped, becomes liable to a fine

Where a contract has been made for the sale of property at a valuation, a valuation made in accordance with its terms will be conclusive as between the parties, in the absence of fraud, collusion or mistake Where there has been an agreement to sell goods on the terms that the price is to be fixed by the valuation of a third party and such third party cannot or does not make such valuation, the agreement is avoided, but if the goods or any part thereof have been delivered to and appropriated by the buyer he must pay a reasonable price therefor Where the third party is prevented from making the valuation by the fault of the seller or buyer, the party not in fault may maintain an action for damages against the party in fault Where the fixing of a value by valuers is not of the essence of an agreement, but is wholly subsidiary to it, the courts will, if justice require it, ascertain the value in order to carry the agreement into effect Where an agreement had been entered into for the sale of a house at a fixed price and of the fixtures and furniture therein at a valuation by a person named by both parties, and he undertook the valuation but was refused permission by the vendor to enter the premises for that purpose, the vendor was ordered to allow the entry so that the valuation might proceed

A person who exercises the calling of an appraiser or who, for or in expectation of any fee or reward, makes any valuation or appraisement chargeable with stamp duty, must (unless he is licensed as an auctioneer or house agent) have an appraiser's licence, upon which a duty is charged and which continues in force from the day of its date until the following 5th of July By default in this respect a liability to a penalty is incurred Moreover, an unlicensed appraiser cannot recover remuneration A valuer is liable to the person who has employed him for the consequences of negligence or want of due care and skill on his part If his services are thereby rendered worthless he will not be able to recover anything by way of remuneration (*See* AUCTION, ESTATE AGENTS) (X)

United States.—The American law conforms substantially to the English as stated above, save that there are no American stamp duties in reference to valuation There are, however, at least three additional fields in which valuation has assumed considerable importance in the United States One is a matter of private law, the other two, of constitutional law The first is the common legislative attempt to control stock-watering by providing that corporate stock shall be issued only in return for full par value in money or property, and giving creditors various civil remedies against directors or against those who receive stock without making adequate return This raises immediately the question of valuation of property exchanged for stock. In substantial effect these statutes have proved inadequate to their purposes They leave no legitimate machinery for promoters to procure the profits which the courts themselves view as proper and necessary, hence there is persistent pressure to devise means of evasion. And

the courts show a distinct tendency to support valuations of the property arrived at "in good faith," which in practice regularly means some substantial addition to provable tangible assets, by way of the anticipated profits from their use And transfer of the stock to a bona fide purchaser is held to wipe out the creditors' claims against the stock Furthermore, the introduction of no-par stock makes possible in many States to-day the complete disregard of the older regulations The second field is valuation for purposes of taxation Here the common practice is for the assessors to undervalue realty, so that tax valuation of realty is not admissible as evidence of value in a suit for any other purpose. And such undervaluation becomes a constitutional right of the tax-payer, in so far as he is entitled not to have his holdings valued at their true worth, if other holdings of like character are undervalued by the assessors A more difficult problem is met in the apportionment of the intangible going value of an interstate enterprise, for taxation by the several States in which the enterprise is operated In the field of communication and transportation agencies, which have been chiefly concerned, the courts have in general worked out the permissible divisions by taking the total tax base of the enterprise (*e g*, gross income or value of outstanding securities, etc) and permitting any one State to reach its due proportion as calculated by the ratio of tangible assets (*e g*, miles of track) or traffic (ton-miles, car-miles, etc.) inside the State to total tangible assets or total traffic. The more recent cases show a definite trend toward nicer approximation to measurement of business actually done in the taxing State. In the case of interstate business enterprises, the combined effects of the interstate commerce clause and of interlocking corporate structure produce a technical chaos incapable of brief exposition The third field is valuation for purposes of determining the rates chargeable by public utilities. On the one hand, such utilities as gas, railroad, water and telephone companies are subject to rate regulation by the government to prevent excessive charges On the other they are private property, in the sense that rates may not be put so low as to be confiscatory. "A fair return on fair value" is the legal formula applied It is clear, however, that value itself, in the market, depends wholly on the return from the assets, so that reference to market value to determine the "fair value" on which a fair return is to be allowed involves reasoning in a circle This the courts have never expressly recognized, but in their actual decisions they have introduced other more stable factors by requiring any rate-regulating commission to "consider" certain phases of cost in determining the fair value. The emphasis has been strong on the reproduction cost of plant and equipment. Originally, this seems to have been influenced by a desire to avoid the padded original costs of early corporate exploitation, more recently, it is a reflection of rising costs of reproduction. The valuers, in the first instance, are of course the railroad or public utility commissions of the States It is clear that market value is by no means always the measure of value which is sought in legal valuation. (K. N. L.)

VALUE. In economics, use is made of three closely related conceptions of value. *exchange value, subjective value* and *imputed price*.

Exchange Value, or value in exchange This denotes the relative importance which the community, as a whole, manifesting its preferences through the process of the market, attaches to a particular good (commodity or service) in comparison with other goods. It is often defined in the older treatises on political economy as "power in exchange." The exchange value of a particular "good" is measured or expressed by the quantity of other goods for which a unit of that good can be exchanged, or, preferably, as a ratio of exchange. Any one good, of course, really has many different specific exchange values, corresponding to the various ratios at which it can be exchanged for different commodities and services. The notion of the general exchange value of a good rests upon an inclusive view of all of its different specific exchange values. The money price of a good is conceived of as one of its specific exchange values or, in other connections, as its general exchange value expressed in terms of money, which thus serves as a "common denominator of values." Because the direct barter of goods for goods is uncommon, the exchange values of different goods have to be inferred from their money prices. Indeed, the conception of exchange value is derived from the conception of price by making abstraction of the use of money as an instrument of purchase and sale This abstraction has been found useful in economics because, first, some aspects of important economic problems are seen more clearly when values are looked upon as though they were determined by the direct comparison of goods with goods without the intervention of money, and second, because it is often desirable to eliminate the effects which changes in the value of money have upon the money prices of different goods. With the development of statistical technique, however, it has been found possible to take separate account of general changes of prices and of relative changes in the prices which are paid for particular goods. For this and other reasons the conception of exchange value has lost some of the importance which it once had in economics Economic analysis now commonly deals, more directly and realistically, with money prices.

Subjective Value.—This denotes the relative importance which an individual consumer attaches to a particular good, in comparison with other goods. It relates always to specific quantities or specific increments or decrements of goods. Even an indivisible good, an automobile for example, is a compound of various qualities, such as size, power, comfort and appearance, and buyers have a certain range of choice within which these qualities may be had in larger or smaller measure and combined in different proportions So far as a consumer chooses rationally rather than impulsively he apportions his outlays so that he would gain nothing by buying more of one thing and less of another. Thus he brings his monthly or annual outlays for different purposes to or towards a common boundary or margin (his "margin of consumption") where the importance which he attaches to what he gets for the final or marginal pound or dollar which he spends, say for food, is equal to the importance of what he gets for the marginal pound or dollar spent for clothing or other object

Imputed Price.—This is an estimate of the amount of money for which a given article or a given quantum of goods could be sold or bought When we say that the value of a work of art, a house, or a stock of goods is so many pounds or dollars, we are using the word value in the sense of imputed price. The "valuation" or appraisal of goods for purposes of taxation or of formal transfer is an imputation of price A nation's wealth can be expressed in terms of its money value only by imputing prices to the various items of which it is composed Value, in this sense, is not the price would could be got at a forced sale or the price which would have to be paid by buyers in order to induce holders to part with their goods *en bloc* It is, instead, an estimate of the price which could be obtained in due course, with no sudden accelerating of either supply or demand. Statements to the effect that the price of a commodity is above or below its value generally mean only that because of a temporary excess of supply or demand or because buyers or sellers lack knowledge of facts which, if known, would affect their offers, the present price is out of line with the probable future price.

Theories of Value.—That the exchange value of a good is determined by the amount of labour required to produce it was at one time a fairly common belief. Adopted and restated by Adam Smith and his successors, this doctrine was later taken over by Karl Marx and other socialists and put into a form in which labour is held to be the sole source or cause of value In its best form, as set forth by Ricardo, the labour theory of value was to the effect that, allowing for temporary fluctuations of supply and demand, the exchange values of different commodities tend to be *proportional* to the respective quantities of labour required to produce them. The rent of land was held to be without influence on the value of its produce, for the reason that the value had to be high enough to cover the labour costs incurred under the most unfavourable conditions of cultivation, where no rent is or can be paid. Capital was regarded as stored up labour, and interest or necessary profit on capital was disregarded on the arbitrary assumption that its amount would be roughly proportionate to the total amount of labour employed in producing a commodity.

Apart from the circumstance that other costs than labour are not adequately brought into the reckoning, the labour theory of value encounters two difficulties. First, different kinds of work call for different kinds and degrees of ability and training, and differ in respect of attractiveness. Different kinds of labour can be fused into a "quantity" of labour only by grading them or weighting them in accordance with the different values which their respective products command in the market, and this procedure leads to circular reasoning Second, so far as there is, in fact, any systematic relation between quantities of labour and the values of products, it is a result of the circumstance that labour is apportioned to different tasks only in such proportion and degree as its different products are valuable Similar difficulties are encountered in any attempts to find a simple relation between values and "real costs."

Dissatisfied with explanations of values in terms of costs, some economists, taking note of the circumstance that values must necessarily be related to the choices and preferences of consumers, sought to find the determinant of value in marginal utility (*i.e*, the utility or importance to the buyer of the least important or "marginal" part of his current consumption of any commodity) Subjective values are proportionate to marginal utilities and exchange values must be proportionate to subjective values If they were not, the consumer would alter his budget by buying more of one thing and less of another Each consumer thus adjusts his purchases so as to bring his own valuations into line with the values which obtain in the market, but the values which obtain in the market are the resultants of the aggregate demand of consumers for different products This aggregate demand determines what and how much shall be produced and what the values of different uses of labour and of other productive agents shall be Such, in brief outline, is the marginal utility theory of value It illuminates some aspects of the problem, but it is quite as one-sided and incomplete as a cost-of-production theory of value is That consumers' preferences determine what shall be produced and what costs of production shall be incurred is no more true than that the relative costs of producing different things determine how far consumers can follow their preferences

Displacement Costs.—The costs which are most directly and systematically related to values are displacement costs Labour displaces other uses of time, saving displaces present consumption, any one use of labour or capital or natural resources displaces other uses, and in general, the production of one good displaces the production of other goods The production of some goods can be increased with a progressively smaller sacrifice of other possible products. Other goods can be had in larger quantities only by sacrificing progressively larger amounts of alternative products As the amounts of a given good which have to be sacrificed in order that other goods may be acquired change, consumers will alter their budgets, but how far they will go will depend upon the relative importance to them of the uses of the increments of goods which they acquire and of the increments which they sacrifice Out of the play of forces such as these, and especially out of the relation between the preferences of consumers on the one hand and the technical conditions which determine the displacement costs of production on the other hand, there emerges a tendency—never fully effective because of continuous changes in the structure of demand and in the conditions of supply—towards the establishing of a system of exchange values which would bring production and consumption fully into equilibrium.

See also ECONOMICS and PRICE. (A Yo)

VALUE, THEORY OF. Until recently there has been no general theory of value Value has long been a fundamental notion of political economy and various theories of its nature have been developed, but it is only in the last decades that it has been universally recognized as one of the great philosophical topics. Its discovery has been held by some to be "the greatest philosophical achievement of the 19th century," and its development as a special field of psychological and philosophical study has gone so far that a special name has been created for it, namely *Axiology*

The development of such a theory requires the consideration of the following problems: (1) What is the nature of values? (definition); (2) What are the fundamental values and how are they to be classified? (3) How may we determine the relative values of things and what is the ultimate standard of value? (4) Are values merely subjective, satisfying merely subjective desires, or are they objective, in some sense other than objects of desire, and giving some law or norm to desire? (5) What is the relation of values to things or of value to existence and reality?

The History of the Value Notion.—A brief sketch of the history of the idea of value in philosophy will help to make clear the meaning of these problems The Greeks did not have the term value as now understood, but in the light of subsequent developments we may see that they had the notion, and were aware of these problems Plato conceived the good or value as the culmination of the world of ideas and the constructive principle of the world which organizes all its forms or laws Aristotle, in proposing to view all things teleologically, and to make the relation of a thing to its end or value essential to its very being, affirmed, not only the objective reality of value qualities, but also their supremacy over all the other attributes of things Neither Plato nor Aristotle developed this line of reflection fully, nor did succeeding philosophers investigate the subtle and perplexing problems involved in it Plato himself called this the most difficult question of all science Nevertheless, the general principle enunciated by Greek philosophy continued to be the rule throughout the middle ages, and the objectivity of value the key to all their thinking

The modern developments of the subject proceed directly from Kant who here, as elsewhere, represents a crisis in philosophic thought The classical conception of the objectivity of the good or value had been abandoned by modern empirical thought If the so-called "secondary" qualities, such as colour, taste, sound, etc are made dependent upon the percipient subject, all the more must the "tertiary" qualities, such as beauty, goodness, etc be made dependent upon human desire and feeling This extrusion of all values from the objective world seemed to Kant to be the necessary consequence of the assumptions of "science" But he could not accept it as the whole story of values By a well-known line of reasoning which cannot be repeated here, he restored their objectivity in a new form Though not "existent" in the same sense as physical things, their reality must be postulated and acknowledged, if life and action are to be possible They have, in his terms, "validity" and "practical reality" With this an entirely new line of thought was set in motion, raising new problems of fact and value, value and validity, value and existence A large part of modern axiology or general theory of value has developed under the inspiration of Neo-Kantianism But it is to R H Lotze (1817–81) more than any other man perhaps except Nietzsche, that the popularity of the term value is due, and certainly he more than any other is responsible for the prevalence of the idea of value as an ultimate notion in philosophy Albrecht Ritschl (1822–89), Lotze's theological colleague at Gottingen, made the value notion central in the discussions of religion and theology and furnished modernist tendencies in theology with a large part of their inspiration and much of their terminology He agrees with Kant that the objects of religion are objects of faith as distinct from knowledge in the scientific sense, but he develops much further the notion that they are matters of value judgment as distinct from theoretical judgment, although equally capable of certainty and validity It is mainly to Ritschl that is due the current distinction between judgments of value and judgments of fact, and the subordination of judgments of fact to judgments of value From Ritschl s position it was easy to pass to that of W Windelband (1848–1915) who, together with H Rickert and Hugo Munsterberg (1863–1916) developed the Neo-Kantian axiology to which reference has been made

The chief stimulus to the development of the general theory of value as a distinct field of psychological and philosophical study, came, however, from the work of A Meinong (1853–1920) and C. von Ehrenfels (1850–) A fresh analysis of value in the economic sense had been undertaken by the Austrian economists, Boehm Bauwerk and Von Wieser, which resulted, among other things, in raising many problems of psychological and even philosophical importance Under their influence, Meinong and Von

Ehrenfels investigated values other than economic, and first undertook a systematic study of the entire field of value The more philosophical developments of the subject are largely due to Meinong Starting with the psychological concept of the economists he gradually came to the view of values as objective and independent of their being experienced At this point the problems of the two modern movements described tended to coalesce No history of value theory would, however, be complete that did not note the influence of Nietzsche, with his "transvaluation of all values," and the Pragmatic movement in philosophy, for which knowledge is subordinated to practice and truth becomes a form of value

The Nature of Value.—The fundamental problem of a general theory of value is the question of the nature of all determinations of value, in other words of so defining it as to include all the forms of value. The immediate and natural answer to this question is to say that value is a determination or quality of an object which involves *any sort of appreciation or interest* Such appreciation, however, involves feeling and ultimately desires or tendencies underlying the feeling. Therefore value *is* the feeling Value and feeling of value are the same thing. This is the psychological notion of value and the theory of value developed on this basis the *psychological theory of value* For many this seems to tell the whole story The economic theory of value made its first scientific steps by abandoning the notion of value, whether in use or exchange, as an objective quality inherent in the thing, and conceiving it as the function of the relation of the object to satisfaction of desire Following this lead, the general theory of value was in the first place a psychological theory of value Even in economic theory, however, it is realized that this is only part of the story Back of desire and feeling lie certain biological tendencies or instincts presupposed by the desire and its satisfaction So that value becomes, in the words of Orestano, "a biological phenomenon appearing in psychological form." A theory of value that shall be not merely a theory of *price* must relate the *instrumental* values of economics to life. Unless we consider these tendencies merely in their aspect of determinants of price, we must have a quite different notion of value to include them. If this is true of the limited field of economic goods or values, it is all the more true of the *intrinsic* values which a more general theory of value recognizes Psychological theories of value thus tend to become biological theories in the broader sense of the term. Value is defined in terms of survival and enhancement of life, and the biological tendencies are graded according to some standard of value-for-life It is at this point, however, that the specifically philosophical theories of value arise. We wish to explain and ultimately validate these values by carrying them back to life. But in this it is already assumed that life and its continuance have value. If values get their significance from their teleological relation to life and its enhancement, then surely life must get its significance from "absolute" values which it embodies; otherwise life and its relative values lose all genuine meaning From a more ultimate point of view a knowledge of value is presupposed in any concept of a valuable life. As the result of reflections of this type, two main positions have emerged in the general philosophical theory of value. Either value is conceived of as a "logically primitive" concept, and therefore as ultimately indefinable, as are certain other ultimate concepts in philosophy, or else it is conceived of as function of the coherent organization of life or experience as a whole.

It may be said without hesitation that value theory is to-day predominantly philosophical rather than psychological. This does not mean, however, that the psychological study of the processes of valuation is not an important part of the general theory. The psychological question is what goes on in consciousness when we value, and while an answer to this question will neither tell us what value ultimately is, nor afford us a standard of value which will enable us to form a system or scale of values, it nevertheless throws light on many questions. The most important contributions here are, perhaps, the studies of the mutations or transvaluations of values The popular interest aroused by Nietzsche in his *Genealogy of Morals* has found a scientific echo in the study of the phenomena, causes and laws of the mutations of values. A notable feature of modern value theory is the interpretation of history as a value science, or part of a philosophy of values.

Classes and Standards of Value.—It is generally admitted that distinct species of value exist, although there is no complete agreement as to what they are or how they are to be classified. It is clear, however, that there are sciences which deal with values and special sciences have been developed to deal with special classes of value. Thus economic value has long been recognized as a fundamental notion of political economy, which ever since Adam Smith divided it into value in use and value in exchange has been defined thus: the former as the utility of objects for human purposes and the latter the power to induce or compel people to pay other valuables for the use of them That ethics also deals with values is generally agreed, although there is dispute as to just what these values are and how they are related. It is now generally recognized that ethical value is not identical with pleasure or happiness, although pleasure is one of the values Aesthetic values are also generally, although not universally, admitted, many pragmatists holding that, since valuation is always judgmental, and the aesthetic "has no logical function, it must be denied the name of value." From the philosophical standpoint, the most important group of values distinguished is perhaps the logical or theoretical values Several schools of thought hold that logic is the science of cognitive values and that truth is a positive and error a negative value Indeed this view is quite generally implied although it is not always explicitly avowed "Religious values" are quite commonly talked about, although whether they constitute a special group or represent rather a fusion of, or a reaction to, the other values is a matter of dispute It may be argued that they do not constitute a distinct class, because there is no specific biological tendency or instinct to which they correspond, or that they represent merely the reaction on the fate of the other values in the universe But the tendency to recognize the value of the "holy" as a distinct type, as developed by the Neo-Kantians, is very strong, and has recently found expression in a much read book, *The Holy*, by Rudolf Otto. Some writers speak of distinct classes of social and political values, but the general tendency, perhaps, is to view these as sub-forms of the ethical

Despite such differences of opinion, incidental to any developing theory, there is substantial agreement as to the existence of these four outstanding classes of values There is, unfortunately, not the same consensus of opinion regarding their relations, *i e*, the ordering of these values in a system or in a scale of relative value and importance. There are in general three accepted ways of classifying them. There is the psychological which, assuming values to be the functions of interests or desire, divides them according to modes of this interest and tends to become ultimately biological and genetic, the outstanding classes being connected with some fundamental "instinct" or tendency. A more historical mode of classification accepts as units those values, or groups of values, which have acquired an institutional form, such as economic, moral, cognitive, political, aesthetic, religious. A third, which has been called the axiological, accepts in the main the trinity or tetrad of the good, the beautiful and the true, to which it adds the higher unity of God. Such classifications or systems of value all have their uses, but it is generally felt that the first two are not sufficient. A large body of opinion, accepting the "axiological" classification, holds that while the economic values are clearly instrumental and relative to the others, the other groups are intrinsic and absolute, and as such ultimately co-ordinate. Others hold that they may be put in relations of subordination in a comprehensive scale of values. There are, however, some things that may be said with a certain degree of assurance. The ethical, aesthetic and logical values are self-sufficient and co-ordinate in the sense that they are irreducible the one to the other. All attempts at such reduction, whether, for instance, of the aesthetic to the ethical, of the ethical to the logical or the logical to the ethical, have proved unsatisfactory. On the other hand, it seems clear that they are all intimately related. No intrinsic value can stand alone This is equally true whether we consider the question from the standpoint of the realization of values in the individual life or from the more objective point of view of their logical relations.

It is impossible to define any one type of value alone or apart from the others. The ancient view that values are subsumable under the heads of goodness, beauty and truth, "a threefold cord, not lightly broken," is in general strengthened rather than weakened by modern value theory.

The idea that these ultimate values are co-ordinate in the sense described does not, however, as might at first appear, exclude the notion of an ultimate standard of value in the light of which some hierarchical principle or scale of value might be developed, and the classes of values be subordinated to each other. On the general question of the commensurability of value as such, there is a large measure of agreement For the opinion, held by a few, that they are incommensurable, there is indeed something to be said It may be objected that an economic satisfaction and an aesthetic experience are of such different inner qualitative content that it is absurd to compare them with each other The fact remains that we do actually compare them constantly We compare values not only within the same class, as when we choose one economic good rather than another; we also choose between types and classes The standpoint of the incommensurability of values can be admitted only in the sense that the different values cannot be expressed in quantitative units and measured in this sense But there are few that hold this idea at the present day For the merely psychological or biological theories, the standard of value is found in such conceptions as intensity of feeling, the strength of the desire, or ultimately in the importance for life of the biological tendencies presupposed For the more philosophical theories, on the other hand, that recognize the limitations of these notions of value, a different conception of the ultimate standard is also necessary In general such a standard is found in the notion of *inclusiveness,* in some functional conception such as the totality of life or experience, that value being highest which contributes most to the coherent functioning and organization of experience as a whole Such a standard may be formulated in terms that seem to avoid metaphysical implications, but in general it may be said that the highness or lowness of an experience of value is held to be determined by its metaphysical content From this point of view a very common table or scale of values is that which puts the economic values as the lowest and the religious (in the broadest sense) as the highest, the ethical, the logical and the aesthetic being arranged in various ways in between The standard here employed is, in the last analysis, some form of the principle of inclusiveness, the different values being arranged either in accord with the degree of integration of our interests or tendencies, or in accord with the range of the metaphysical content to which they correspond

Logical or Theoretical Values—Validity.—The inclusion of logical or theoretical values in the general theory of value is undoubtedly the main reason for the outstanding place which axiology has in present day thought. Such an inclusion obviously involves a radical revision of our entire notion of values and of the relation of value to fact and truth It is pointed out by the value philosophers that for an ultimate analysis, logic is also a science of values The Pragmatists insist that theoretical values "presuppose purposes, selections, choices," and that "judgments are acts which do not differ in kind from those which are openly practical" The Neo-Kantian axiologists point out that the desire for truth and rationality, the demand for logical consistency or validity, is itself a craving for what *ought to be* and that here too we are moved by an ideal and directed by a norm, as surely as in the realms of ethical and aesthetic values. In either case validity becomes a form of value and logical rules instruments of the will to truth. The development of this notion involves difficult problems which cannot be gone into here Whether the "value" of truth is relative or absolute, whether truth is the ultimate value upon which all the others in some way depend, or merely subordinate and instrumental to the other values; or, finally, in some way co-ordinate with them—all these are debated questions which, as we have seen, in turn affect the problems both of classification and order of values. In any case, the notion of validity as a form of value has brought about in many quarters a radical revision of our notion of the relation of value to fact and truth Against purely intellectualistic or "scientific" views it is contended, not only that every fact is ultimately an evaluation, but also that the logical impulse ought not to have the primacy over the other demands of our nature, and that no philosophical system can be adequate which fails to do justice to all our values. Philosophic system tends to become, from this point of view, a system of values, or at least to presuppose such a system

Value and Reality.—Whatever differences of opinion there may be among the various theories of value, there is substantial agreement that values are not subjective in the sense that they are merely matters of opinion and exist only for the persons who appreciate or feel them Even for the psychological-biological theory, while they are dependent upon interest (desire and feeling), they are independent of judgment and opinion The "objectivity" thus universally accorded values is indeed given different meanings, but in any case it is now generally agreed that values cannot be denied existence or reality in any world that can exist for man They must, it would seem, exist in several senses

Values "exist" (1) in the sense that they are operative and effective in and on human minds and in human action, and find embodiment in the objective institutions of society. They are "real" in the sense that they are valid, that is they claim to be true ideals as opposed to false ideals or fictions They must, however, be real in a still more ultimate sense (metaphysical), in that they are part of the nature of things, and not something merely added to existences For values to be real in either of the first two senses they must be real in the third For both must be so related to real existence that they constitute the key to the nature of the real Otherwise they become false ideals and futile fictions The question of just how values may be said to exist (to be part of the nature of things) is a difficult and debated question that cannot be gone into here It is possible, however, to state a general proposition to which almost all theories of value would subscribe Values are not mere subjective incidents, more or less gratuitously superadded to fact, but are inherent in the structure of reality. Reality in its fullness contains and exhibits values, and they can be extruded from it only by a process of abstraction that is relative to restricted purposes (of special sciences) and which is never quite successful This reinstatement of the objective reality of values (in its essentials the Greek notion) is partly due to developments within value theory itself and partly to a larger movement in philosophy as a whole In any case, it is now widely felt that in the answer to the problems of value is to be found the key to the philosophical interpretation of reality as a whole

Bibliography—The lit. of the subject is extensive and scattered, some of the most important contrib. being found in art and journ. and in general works in philosophy The only works in English expressly devoted to the theory of values are W M Urban *Valuation, Its Nature and Laws* (1909); and R B Perry *General Theory of Value* (1926) Refs to the more extensive liter will be found in an art by W M Urban, written in prep for the Sixth Inter Congress of Philosophy, entitled *Value Theory and Aesthetics*, and pub. in the *Monist* for Oct, 1926 Important works in general philosophy in which the value notion is central are Hugo Munsterberg *Eternal Values* (1909), B Bosanquet *The Principle of Individuality and Value* (1912), and the *Value and Destiny of the Individual* (1913) (rep the idealistic point of view), S Alexander *Space, Time and Deity* (rep the realistic and naturalistic point of view); and W. R. Sorley *Moral Values and the Idea of God* (1919) The Ger. and Fr. lit is even more extensive Only a few of hist. import and of recent pub can be noted Among these are Ch V. Ehrenfels *System der Werttheorie* (1897), A Meinong *Zur Grundlegung der Allgemeinen Werttheorie* (1923); G Simmel *Philosophie des Geldes* (1900), H Rickert, *System der Philosophie*, 1921; W Stern *Wertphilosophie* (1924), C Berguer *La Notion de Valeur* (1908), C Bouglé *L'Évolution des Valeurs* (1922). (W M U)

VALVES (MECHANICAL) are devices for controlling the flow of air, gases, or liquids They vary from the small air-valve in the automobile tyre to huge valves for controlling the flow of large volumes of water in such engineering developments as the locks of the Panama Canal

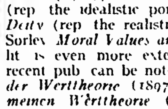


Fig. 1

One of the simplest types is the valve shown in fig 1 This is made in all sizes up to about 10 ft in diameter in water-pipes and is known as the butterfly-valve This valve is similar to the

damper used in stove-pipes. Another simple type is the flap-valve which is used as a check-valve in hand-pump pistons, to allow water to pass through the plunger on the down stroke and to prevent its return on the lift stroke. A similar valve (fig 2) is also used between steam boilers and the pump or other method of supplying the boiler with water When the water pressure is withdrawn, the steam pressure in the boiler forces the valve to its seat and retains the water in the boiler In another form of check valve the stem guides the valve to its seat

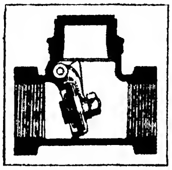


FIG 2

It is but a step from this to the globe-valve in fig 3 where the valve is closed by screwing down on the valve stem This type of valve is probably used more largely than any other in controlling water and steam. The valve seat in fig. 3 is usually separate from the valve stem In most cases the seat can be easily removed when worn and replaced In some designs of simple globe valves, the seat can also be replaced when worn.

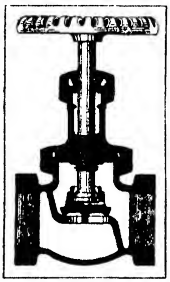


FIG 3

In a later design of globe-valve, which has replaced the valve in fig 3 to a considerable extent the valve acts as a gate in the line of flow, and does not compel the liquid or gas to take such a circuitous route as in the globe-valve Gate-valves are made with both straight and angular seats When the angular seat is used, the gate acts as a taper wedge between the seats When the seats are parallel, the wedging action is secured by a tapered piece on the valve stem being forced between the two discs The valve openings in both types are usually round, as when placed in a pipe line and forming part of it In exceptional cases, however, the valves are rectangular, as in some of the gates of the intakes of the Panama Canal locks

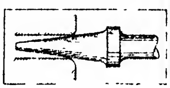


FIG. 4

A valve used largely in high pressure work and for securing fine adjustments of the opening, as in spraying or atomizing, is known as the needle-valve (fig 4) The area of the opening can be varied very slightly as the needle is moved in its seat By varying the angle of the needle point, the opening per unit of movement can be varied between wide limits This type of valve is used in spraying fuel into Diesel engine cylinders

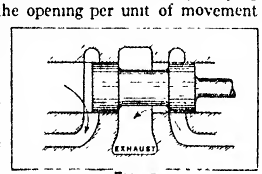


FIG 5

Valves for admitting steam or gas to engines are either sliding, rotary or poppet The slide-valve is among the oldest types used for this purpose, but has largely disappeared, owing to the power required to move them under high pressure. The old steam engine D-valve admits steam first to one end of the cylinder and then the other, the exhaust taking place in the central cavity This type of valve has now been largely supplanted by the piston-valve, particularly in locomotive use. A piston-valve (fig. 5) acts in the same way as the D-valve, the difference being that the valve is balanced by the steam at each end or in the centre In some cases, the admission of the steam takes place at the centre of the valve and the exhaust from each end.

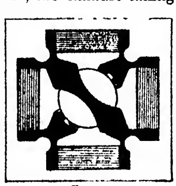


FIG. 6

Rocking- or rotary-valves are also used for similar purposes. Such valves admit steam in one position and block its flow when turned so as to close the port Valves of this kind were used on steam engines of the Corlis type Similar valves are also used to direct the flow of air, water, or gas in one or more directions at will. They are frequently known as three-way or four-way valves A four-way valve is shown in fig 6. When moved from one position to another, the flow is directed into any of the pipes shown. The simplest form of rotary-valve is the plug cock in fig. 7 (For gasolene engines of the poppet and sleeve types *see* MOTOR CAR, *Valves*)

Safety-valves, for relieving the pressure of boilers, pressure tanks, or pipe lines, may be said to be check-valves held to their seats by weights or springs set so as to open when the desired blowing-off pressure has been reached. Safety-valves are made in a variety of forms, the older type having a lever with a weight placed at the proper point to give the desired pressure. Loaded valves have springs over the valve seat instead of the lever. (F H C)

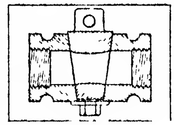


FIG 7

VALVES or PISTONS, in music, are mechanical contrivances applied to wind instruments in order to establish a connection between the main tubing and certain supplementary lengths required for the purpose of lowering the pitch Various devices have been tried from the days of ancient Greece and Rome to produce this effect, the earliest being the additional tubes inserted into the lateral holes of the aulos and tibia (*qq v*) in order to prolong the bore and deepen the pitch of each individual hole; these tubes were stopped by the fingers in the same manner as the holes This device enabled the performer to change the mode or key in which he was playing, just as did the crooks—or coils of tubing inserted between the mouthpiece and the main tube in the trumpet and horn, and between the slide and the bell joint in the trombone—many centuries later

But the resourcefulness of the ancients did not stop there The tibiae found at Pompeii had sliding bands of silver, one covering each lateral hole in the pipe; in the band were holes (sometimes one large and one small, probably for semitone and tone) corresponding with those on the pipe By turning the band the holes could be closed, as by keys, when not required By fixing the ὅλοι in the holes of the bands, the bore was lengthened instantly at will, and just as easily shortened again by withdrawing them; this method was more effective than the use of the crooks, and foreshadowed the valves of eighteen centuries later The crooks, or coils of tubing inserted between the mouthpiece and the main tube in the trumpet and horn, and between the slide and the bell joint in the trombone, formed an important step in this direction

Although the same principle underlies all these methods, *i e*, the lengthening of the main column of air by the addition of other lengths of tubing, the valve itself constitutes a radical difference, for the adjustment of crooks demands time and the use of both hands. The action of the valve being as instantaneous as that of the key, the instrument to which it was applied was at once placed on a different basis, becoming a chromatic instrument capable of the most delicate modulations from key to key

The slide had already accomplished this desirable result, but as its application was limited to instruments of which the greater part of the bore was cylindrical, *i e*, the trumpet and trombone, its influence on concerted musical composition could not be far-reaching In fact it is doubtful whether the chromatic possibilities of the slide were fully realized until the end of the 18th century, when, key mechanism having made some advance, it was being applied successfully to the transverse flute, and to the clarinet and oboe families

In 1760 Kólbel, a Bohemian horn-player engaged in the St. Petersburg Imperial Orchestra, turned his attention to this method of extending the compass of brass instruments His experiments, followed up by Anton Weidinger of Vienna at the beginning of the 19th century, produced a trumpet with five keys and a complete chromatic compass. Halliday followed with the keyed bugle in 1810. Halary applied the principle of the keyed bugle to the bass horn in 1817, and produced the ophicleide—an ideal chromatic bass as far as technical possibilities are concerned. The horn had become a chromatic instrument through Hampel's discovery of

bouché sounds, but the defects in intonation and timbre still remained. Such were the conditions when the successful application of the valve to brass wind instruments by Heinrich Stölzel of Silesia brought about an entire revolution in the design and construction of these instruments. Further efforts to perfect the key system as applied to the brass wind were abandoned in favour of valves, and the short space of two decades witnessed the rise of the Flügel-horns, the tubas, the saxhorns and the cornet-à-pistons; the trombone, French horn and trumpet having led the van

Although the valves of brass wind instruments vary in form and detail according to the makers, the general principles governing their action are the same for all types The piston, placed on some branch of the main tube, must be so constructed that on being depressed it closes the natural windways through the main bore and opens others into the additional piston length. The piston, seated on a spring, instantly regains its normal position when the finger is removed The length of tubing attached to each valve is calculated on the basis of the length of the main column, to give for the first piston a tone, for the second a semitone, for the third a tone and a half, and for the fourth two tones

There was, however, a difficulty at first In the early valved instruments it was found that the intonation of the notes yielded by the combined pistons was seriously inaccurate, an increase in the length of the additional tubing being required to give the right results, and it took many years before the instrument-makers succeeded in satisfactorily overcoming this defect and producing the perfected instruments of the present day

Although the accredited inventor and patentee of valves applied to musical instruments was Heinrich Stolzel, of Pless in Silesia, the actual inventor was really one Blumel, also a Silesian, who sold his rights to Stolzel in 1815.

VÁMBERY, ARMIN (1832–1913), Hungarian Orientalist and traveller, was born of humble parentage at Duna-Szerdahely, a village on the island of Shutt, in the Danube, on March 19, 1832 He was educated at the village school until the age of 12, and owing to congenital lameness had to walk with crutches At an early age he showed remarkable aptitude for acquiring languages, but straitened circumstances compelled him to earn his own living After being for a short time apprentice to a ladies' tailor, he became tutor to an innkeeper's son He next entered the untergymnasium of St Georgen, and proceeded thence to Pressburg Meanwhile he supported himself by teaching on a very small scale, but his progress was such that at 16 he had a good knowledge of Hungarian, Latin, French and German, and was rapidly acquiring English and the Scandinavian languages, and also Russian, Serbian and other Slavonic tongues At the age of 20 he set up as teacher of European languages in Constantinople, and shortly afterwards became a tutor in the house of Pasha Hussein Daim Under the influence of his friend and instructor, the Mollah Ahmed Effendi, he became, nominally at least, a full Osmanli, and entering the Turkish service, was afterwards secretary to Fuad Pasha After spending six years in Constantinople, where he published a *Turkish-German Dictionary* (1858) and various linguistic works, and where he acquired some 20 Oriental languages and dialects, he visited Tehran; and then, disguised as a dervish, joined a band of pilgrims from Mecca, and spent several months with them in rough and squalid travel through the deserts of Asia He succeeded in maintaining his disguise, and on arriving at Khiva went safely through two audiences of the khan Passing Bokhara, they reached Samarkand, where the emir, whose suspicions were aroused, kept him in audience for a full half-hour; but he stood the test so well that the emir was not only pleased with "Resid Effendi" (Vámbéry's assumed name), but gave him handsome presents. He then reluctantly turned back by way of Herat, where he took leave of the dervishes, and returned with a caravan to Tehran, and subsequently, in March 1864, through Trebizond and Erzerúm to Constantinople By the advice of Prokesch-Osten and Eötvös, he paid a visit in the following June to London; there his daring adventures and linguistic triumphs made him the lion of the day In the same year he published his *Travels and Adventures in Central Asia.* In connection with this work it must be remembered that Vámbéry could write down but a few furtive notes while with the dervishes, and dared not take a single sketch, but the weird scenes, with their misery and suffering, were so strongly impressed on his memory that his book is convincing by its simplicity, directness and evidence of heroic endurance Vámbéry also called the attention of politicians to the movements of Russia in Central Asia From London he went to Paris; then returning to Hungary, he was appointed professor of Oriental languages in the University of Budapest there he settled down, contributing largely to periodicals, and publishing a number of books He died at Budapest on Sept 15, 1913

His travels have been translated into many languages, and his autobiography, *Arminius Vámbéry, his Life and Adventures* (1883; 9th ed, 1914), was written in English Amongst the best known of his works, besides those alluded to, are *Wanderings and Adventures in Persia* (1867), *Sketches of Central Asia* (1868), *History of Bokhara* (1873), *Manners in Oriental Countries* (1876); *Primitive Civilization of the Turko-Tatar People* (1879); *Origin of the Magyars* (1882); *The Turkish People* (1885), *Hungary* (1887), with Heilprin, and *Western Culture in Eastern Lands* (1906)

VAMPIRE, a term originally applied to bloodsucking ghosts, now transferred to bloodsucking bats inhabiting South America. In its original meaning a vampire is supposed to be the soul of a dead man which quits the dead body at night to suck the blood of living persons Hence, when the grave is opened, the corpse is found to be fresh. To put a stop to his ravages the commonest method is to drive a stake through the body. The belief in vampires is still prevalent among Slavonic peoples.

HEAD OF VAMPIRE (DESMODUS RUFUS), A SMALL BAT OF CENTRAL AMERICA

The blood-sucking bats comprise two species (*Desmodus rufus* and *Diphylla ecaudata*) from the forest of tropical America Their attacks upon men and warm-blooded animals were noticed by early writers, but for many years the bats themselves were not identified and the large frugivorous *Glossophaga soricana* and *Vampyrus spectrum* were mistaken for the true sanguivorous species *D rufus* is the more abundant species, it is a small bat, about 3 in in length with reddish-brown fur, and peculiar teeth (*see* fig) adapted to its mode of feeding They are said to be able to pierce the skin and suck blood without awakening their victim. The oesophagus is very narrow, as is the pyloric division of the stomach, while the cardiac part is produced into a large diverticulum. *D ecaudata* is less abundant, confined to Brazil, and differs in the details of the teeth

VAN. (1) The chief town of a vilayet of the same name in Asiatic Turkey, altitude, 5,400 ft. Pop. (1927) 22,549 It is situated about a mile from the eastern shore of Lake Van, and built along the south side of the citadel rock, an isolated rocky ridge 1,300 yd long, rising 360 ft. out of a plain which extends up to the sharply defined rocky mass of the Varak range, 8 m distant On the gently sloping ground east of the citadel are the Gardens, covering an area of 5 m by 3, and containing several suburbs and detached houses, along central avenues fringed with trees, and having channels of running water by the sides for irrigation.

The town itself is a poor place with flat-roofed mud houses, narrow winding streets, and surrounded by a ruinous mud wall, but it still contains the business quarter, the government offices and the principal bazaars Water comes from *karez* or underground channels and streams from Varak, fed from the Sikhe Lake, an ancient reservoir which preserves the snow waters on the summit of the mountain For the southern quarter there is the Shemiram Canal, also of very ancient construction, which derives its supply from a large spring 19 m distant, near Meshingird The climate is generally healthy, extremely cold in winter, with 2 to 3 ft of snow from December to March, while the summer heat is not excessive The Persian trade of Van has declined, European goods, with which the bazaars are fairly well supplied, come from Trebizond through Erzerum. There is a fair local trade in wheat and agricultural produce, also sheep and cattle, wool, hides and furs for export.

The cuneiform inscriptions of Van are very numerous, the town

having been the capital of the Vannic kingdom of the Assyrian period, for which *see* URARTU.

In the sixth century B.C. Van passed into the hands of the Persians, and shortly before it fell to Alexander the Great it was rebuilt, according to Armenian historians, by a native prince called Van. In 149 B.C. Valarsaces or Vagharshag, the first Armenian king of the Arsacidae, rebuilt the town, and a colony of Jews was settled in it by Tigranes (94–56 B.C.). In the middle of the 4th century A.D. it was taken by Sapor (Shapur) II., and became the capital of an autonomous province of the Sassanian Empire, until it fell into the hands of the Arabs (*c.* 640), under whom it regained its autonomy. About 908 the governor of Van or Vaspuragan was crowned king by the caliph Moktadir, and in 1021 his descendant Senekherim was persuaded by Basil II. to exchange his kingdom for the viceroyalty of the Sebasteian theme. After having formed part of the possessions of the Seljuks, Mongols, Tatars and Persians, Van passed in 1514, after the defeat of Shah Ismail by Selim I. at the battle of Kalderan, to the Osmanlis, who only occupied the town in 1543. In 1636 it was taken by the Persians, but soon recovered. In 1845 the town was held for a time by the Kurd chief Khan Mahmud.

(2) The vilayet of Van lies along the Persian frontier between the vilayets of Bayazid and Hekkiari. The mineral wealth of the vilayet has never been fully explored, but is believed to be great.

(3) LAKE VAN, called Arsissa Palus and also Thospitis from its Armenian names, is roughly rectangular 55 m. long and 40 broad, with a long north-eastern arm which increases the greatest length to 80 m. It stands about 5,260 ft. above sea-level. It is without an outlet, and its greatest depth is along the southern shore. It has constant steady fluctuations, rising and falling some 8 ft. in a periodic movement of five years. In the middle of the 19th century a sudden rise submerged several places on the banks, including Arjish Kale, and the waters did not again subside. The north-eastern arm is much shallower than the rest. The water is bitter and undrinkable, being largely impregnated with carbonate and sulphate of soda with some borax. The salts are evaporated in pans, and called *perek*, being sold for washing purposes. There is, however, good water along the coast from springs and streams.

The lake has been navigated from the earliest times, and about 80 sailing boats, carrying about 20 tons burden, now ply on it, chiefly with wheat and firewood. Severe storms make navigation dangerous in winter. The southern shore is fringed by a steep range of mountains, with several thriving villages along the coast. The hills have now been almost denuded of trees. At the south-eastern corner is the island of Akhtamar with its ancient church, erected (*c.* 928) by Gagig, first king of the Ardzrunian dynasty. The Catholicos of Akhtamar was one of the highest offices in the Armenian Church, and dated from 1113. Large numbers of *darekh*, a kind of herring, exist in the lake, and are caught in nets from boats or when they enter the shallow lagoons in the spring and summer. Either fresh or salted they form an important article of diet of the poorer people.

VANADINITE, a mineral consisting of lead chloro-vanadate, (PbCl) $Pb_4(VO_4)_3$, crystallizing in the hexagonal system and isomorphous with pyromorphite and mimetite (*q.v.*). The crystals are usually six-sided prisms terminated by the basal planes, but are sometimes modified by numerous pyramidal planes which exhibit parallel hemihedrism. Rounded crystals and groups also occur. The colour is usually light brown or yellow, but crystals from Arizona are brilliant scarlet. Owing to isomorphous replacement of the vanadium by phosphorus and arsenic, the specific gravity varies from 6.6 to 7.2; a variety containing much arsenic is called *endlichite*. The mineral is one of secondary formation in veins of lead ore. In New Mexico and Arizona it has been mined as a source of vanadium for the manufacture of vanadium-steel. Several occurrences are known in South Africa.

VANADIUM, a metallic chemical element belonging to a family which also includes columbium (*q.v.*) and tantalum (*q.v.*). Although one of the rarer elements, vanadium (symbol V, atomic number 23, atomic weight 51), is fairly widely distributed, and since its application in the production of special steels (*q.v.*), several of its minerals have been extensively exploited.

Occurrence.—Patronite, native vanadium sulphide, which is an important source of the metal, occurs in Peru associated with iron pyrites in coal deposits. Carnotite, potassium uranyl vanadate, $K_2O,2UO_2,V_2O_5,3H_2O$, is found in Colorado and Utah and is extensively worked for vanadium, radium and uranium. Vanadinite $[Pb\{3Pb_3(VO_4)_2\}]Cl_2$, isomorphous with pyromorphite and mimetite, occurs as deep red crystals in Arizona, New Mexico, South East Africa and Northern Rhodesia. Other vanadium minerals are descloizite, a lead zinc vanadate found in New Mexico and Arizona, and roscoelite, a micaceous mineral in which aluminium is partially replaced by vanadium; the latter occurs in Colorado and is an important source of the metal. Mottramite, a basic vanadate of lead and copper, is found in Cheshire. In addition to these minerals in which it is a major constituent, vanadium occurs in numerous rocks and deposits. Many iron ores such as the minette of Lorraine and the German and Swedish iron ores contain as much as 0.3 to 0.7% of vanadium pentoxide.

A new metal was first observed in vanadinite by M. Del Rio (1801). Subsequently N. G. Sefstrom (1830) isolated its compounds from the slag of Taberg iron and having noticed the beautiful colours which they displayed in solution, he called the new metal vanadium, in allusion to Vanadis, a name sometimes given to Freya, the Scandinavian goddess of beauty. F. Wohler (1830) showed that vanadium was identical with Del Rio's erythronium and a more extended study of the metal and its compounds was made by J. J. Berzelius (1831). In 1868 H. E. Roscoe proved that the supposed vanadium obtained by the earlier investigators was chiefly the nitride or oxide of the element and by a brilliant application of the principle of isomorphism, he showed that vanadium was a member, together with phosphorus and arsenic, of Group V. of the periodic classification.

Extraction of Vanadium Oxide from its Minerals.—Patronite is roasted and fused with sodium carbonate, the sodium vanadate thus formed is extracted with water, and the addition of ammonium chloride then precipitates ammonium vanadate. On ignition this salt leaves vanadium pentoxide. The vanadium when dissolved as vanadate may also be precipitated as calcium or ferrous vanadate. The native vanadates, carnotite, mottramite, etc., are extracted with concentrated hydrochloric acid; the acid extract and washings are evaporated with ammonium chloride, when ammonium metavanadate separates. (For further details of separation consult special treatises indicated in the bibliography.)

Metallic Vanadium.—The metal was first obtained by Roscoe on passing hydrogen over the heated dichloride. It is also prepared by reducing the pentoxide with "mischmetall," a mixture of the rare-earth metals. It has been prepared by the aluminium reduction method from vanadium trioxide and by the electrolysis of sodium vanadate in hydrochloric acid.

Vanadium is a silvery white metal with specific gravity 5.5 to 5.89; its melting point is 1,710° C. The fusibility is diminished by the presence of vanadium carbide or oxide. Vanadium is stable in air and is unacted on by bromine water, aqueous alkalis, hydrochloric acid or cold sulphuric acid. It is dissolved by hydrofluoric acid or hot sulphur acid to green solutions. Molten potash or potassium nitrate attacks the metal forming potassium vanadate. Its alloy with aluminium containing up to 10% of vanadium is malleable. Cuprovanadium is an alloy employed in copper castings and bronzes.

Ferrovanadium.—The greater part—about 90%—of the vanadium extracted is used in form of ferrovanadium alloys containing 25 to 30% of vanadium. Such alloys are produced by the "thermite" process on iron vanadate, by the reduction of this compound with carbon in the electric furnace, or by electrolysis of vanadium pentoxide dissolved either in fused ferrosilicon or in a molten mixture of iron fluoride and calcium carbide. When vanadium is added to steel it effects the removal of oxygen and nitrogen carrying these into the slag, and the portion which remains in the metal increases the tensile strength, toughness and elastic limit of the steel. These improvements are effected by comparatively small amounts ranging from 0.05 to 0.5%.

Compounds of Vanadium.—Vanadium salts are used as catalysts in a variety of chemical operations. A trace of vanadic acid accelerates the oxidation of cane sugar by nitric acid. (*See* MESOXALIC ACID and OXALIC ACID.) A very small amount of vanadyl sulphate promotes the development of aniline black Vanadium pentoxide has been utilised as a catalyst in bringing about the combination of sulphur dioxide and oxygen to sulphur trioxide, and in the aerial oxidation of naphthalene to phthalic anhydride, benzene to maleic anhydride and benzoquinone, toluene to benzaldehyde, and anthracene to anthraquinone Vanadium resinate and linoleate have been employed as driers for linseed oil and other drying oils, the action being more rapid than that induced by lead or manganese salts Ammonium vanadate has been used in leather dyeing and other vanadium salts have been employed in photography and chemotherapy, where vanadium arsenate and salicylate have produced beneficial effects, the latter as a substitute for salvarsan

Vanadium exhibits five stages of valency, each stage giving rise to characteristic colours. An acid solution of vanadium pentoxide, V_2O_5, is yellow to orange, mild reducing agents convert to the V_2O_4 stage which is characterised by a deep blue colour Further reduction of $VOCl_2$ leads to a green solution, now containing hydrated trichloride, VCl_3, corresponding with the V_2O_3 stage Drastic reduction gives rise to a lavender solution of VCl_2 corresponding with the VO stage A lower oxide, V_2O, is described but is unimportant

Vanadium pentoxide, V_2O_5, made by igniting ammonium metavanadate, NH_4VO_3, crystallises in yellowish-red prisms sparingly soluble in water but dissolving in aqueous alkalis to vanadates and in acids to vanadic salts such as $(VO)_2(SO_4)_3$ Metavanadic acid, HVO_3, is obtained as a brown powder by boiling copper vanadate with nitric acid, and when produced from this vanadate by digestion with ammonium chloride it separates in gold spangles known as "vanadium bronze" and employed as a pigment Vanadic acid and its oxide V_2O_5 enter into many complex combinations—polyvanadates, phosphovanadates, arsenovanadates, molybdovanadates and tungstovanadates. Vanadyl chloride, $VOCl_3$, a yellow liquid boiling at 127° C, is prepared by passing chlorine over heated vanadic oxide, but when carbon or sulphur is present vanadium tetrachloride, VCl_4, is also obtained as a reddish-brown liquid boiling at 154° C Vanadium tetroxide, V_2O_4, is a blue infusible substance obtained by mild reduction of the pentoxide, it dissolves in acids to yield blue vanadyl salts such as $VOSO_4$ and $VOCl_2$ and in aqueous caustic alkalis to brown solutions of the alkali vanadates (also termed hypovanadates); the potassium salt is $K_2V_4O_9.7H_2O$

Vanadium trioxide, V_2O_3, a black infusible powder produced by reducing the heated pentoxide in hydrogen, dissolves slowly in hydrochloric acid to yield vanadium trichloride, the green solution of which is more readily prepared by reducing vanadic oxide with magnesium and hydrochloric acid Anhydrous vanadium trichloride, VCl_3, prepared by heating vanadium pentoxide in chlorine and sulphur chloride, forms bluish-red crystals resembling anhydrous chromic chloride

Vanadium trisulphate, $V_2(SO_4)_3$, a crystalline yellow powder, combines with sulphates of ammonium, potassium, rubidium and caesium to form vanadium alums (*See* ALUMS) Vanadous oxide, VO, a grey powder having metallic lustre and metallic conductivity, is obtained by reducing the higher oxides with potassium It was erroneously regarded as a metal by Berzelius and shown to be an oxide by Roscoe The corresponding vanadous chloride, VCl_2, produced by reducing the tetrachloride with hydrogen, forms light green crystals dissolving readily to a lavender solution

Vanadium acetylacetone, $V\{CH(CO{\cdot}CH_3)_2\}_3$, obtained by the interaction of vanadium trichloride, acetylacetone and aqueous sodium carbonate, crystallises from chloroform in dark brown tabular prisms melting at 185–190° C, and on exposure to moist air undergoes oxidation to bluish-green vanadyl acetylacetone, $VO\{CH(CO{\cdot}CH_3)_2\}_2$, also prepared by dissolving vanadyl hydroxide, $VO(OH)_2$, in alcoholic acetylacetone (G T Morgan and H. W Moss, 1913)

Vanadium forms three sulphides, V_2S_5, V_2S_3 and VS, the most stable of which is the trisulphide The nitride, VN, produced by direct combination of its constituents, forms a metallic powder formerly confused with the metal itself The carbide, VC, an electric furnace product, forms hard silvery white crystals melting at 2750° C.

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VANADIUM STEEL. The desirability of adding vanadium to certain steels has been known since 1896, but it was too rare to be used until 1905 when a rich deposit was discovered in Peru Since then many minor localities have been worked, so that while ferrovanadium is still expensive, owing to the difficulty with which it is reduced and refined, there is ample raw material for present use Vanadium has a great chemical affinity for oxygen and nitrogen dissolved in steel, to avoid waste it is only added to dead-melted steel, in the ladle after all other quieting additions have been made Even so, much of it slags off the residual analysis being usually 0 15 to 0 25% It is sometimes thought that its chief action is as a cleanser, allowing the iron, carbon, manganese and chromium to exhibit their inherent virtues, however, since in high-speed steel (*q v*) it is present from 0 5 to 2 0% with undoubted advantage, it is probable that even the modicum present in ordinary steels has the definite advantage of forming finely dispersed carbides, greatly refining the grain (as seen under the microscope) and increasing the elastic limit and resistance to shock or impact

Chromium-vanadium steels are now widely used for axle forgings, clash gears and springs, where strength, hardness, impact and fatigue resistance are a requisite The Society of Automotive Engineers' standards include several alloys with carbon from 0 15 to 0 55%, manganese from 0 50 to 0 80% (even higher with higher carbon), chromium from 0 80 to 1 10% and vanadium from 0 15 to 0 25% These low alloys will give about the same properties after heat treatment as the nickel-chromium steels (*q v*) Case-hardened articles made of the lower carbon contents have intense surface hardness and wear resistance, to intensify the skin hardness such steels are frequently quenched from a cyanide bath, and the vanadium is said to prevent the usual embrittlement caused by nitrogen

Carbon-vanadium steels are mostly used in the annealed state for locomotive castings or forgings and are preferred over other alloys which must be heat treated, because subsequent heating at shops unequipped for precise work will not seriously reduce their strength Locomotive frames of cast steel containing 0 20% vanadium have an elastic limit 25% above that of a similarly annealed plain carbon casting without any loss in ductility Locomotive side rods, driving axles and large shafting for electrical machinery or reciprocating engines are frequently forged of carbon-vanadium steels, made in the acid open-hearth furnace Before machining they are usually air cooled from just above the critical range to refine the grain, and then annealed at just below the critical range to relieve all internal strains (*See* IRON AND STEEL) (E E T)

VAN BEERS, JAN (1821–1888), Belgian poet, usually called "the elder" to distinguish him from his son, Jan van Beers, the painter, was born at Antwerp on Feb 22, 1821 Van Beers started life as a teacher of Dutch language and literature, first at Malines, then at Lierre, and in 1860 was appointed a professor of both at the Athenaeum (high school) in Antwerp where he had also been a sub-librarian in the communal library Van Beers's historical poems, the principal of which is, perhaps, *Jakob Van Maerlant* (Amsterdam, 1860), helped the Flemish revival in Belgium He is best known, however as the writer of ballads and songs. Among the best are *De Blinde* ("Blind"), *De Zieke Jongeling* ("Young and Doomed"), *Bij 't Kerkportaal* ("At the Church Porch") Van Beers's poetry, full of glow and pathos, simple yet forcible, is somewhat akin to that of Longfellow In 1884 his poems were collected in a volume; Van Beers died at Antwerp on Nov 14, 1888

VANBRUGH, SIR JOHN (1664–1726), British dramatist and architect, was born in the parish of St. Nicolas Acons in the City of London, and christened on Jan 24, 1664. His father was a sugar baker, and his grandfather, Gillis van Brugg, came to England from Ghent in James I.'s reign. The Vanbrughs left London during the Plague and went to Chester After a few years at the King's School, Chester, John at nineteen was sent to France to study the arts, after two years' absence he returned to take up a commission in the regiment soon to be known as the 13th Foot. In the early autumn of 1690 Vanbrugh was arrested at Calais on a charge of espionage, on the information of a lady. He was imprisoned at Vincennes, but on Feb 1, 1692, by a *lettre de cachet,* he was removed to the Bastille His enforced leisure was responsible for the first draft of the *Provok'd Wife.* For a time after his return he resumed his commission

The production of Cibber's *Love's Last Shift* at the Theatre Royal in January 1696 kindled afresh his attachment to the comic muse He thought it would be interesting to develop the situation upon which Cibber had rung down the curtain, and the result was *The Relapse,* "got, conceived and born in six weeks' space." It was given on Boxing Day 1696, with Cibber as Foppington, one of the three parts borrowed from the preceding comedy. The Sir Novelty Fashion of Cibber was developed in this play into Lord Foppington, who has been pronounced "the best fop ever brought upon the stage" Foppington, Tunbelly Clumsy and Miss Hoyden are as fine a trio of comic characters as any play can show *Aesop* at Drury Lane followed This ran for a week only, but the success of *The Relapse* was so triumphant that Montague, afterwards Lord Halifax, asked at once for the *Provok'd Wife* for the theatre in Lincoln's Inn Fields, and it was produced at that theatre in May 1697 Sir John Brute, the husband, is Vanbrugh's masterpiece, and as usual the servants' characters are well drawn The play was a complete triumph, and Brute was one of Garrick's great parts Vanbrugh was fiercely attacked by Jeremy Collier for immorality in 1698, and wrote nothing more for the stage until 1700, when an adaptation of the *Pilgrim* of Beaumont and Fletcher was produced at Drury Lane. In this play, in the part of Alinda, Anne Oldfield scored her first success. Two years later appeared *The False Friend,* a version of Le Sage's *Traitre puni* Other adaptations from the French were *A Country House,* from Dancourt's *Maison de campagne; Confederacy* (1705), from the same author's *Bourgeoises à la mode; Squire Trelooby* (1704), a version of Molière's *Monsieur de Pourceaugnac;* and *The Mistake* (1705), from Molière's *Dépit amoureux* As a dramatist Vanbrugh is less polished than Congreve, and less remorseless than Wycherley He was not primarily a man of letters, and, as Cibber said, his dialogue is "common conversation committed to paper" No one would trouble to defend his dramatic morality, but his worst efforts are less repulsive than Wycherley, because there is less ruthless realism and more fun in his attitude His plays are farce, very often, rather than strict comedy, and warmed with humour

Collier's attack and the resulting movement must have been responsible in part for "Van" turning his attention to architecture The demand for splendid country seats in the new Palladian style was steadily increasing, and his reputation as a modern wit was an introduction in itself In 1702 he was entered as comptroller of the Royal Works (now the Board of Works, where several of his designs may still be seen). In 1703 he wrote to ask his friend Jacob Tonson to procure him a "Palladio," and in the same year he was a commissioner at Greenwich. In the meantime, Vanbrugh had been appointed architect to the earl of Carlisle, and the result, completed in 1714, was the Corinthian mansion of Castle Howard. The work is an extension of the Palladian plan introduced by Inigo Jones, with the addition of immense corridors in segmental colonnades leading from the main entrance to the wing blocks From a scenic artist's point of view, it is a magnificent (and certainly his best) piece of work. The earl procured for Vanbrugh a high place in the College of Arms. In March 1704 he was actually promoted Clarenceux, though he not only knew nothing of heraldry but had openly ridiculed that grave science in *Aesop* His next work was to prepare designs for Kneller Hall near Hounslow. But the success of Castle Howard now caused him to entertain the rash project of building a theatre in the Haymarket, from his own design, for the acting of his own plays. Congreve joined in the venture. The magnitude of Vanbrugh's architectural ideas grew as the work went on, and with the ideas the structure grew till a theatre meant for the delicate *bijouterie* work of polite comedy seemed growing to the proportions of the Roman Colosseum When at length the time came to test the acoustics of the pile, it was found to be sadly defective What changes were made to rectify the errors of structure does not appear. The theatre was opened to the public with an Italian opera, which was followed by three of Molière's comedies, and these by the *Confederacy,* Vanbrugh's masterpiece.

Vanbrugh at last withdrew from the disastrous speculation; Congreve had already withdrawn. But a man to whom Fortune had been so kind as she had been to Vanbrugh could hardly be depressed by any of her passing frowns Queen Anne at once sent him abroad on an important state errand, and afterwards he was commissioned to build Blenheim Upon the merits and demerits of this famous "hollowed quarry" there has been much conflict of opinion. Blenheim Palace is probably the largest domestic building in England, and consists of three blocks, the centre containing the private living rooms, one wing the stables, and the other the kitchens and storehouses It is planned on a colossal scale Vanbrugh considered a building and the parts of a building as simply so much material for effect, without regard to their reasonable use and the necessary limitations of design Personal comfort was sacrificed to perspective Windows were to adorn the elevation, not to light the interior, and, as Voltaire said, if the rooms had only been as wide as the walls were thick, the château would have been convenient enough. After Blenheim and Castle Howard, his next largest palace was probably Fleurs, near Kelso. Blenheim, however, was a source of great sorrow to the kindly dramatist. Though parliament had voted for the building of it, no provision had been made for the supplies The queen while she lived paid them, and then Vanbrugh was left to the meanness of the duke of Marlborough, and afterwards to the insolence of the "wicked woman," who did her best to embitter his life. Besides Castle Howard and Blenheim, he built many other country mansions, such as Grimsthorpe and Duncombe Hall in Yorkshire, Eastbury in Dorsetshire.

In January 1719 Vanbrugh married Henrietta Maria, daughter of Colonel Yarborough of Heslington, and four years afterwards, at the accession of George I, he was knighted He afterwards wrote again for the stage, and the unfinished fragment of the *Journey to London* (completed by Cibber as *The Provok'd Husband* in 1728) shows that his powers remained to the last as fine as ever. His married life was mostly spent at Blackheath, very probably in "Bastile House" on Maze Hill, repaired in 1904 and now known as Vanbrugh Castle His wife died there at a great age in 1776, but "Van" himself died on March 26, 1726 in his modest town house in Whitehall The site is occupied to-day by the War Office The famous epitaph, "Lie heavy on him, earth," is attributed to Abel Evans

Vanbrugh's works were edited in 2 vols., 1893, by W. C. Ward (portraits) *Select Plays* were issued in the Mermaid Series (ed. A. E. H. Swaen) in 1896 *See* G H. Lovegrove's ***Life, Works and Influence of Sir John Vanbrugh*** (1902), Max Dametz's ***Vanbrughs Leben und Werke*** (1898), and ***Swift's Works*** (Bohn), xi. 80 sq ***The Complete Works of Sir John Vanbrugh*** (Plays and Letters) edited by B. Dobree and G. Webb (Nonesuch Press, 1928), with introduction by B. Dobree.

VAN BUREN, MARTIN (1782–1862), 8th president of the United States, was born at Kinderhook, N Y, on Dec. 5, 1782, of Dutch descent. His father was a farmer and tavern-keeper. His education was limited to that which could be obtained in the common schools and at Kinderhook academy. In 1796 he began the study of law, completing his preparation in 1802 at New York, where he studied under William Peter Van Ness (1778–1826), an eminent lawyer and later Aaron Burr's second in the duel with Alexander Hamilton. In 1803 he was admitted to the bar and continued in active and successful practice for 25 years His prac-

tice made him financially independent, and paved the way for his entrance into politics. New York politics after 1800, the year of the election of Jefferson and the downfall of the Federalists, were peculiarly bitter and personal. The Republicans were divided into three factions, followers respectively of George Clinton (and later of his nephew, De Witt Clinton), Robert R. Livingston and Aaron Burr; and such Federalist control as there was from time to time after 1799, depended upon coalition with one or other of these groups. Van Buren, who early allied himself with the Clintonians, served as surrogate of Columbia county from 1808 to 1813 In 1812 he entered the State senate, in which his career covered two terms (1812–20) In 1815 he became attorney general, an office which he held, still as a member of the senate, until 1819, when he was displaced to make room for a Federalist. He had already, in 1808, removed from Kinderhook to Hudson, and in 1816 he took up his residence in Albany, where he continued to reside until he entered Jackson's cabinet in 1829 As a member of the State senate he supported the War of 1812 He was chosen to draft the resolution of thanks voted by the legislature to Gen Andrew Jackson after the battle of New Orleans He broke with De Witt Clinton in 1813, but nevertheless favoured, in 1817, Clinton's plan for the Erie canal. His attitude towards slavery at the moment was shown by his vote, in Jan 1820, for a resolution opposing the admission of Missouri as a slave State It is at this point that Van Buren's connection began with so-called "machine politics," a connection which has made his name odious to some historians of the period He was a leading member of the "Albany regency," a group of politicians who for more than a generation controlled the politics of New York and powerfully influenced those of the nation, and who did more than any other agency to make the "spoils system" a recognized procedure in national, State and local affairs Van Buren did not originate the system, for it was already well developed when he entered public life; but the nickname of "Little Magician" which presently attached to him testifies to the skill with which he exploited it

In 1821 he was elected to the U S Senate in which his course was not altogether consistent, though in this respect he is not to be judged more harshly than some of his associates He at first favoured internal improvements, and in 1824 proposed a constitutional amendment to authorize such undertakings, but the next year took ground against them He voted for the tariff of 1824, then gradually abandoned the protectionist position He early recognized the availability of Andrew Jackson, however, as a presidential candidate, and after the election sought to bring the Crawford and Jackson followers together, at the same time strengthening his control as a party leader in the Senate Always notably courteous in his treatment of opponents, he showed no bitterness either towards J Q Adams or Henry Clay, and voted for Clay's confirmation as secretary of State notwithstanding the "corrupt bargain" charge, at the same time he opposed internal improvements and declined to support the proposal for a Panama Congress In the debate on the "tariff of abominations" in 1828 he took no part, but voted for the measure in obedience to instructions from the New York legislature—an action which was cited against him as late as the presidential campaign of 1844 Van Buren was not an orator, but his more important speeches show careful preparation and his opinions carried weight; and the oft-repeated charge that he refrained from declaring himself on crucial questions is hardly borne out by an examination of his senatorial career. In 1827 he was re-elected to the Senate and became one of the recognized managers of the Jackson campaign.

In 1828 Van Buren was elected governor of New York for the term beginning Jan 1, 1829, and resigned his seat in the Senate. But on March 5 he was appointed by President Jackson secretary of State and he resigned the governorship. As secretary of State he took care to keep on good terms with the "kitchen cabinet," the group of politicians who acted as Jackson's advisers, and won the lasting regard of Jackson by his courtesies to Mrs. John H. Eaton, wife of the secretary of War, with whom the wives of the cabinet officers had refused to associate. He did not oppose Jackson in the matter of removals from office, but was not himself an active "spoilsman," and protested strongly against the appointment of Samuel Swartwout (1783–1856), who was later a defaulter to a large amount as collector of the port of New York He skilfully avoided entanglement in the Jackson-Calhoun imbroglio. In the controversy with the Bank of the United States he sided with Jackson After the breach between Jackson and Calhoun, Van Buren was clearly the most prominent candidate for the vice presidency Jackson, in Dec 1829, had already made known his own wish that Van Buren should receive the nomination. In April 1831 Van Buren resigned and in August he was appointed minister to England, arriving in London in September He was cordially received, but in February learned that his nomination had been rejected by the Senate on Jan 25 The rejection was in fact the work of Calhoun, the vice president, when the vote was taken enough of the majority refrained from voting to produce a tie and give Calhoun his longed-for "vengeance" No greater impetus than this could have been given to Van Buren's candidacy for the vice presidency In May the Democratic convention, the first held by that party, nominated him for vice president on the Jackson ticket No platform was adopted, the widespread popularity of Jackson being relied upon to win success at the polls Van Buren's declarations during the campaign were vague regarding the tariff and unfavourable to the United States bank and to nullification, but he had already somewhat placated the South by denying the right of Congress to abolish slavery in the District of Columbia without the consent of the slave States In the election he received 189 electoral votes, while Jackson received 219 for president Jackson now determined to make Van Buren president in 1836 In May 1835 Van Buren was unanimously nominated by the Democratic convention at Baltimore. He expressed himself plainly during the canvass on the questions of slavery and the bank In the election Van Buren received 170 electoral votes against 73 for William Henry Harrison, his principal opponent; but the popular vote showed a plurality of less than 25,000 in a total vote of about 1,500,000 The election was in fact a victory for Jackson rather than for Van Buren

The details of Van Buren's administration belong to the history of the United States (*see* UNITED STATES) He took over all but one of Jackson's cabinet, and met with statesmanlike firmness the commercial crisis of 1837. No exhibition of ability or courage, however, nor yet the most skilful manipulation of the political machinery of the party could prevent continued hostility to him and to the methods for which he was widely believed to stand Nevertheless, he was unanimously renominated by the Democrats in 1840 Charged with being "a Northern man with Southern principles," his nomination obviously failed to arouse enthusiasm or even inspire confidence Yet the election of Harrison, the Whig candidate, was less of a revolution than many affected to think On the expiration of his term Van Buren retired to his estate at Kinderhook, but he did not withdraw from politics or cease to be a figure of national importance He confidently expected to be nominated for president in 1844 but in the Democratic convention, though he had a majority of the votes, he did not have the two-thirds which the rule of the convention required, and after eight ballots his name was withdrawn In 1848 he was again nominated, first by the "Barnburners" faction of the Democrats, then by the Free Soilers, with whom the "Barnburners" coalesced, but no electoral vote was won by the party In the election of 1860 he voted for the fusion ticket in New York which was opposed to Abraham Lincoln, but he could not approve of President Buchanan's course in dealing with secession, and later supported Lincoln He died in Kinderhook on July 24, 1862 His memoirs, to 1834, remain unpublished, but an *Inquiry into the Origin and Course of Political Parties in the United States* was compiled from it by his sons and published in 1867.

The best biography of Van Buren is by Edward M. Shepard, in the "American Statesmen Series" (rev ed, Boston, 1889) The life by George Bancroft (1889) is highly eulogistic. Von Holst's *United States*, MacDonald's *Jacksonian Democracy*, Garrison's *Westward Extension* and T. C. Smith's *Parties and Slavery* (the last three in the "American Nation Series") give much attention to Van Buren's public career The Van Buren mss are in the Library of Congress *See* also James Schouler, "The Calhoun, Jackson and Van Buren Papers," Mass Hist Soc. Proc, 2nd ser, vol xviii, p 459–465 (Boston, 1905); "Correspondence Between George Bancroft and Martin Van Buren,"

Mass Hist Soc Proc, 3rd ser., vol II, p. 381–442 (Boston, 1909); Elizabeth Howard West, *Calendar of the Papers of Martin Van Buren*, prepared from the original manuscripts in the Library of Congress (1910), Bernard C. Steiner, "Taney's Letters to Van Buren in 1860," *Maryland Hist Mag*, vol x, p. 15–24 (Baltimore, 1915), and "Autobiography of Martin Van Buren," Amer. Hist. Assoc. Ann. Rep., 1918, vol. 2, p. 7–808 (1920), Denis Tilden Lynch, *Martin Van Buren* (1929).

VAN BUREN, a city of western Arkansas, U.S A, 5 m N.E of Fort Smith, on Arkansas river and Federal highway 64, the county seat of Crawford county, served by the Frisco and the Missouri Pacific railways Pop. (1920) 5,224 (89% native white) Van Buren is on the edge of the coal and gas fields of western Arkansas, in a farming and fruit-growing region It ships great quantities of canteloupes, peaches, strawberries, early vegetables, cotton and other agricultural products. The city was founded in 1838 and incorporated in 1842

VANCOUVER, GEORGE (*c.* 1758–1798), English navigator, was born in 1758 He entered the navy at the age of 13, and accompanied James Cook in his second (1772–74) and third (1776–80) voyages of discovery. After serving for several years in the West Indies, both under Rodney (his commander in the action of April 12, 1782) and under Alan Gardner (1786–89), Vancouver, on Gardner's recommendation, was appointed to command an expedition to the north-west coast of America, to take over from the Spaniards the territory they had seized (and subsequently relinquished) in that region, to explore the coast from 30° N round to Cook's River (or Inlet), to search for an eastward passage to the great lakes, and to ascertain the true character of Juan de Fuca Strait. Vancouver, accompanied by Lieutenant Broughton, left Falmouth on April 1, 1791 and proceeded by way of the Cape of Good Hope to Australia, where he carefully surveyed part of the south-west coast, especially King George's Sound, whose value as a harbour he pointed out He next made for Dusky Bay, New Zealand (which he was the first properly to explore), and thence sailing north-east, discovered Oparo islet (27° 36′ S; 144° 12′ W), and on Dec 30 reached Tahiti, where he was again joined by Broughton, who meanwhile had discovered Chatham island After staying about three weeks at Tahiti and several weeks at the Hawaiian islands, Vancouver on April 18, 1792, sighted the west coast of North America (California, then known as New Albion) in 39° 27′ N He examined the coast up to 52° 18′ N with minute care, surveying all inlets, discovering the Gulf of Georgia, and circumnavigating Vancouver island.

After another visit (Feb–March 1793) to the Hawaiian islands, in whose races and affairs he took great interest, Vancouver resumed his exploration of the American coast in April, surveying north to 56° N, and south (past the Spanish Californian settlements) to 35° N During a fresh stay at the Hawaiian islands (Jan–March 1794) Vancouver accepted their submission to Great Britain, but his annexation seems never to have been officially ratified Quitting the group again in March 1794, Vancouver sailed, by Chernigov island and Kodiak island, to Cook's inlet, which was now proved to be no river After a fresh survey of much of the coast north of San Francisco, Vancouver set out homewards via Cape Horn and St Helena in Oct 1794. On the way he made a careful examination of Cape St Lucas, the southern point of Lower California, the Galapagos islands and some other points He reached the Thames on Oct 20, and immediately set about the preparation of his narrative; but he died at Petersham in Surrey on May 10, 1798, before he had completed his task. His brother John, assisted by Captain Puget, published the complete record in 1798

See *A Voyage of Discovery to the North Pacific Ocean and round the World . . in 1790–95 . . under Captain George Vancouver*, 3 vols (1798), with an atlas of maps and plates.

VANCOUVER, British Columbia, fourth city of Canada and its chief port, situated on the south side of Burrard inlet, had a population in the city proper of 117,217, including about 10,000 Orientals, in 1921 The growth of the city dates from the coming of the Canadian Pacific railway in 1885, and the increasing Oriental trade and the shipping of wheat to Europe by way of the Panama Canal have revolutionized the status of the port in recent years. In 1912 there were no shipments of grain or flour, but in 1926, 45,229,906 bu. of wheat were exported. In 1912, 9,382 vessels entered, and in 1926, 19,767, the largest tonnage of any Canadian port. The wheat storage capacity of the port is now very large, and the whole crop of Alberta can be handled. The export trade is particularly active when the Great Lake ports are closed by ice Timber, canned and salt fish, flour, and apples are other important articles of export There were 498 industrial establishments in 1926, including a number of foundries, fish canning and curing and oil works, shingle, saw, paper, and pulp mills, sugar refineries, breweries and shipbuilding yards

The harbour is one of the finest natural harbours in the world, and large improvements, including three new piers, have been made in recent years The port is a terminus of the Canadian Pacific and Canadian National railway systems, and of the British Columbia electric railway company's line The Pacific Great Eastern line, serving the country north of Howe Sound, is designed also to terminate at Vancouver. Fifty steamship lines run to Japan, China, Australasia, Honolulu, San Francisco, Alaska, etc Industrial development is also proceeding rapidly, especially on Granville Island, a large block of reclaimed land near the business district South Vancouver is a separate municipality, mainly industrial, with a population of 32,267 in 1921 North Vancouver on the north shore of Burrard inlet, nearly 2 m from the centre of the city, had a population of 7,652 in 1921, and is connected by bridge and railway with Vancouver proper. Point Grey, with a population of 13,736, is a growing residential suburb to the south and west of Vancouver, and contains the University of British Columbia, which has absorbed the British Columbia branch of McGill university The still newer municipality of West Vancouver adjoins North Vancouver

VANCOUVER, a city of south-western Washington, U S A, at the head of deep-water navigation on the Columbia river (here crossed by the Interstate highway bridge, 3,531 ft long), 8 m N of Portland; the county seat of Clark county It is on Federal highways 99 and 830, has a large airport, the Portland base of the Pacific coast airmail service; and is served by the Great Northern, the Northern Pacific, the Spokane, Portland and Seattle and the Union Pacific railways, electric trolley and motor-stage lines and ocean and river steamers The population was 12,637 in 1920 (86% native white) and was estimated locally at 17,500 in 1928 It is the trading centre for large lumber operations, and for one of the most diversified agricultural districts of the State, noted for its prunes, filberts, walnuts, small fruits, poultry and dairy products The traffic of the port is growing rapidly, and in 1927 included 87,733,033 ft. of logs rafted in to the city's mills and 72,770,000 ft of lumber shipped out The manufactures (valued at $5,973,728 in 1925) are chiefly lumber and lumber products, paper, dried and canned fruits, fruit juices and syrups, dairy products, furs, logging machinery and linen twines and fabrics The State schools for the deaf and the blind are within the city limits Adjoining it on the east is Vancouver Barracks, one of the principal U S army posts on the coast (established 1849) Its polo and flying fields adjoin the commercial aviation field Vancouver is the oldest city of Washington It was founded in 1825 by Dr. John McLoughlin, chief factor of the Hudson's Bay Company, who built a stockade (Ft. Vancouver) on a site now included in the military reservation, and it was one of the company's important trading posts until 1846, when it was taken over by the United States The village became the county seat in 1854 and was chartered as a city in 1889

VANCOUVER ISLAND, the largest of an archipelago of innumerable islands which fringes the Pacific coast of Canada, being at the same time the largest island on the west coast of North America. It forms part of British Columbia. Pop. (1921), 116,730. It extends from 48° 20′ to 51° N and from 123° to 128° 30′ W, and is thus 285 m. long and from 40 to 80 m. wide, with an area of about 20,000 sq m. It is bounded on the south by the Strait of Juan de Fuca, and is separated from the mainland of the province by the Strait of Georgia and Queen Charlotte sound A partially submerged range of mountains, which has been termed the Vancouver range, runs parallel to the coast of

British Columbia, a portion of this range forms Vancouver island, and it again rises above the level of the sea farther north, forming the Queen Charlotte islands. The coast-line is generally precipitous. The west coast is much broken by bays and inlets—the transverse valleys of the sunken range—which penetrate far inland Among these may be mentioned the Alberni canal, which is 20 m long with a fine harbour at its head, and the city of Port Alberni (pop in 1921, 1,056), served by the Esquimalt and Nanaimo railway. Nootka sound, 6 m wide, and sending three arms inland, as well as Clayoquot, Esperanza, Kyuquot and Quatsino sounds, also penetrate deeply into the island The general height of the mountain-range on Vancouver island is from 2,000 to 3,000 ft ; Victoria peak is 7,484 ft high.

There are extensive beds of coal, especially on the east coast, which are mined at Nanaimo, Connox, Ladysmith and other points, and there are large iron deposits Copper is also mined at Tyee, and smelted at Ladysmith The island is covered with dense forests, which yield immense supplies of magnificent timber, constituting with the coal-field and fisheries the chief resources of the island. There are some level tracts on the south-east coast, as well as in the narrow, well-watered valleys of the interior, which afford excellent agricultural land on which cereals of all kinds, as well as all the fruits of the temperate zone, flourish, and which are also suitable for raising sheep and cattle. The climate of Vancouver island, especially in the south, is wonderfully mild for the latitude

VANDALS, a term used by early writers only as a collective designation for a group of Teutonic tribes including, according to Pliny, the Burgundians and the Goths The Vandals as a separate people figure in the earliest legends both of the Goths and the Lombards, and first came into contact with the Romans during the Marcomannic War In the time of Aurelian they invaded Pannonia, and during the reign of Probus we find them fighting in Dacia In the time of Constantine I, according to Jordanes, they suffered a great defeat at the hands of Geberich, king of the Goths, their own king Visimar being killed, and the survivors were allowed by the Romans to settle in Pannonia

Invasions.—In A D 406 they moved westward, according to some writers at the instigation of Stilicho, who is himself said to have been of Vandal origin, and crossing the Rhine at Mainz proceeded towards Gaul

Owing to defeat at the hands of the Franks the Vandals could not settle in Gaul and in 409 their king Gunderic led them across the Pyrenees They appear to have settled in Spain in two detachments One, the Asdingian Vandals, occupied Galicia, the other, the Silingian, Andalusia The Silingian Vandals were well-nigh exterminated during the next 20 years but their Asdingian brethren marched across Spain and took possession of Andalusia In 428 or 429 the whole nation set sail for Africa, upon an invitation received by their king from Bonifacius, count of Africa, who had fallen into disgrace with the court of Ravenna Gunderic was now dead, and supreme power was in the hands of his bastard brother Gaiseric who was for 50 years the terror of Constantinople and Rome Probably in the month of May 428, he assembled all his people on the shore of Andalusia, and numbering the males among them from the greybeard down to the newborn infant found them to amount to 80,000 souls The nation was transported to Africa in ships supplied by Bonifacius Although he soon returned to the Imperial allegiance only three cities of Roman Africa—Carthage, Hippo and Cirta—remained untaken by the Vandals by May 430 At length (Jan. 30, 435) peace was made between the emperor Valentinian III and Gaiseric. The emperor was to retain Carthage and the small but rich proconsular province in which it was situated, while Hippo and the other six provinces of Africa were abandoned to the Vandal. Gaiseric observed this treaty no longer than suited his purpose On Oct. 19, 439, he suddenly attacked and took Carthage. The Vandal occupation of this great city, the third among the cities of the Roman empire, lasted for 94 years. Gaiseric seems to have counted the years of his sovereignty from the date of its capture. Henceforward he made of Carthage a pirate's stronghold, whence he issued forth, like the Barbary pirates of a later day, to attack, as he himself said, "the dwellings of the men with whom God is angry," leaving the question who those men might be to the decision of the elements Almost alone among the Teutonic invaders of the empire he set himself to form a powerful fleet, and was probably for 30 years the leading maritime power in the Mediterranean. Gaiseric's celebrated expedition against Rome (455), undertaken in response to the call of Eudocia widow of Valentinian, was only the greatest of his marauding exploits He took the city without difficulty, and for 14 days, in a calm and business-like manner, emptied it of all its movable wealth. Eudocia and her two daughters were carried into captivity.

Empire and Defeat.—There does not seem to be in the story of the capture of Rome by the Vandals any justification for the charge of wilful and objectless destruction of public buildings which is implied in the word "vandalism" It is probable that this charge grew out of the fierce persecution which was carried on by Gaiseric and his son against the Catholic Christians The bishops were almost universally banished, and the congregations were forbidden to elect their successors, so that the greater part of the churches of Africa remained "widowed" for a whole generation In 476, at the very close of Gaiseric's life, by a treaty concluded with the Eastern emperor, the bishops were permitted to return There was then a short lull in the persecution, but on the death of Gaiseric (477) and the accession of Hunneric it broke out again with greater violence than ever

On the death of Hunneric (484) he was succeeded by his cousin Gunthamund, Gaiseric having established seniority among his own descendants as the law of succession to his throne Gunthamund (484–96) and his brother Thrasamund (496–523), though Arians, abated some of the rigour of the persecution, and maintained the external credit of the monarchy On the death of Thrasamund, Hilderic (523–31), the son of Hunneric and Eudocia, at length succeeded to the throne He adhered to the creed of his mother rather than to that of his father; and, in spite of a solemn oath sworn to his predecessor that he would not restore the Catholic churches to their owners, he at once proceeded to do so and to recall the bishops Hilderic, elderly, Catholic and timid, was very unpopular with his subjects, and after a reign of eight years he was thrust into prison by his cousin Gelimer (531–534).

The wrongs of Hilderic, a Catholic, with the blood of the emperor Theodosius in his veins, afforded to Justinian a long-coveted pretext for overthrowing the Vandal dominion A great expedition under the command of Belisarius reached Africa in the beginning of Sept 533 A large force of Vandals was then occupied in Sardinia under Gelimer's brother Tzazo, and the landing of Belisarius was entirely unopposed He marched rapidly towards Carthage and on Sept 13, defeated Gelimer at Ad Decimum, 10 m from Carthage Next day he entered Carthage and ate the feast prepared in Gelimer's palace for its lord Belisarius, however, was too late to save the life of Hilderic, who had been slain by his rival's orders as soon as the news came of the landing of the imperial army On the return of Tzazo from Sardinia a force was collected considerably larger than the imperial army, but the Vandals were defeated and Gelimer took to flight He took refuge in a mountain fortress called Pappua on the Numidian frontier, and there, after enduring great hardships in the squalid dwellings of the Moors, surrendered to his pursuers in March 534. The well-known stories of his laughter when he was introduced to Belisarius, and his chant, "Vanitas vanitatum," when he walked before the triumphal car of his conqueror through the streets of Constantinople, probably point to an intellect disordered by his reverses and hardships The Vandals who were carried captive to Constantinople were enlisted in five squadrons of cavalry and sent to serve against the Parthians under the title "Justiniani Vandali." Four hundred escaped to Africa and took part in a mutiny of the imperial troops, which was with difficulty quelled by Belisarius (536). After this the Vandals disappeared from history The overthrow of their kingdom undoubtedly rendered easier the spread of Saracen conquest along the northern shore of Africa in the following century. (F G M B, T H)

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cc 2, 43, Ptolemy, ii. c. 11, §§ 18 ff.; Julius Capitolinus, *De Bello Marcomannico*, 17, Vopiscus, *Probus*, 18; Dexippus, *Excerpta*, pp 19 ff. (Bonn), and Jordanes, 4, 16, 22, Procopius, *De Bello Vandalico*, a first-rate authority for contemporary events, must be used with caution for the history of the two or three generations before his time The chroniclers Idatius, Prosper and Victor Tunnunensis supply some facts, and for the persecution of the Catholics Victor Vitensis and the *Vita Augustini* of Posidius may be consulted *See* also L. Schmidt, *Geschichte der Wandalen* (Leipzig, 1901).

VANDAMME, DOMINIQUE RENÉ, Count (1770–1830), French soldier, was born at Cassel, near Dunkirk, on Nov. 5, 1770. He enlisted in the army in 1786, served in Martinique in 1788 and on returning to France entered into the Revolutionary movement, raising a company of light infantry. He was rapidly promoted and after Hondschoote he was made general of brigade, serving in the Low Countries (1794), on the Rhine (1795) and in Germany (1796). In 1799 he was promoted general of division, and served in Holland, Germany and Switzerland. He was a devoted servant of Napoleon In 1805, for his leadership at Austerlitz, he was given the Grand Eagle of the Legion of Honour, and in 1806–07 he commanded a small corps of the *Grande Armée* which reduced the Silesian fortresses In 1808 he was made count of Unebourg In 1809 he served in the Eckmuhl campaign, but in 1812, while commanding the Westphalian contingent he quarrelled with King Jerome Bonaparte and returned to France. He returned to the army in 1813, but his corps, sent against the line of retreat of the Allies at the battle of Dresden, was surrendered at Kulm (*See* Napoleonic Campaigns) At the end of the war he was forbidden to enter Paris When Napoleon returned Vandamme joined him and was made a peer of France and placed at the head of the III corps in the Army of the North (*See* Waterloo Campaign) The Restoration first imprisoned and then exiled him. He died at Cassel on July 15, 1830.

See Du Casse, *Le Général Vandamme et sa correspondance*.

VANDERBILT, CORNELIUS (1794–1877), American capitalist, was born near Stapleton, Staten island (N Y), on May 27, 1794. At the age of 16 he bought a sailboat, in which he carried farm produce and passengers between Staten island and New York, in 1813 carrying supplies to fortifications in New York harbour and the adjacent waters, and in 1817–29 he was a captain on a steam ferry between New York and New Brunswick. He developed an extensive carrying trade along the coast in a fleet which became so large as to win for him the popular designation of "Commodore " In 1849 he got from the Nicaraguan Government a charter for a route across the isthmus In 1855–61 he operated a freight and passenger line between New York and Havre. In 1857–62 he sold his steamships and turned his attention to railways In 1857 he became a director, and in 1863 president, of the New York and Harlem Railway.

He then acquired a controlling interest in the Hudson River Railway, of which he became president in 1865; and in 1868 he became president of the New York Central (between Albany and Buffalo), which in 1869 he combined with the Hudson River Road, under the name of the New York Central and Hudson River Railroad. His acquisition of the Lake Shore and Michigan Southern Railway in 1873 established a through line between New York and Chicago At the time of his death (in New York city on Jan. 4, 1877) he controlled the New York Central and Hudson River, the Lake Shore and Michigan Southern, the Harlem, and the Canada Southern railways, and had holdings in many others. He endowed Vanderbilt university.

His eldest son, William Henry Vanderbilt (1821–1885), was born in New Brunswick (N J.), on May 8, 1821. He was a clerk in a New York banking house from 1839 to 1842. In 1860 he was appointed receiver of the Staten Island Railway, of which he was elected president in 1862, and which he brought into connection with New York by means of a line of ferry-boats. He became vice president of the Hudson River Railway in 1865, vice president of the New York Central and Hudson River Railroad in 1869, and president in June 1877, succeeding his father as president of the Lake Shore and Michigan Southern, the Canada Southern, and the Michigan Central railways. He died in New York City on Dec. 8, 1885.

William Henry's eldest son, Cornelius (1843–1899), became assistant treasurer of the Harlem Railway in 1865, and treasurer in 1867; in 1877, after the death of his grandfather, he was elected first vice president of the New York Central, and in 1878 became treasurer of the Michigan Central and vice president and treasurer of the Canada Southern. In 1883 he became chairman of the boards of directors of those two systems.

See W. A. Croffut, *The Vanderbilts and the Story of their Fortune* (Chicago, Ill, 1886), D. W Cross, "The Railroad Men of America," in *Magazine of Western History*, vol viii. (Cleveland, Ohio, 1888), and Burton J Hendrick, "The Vanderbilt Fortune," in *McClure's Magazine*, vol. xxxii. (1908-1909).

VANDERGRIFT, a borough of Westmoreland county, Pennsylvania, U S.A , on the Kiskimminetas river and the Pennsylvania railroad, 20 m N E of Pittsburgh. Pop (1920) 9,531 (85% native white). It is in a farming and coal-mining region, which also has gas wells; and the borough manufactures sheet iron, tin plate and other commodities.

VANDERLYN, JOHN (1776–1852), American artist, was born in Kingston (N.Y.), on Oct 15, 1776. He was employed by a print-seller in New York, and was first instructed in art by Archibald Robinson (1765–1835), a Scotsman who was afterwards one of the directors of the American Academy. He copied some of Gilbert Stuart's portraits, including one of Aaron Burr, who placed him under Gilbert Stuart as a pupil. In 1796 Vanderlyn went to Paris, and in 1805 to Rome, where he painted his picture of "Marius amid the Ruins of Carthage," which was shown in Paris, and obtained a gold medal there. This success caused him to remain in Paris for seven years, during which time he prospered greatly. In 1812 he showed a nude "Ariadne" (engraved by Durand, and now in the Pennsylvania Academy), which increased his fame When Aaron Burr fled to Paris, Vanderlyn was for a time his only support Vanderlyn returned to America in 1815, but did not meet with success, he worked very slowly, and neither his portraits nor various panorama which he exhibited brought him any considerable financial return In 1842, through friendly influences, he was commissioned by Congress to paint "The Landing of Columbus" for one of the panels in the rotunda of the Capitol at Washington Going to Paris, he employed to assist him a French artist, who, it is said, did most of the work He died at Kingston (N Y), on Sept. 23, 1852.

VAN DER STAPPEN, CHARLES (1843–1910), Belgian sculptor, was born in Brussels, September 1843 His first contribution to the Brussels Salon was "The Faun's Toilet" of 1869, and after this he soon became recognized as the leader, along with Paul de Vigne, of the new Belgian school of sculpture which, while remaining true to life, drew inspiration from Greek art and the Italian renaissance. Examples of Van der Stappen's decorative sculpture are seen in the decoration on the Palais des Postes, Brussels (1872), the pediment "Orchestration" for the Conservatoire de Musique, and the noble bronze group, "The Teaching of Art," on the façade of the Palace of Fine Arts, Brussels. He also executed the statues for the Alhambra Theatre and the caryatides for the house of the architect M de Curté (1874) His best-known monuments are those to "Alexandre Gendebien" (1874) and "Baron Coppens," at Sheel (1875).

See *Charles van der Stappen*, by Camille Lemonnier; *Les Artistes belges contemporains* (1896) by E L de Taeye; *The Renaissance of Sculpture in Belgium*, by O G. Destrée (London, 1895); *Charles van der Stappen*, by A. Goffin (1911).

VANDERVELDE, EMILE (1866–) Belgian statesman, was born on Jan. 25, 1866 at Ixelles near Brussels. He studied law at Brussels university and in 1885 took his doctorate in social science. In the following year he joined the Belgian Labour Party and soon became its acknowledged leader. He first entered parliament in 1894 as Socialist member for the Charleroi constituency, but after 1900 was returned continuously by Brussels. In the chamber he achieved both influence and prestige and played a prominent part in the struggle to attain universal suffrage, a struggle which resulted in more than one national general strike. On the outbreak of the World War, Vandervelde devoted himself to the problems of national defence, the liberation of his invaded country, and in Aug. 1914 was summoned to join the Government

as minister of state, later becoming member of the cabinet At the time of peace negotiations and the signing of the Versailles Treaty, he used his influence to obtain the insertion of labour clauses, relating especially to the eight-hour day. As minister of justice in the "Liberal-Catholic-Socialist" cabinet formed after the war, Vandervelde effected great humanitarian and scientific reforms in the prison system. After the important successes achieved by the Labour Party at the general elections of 1925 he entered the "Socialist-Catholic Coalition" cabinet as minister for foreign affairs and played an important part in negotiating the Locarno Pact in 1925, which he signed on behalf of Belgium. He retained the portfolio of foreign affairs in M. Jaspar's ministry of "National Unity." He had come to be regarded abroad as well as in Belgium as essential in Belgian foreign policy, partly because of his success at Locarno and the high esteem in which he was held by his foreign colleagues at Geneva. But he was constantly subjected to criticism because of his genuine internationalism, and early in 1927 he had some difficulty in soothing his non-Socialist critics In internal politics he fought for a reduction of the term of military service to six months and thorough reorganization of the army system. This attitude of the Socialist members of the Jaspar cabinet was the immediate cause of its fall, it was reorganized by Jaspar without the participation of Vandervelde and the Socialists.

Considered by some to be the most powerful Socialist orator in the French language since the death of Jaurès, Vandervelde has played a very conspicuous rôle in all the international Socialist congresses since the beginning of the present century In 1924 Vandervelde was made professor of political economy at the University of Brussels

BIBLIOGRAPHY—Among his works are *Le socialisme en Belgique,* with J. Destrée (1898), *Le collectivisme et l'évolution industrielle* (1900, trans by R P. Farley 1907), *Essais sur la question agraire en Belgique* (1902), *La Belgique et le Congo* (1911), *La grève générale en Belgique, avril 1913* (1914), *Le socialisme contre l'état* (1918), *Réalisations socialistes* (1923), *Le parti ouvrier belge, 1885–1925* (1925)

VAN DER VLUGT, W. (1853–), Dutch professor of jurisprudence, was born on March 12, 1853, and educated at Haarlem and at Leyden university He was appointed professor of the philosophy and the encyclopaedia of jurisprudence at Leyden university and was named emeritus professor on his retirement in 1923 He sat for four years (1902–06) in the second chamber of the States General

His numerous publications include *Transvaal versus Great Britain* (1889); *La Question des Iles d'Aland* (1921), and a number of lectures, addresses and articles for various periodicals In 1925 was published part of an introductory volume to his lectures on the encyclopaedia of jurisprudence

VANDEVELDE or **VAN DE VELDE,** name of a family of Dutch artists active during the 17th century The most notable members were.—

ADRIAN VAN DE VELDE (1636–1672), landscape and animal painter, born at Amsterdam in Nov 1636 He was a son of Willem Van de Velde I (*q v.*) He was trained in the studio of Jan Wynants, where he made the acquaintance of Philip Wouwerman, who seems to have helped him with his studies of animals He was employed by his master to introduce figures into his landscapes, and he rendered a similar service to Hobbema, Ruysdael, Verboom and others; for he knew well how to subordinate the figures and make them take their place in landscape compositions His favourite subjects are scenes of open pasture land with sheep, cattle and goats, admirably drawn and with clear, silvery colouring He also painted a few excellent winter scenes with skaters, and executed a Passion series for the Spinhuiskerk at Amsterdam (now in the parsonage of the Augustinian church "De Ster"). In addition to his paintings, of which de Groot catalogues 387, he made about 30 etchings; they are distinguished by a pleasing tonality, and by delicacy and certainty of touch. He died at Amsterdam on Jan 21, 1672.

JAN VAN DE VELDE II. (1593–after 1641), an engraver who excelled in portraiture, genre and biblical scenes, and views of towns and landscapes There are 429 engravings by him extant. He was a brother of Willem Van de Velde I. (*q.v.*)

WILLEM VAN DE VELDE I. (1611–1693), a celebrated draughtsman of ships, born at Leyden He was employed by the Dutch Government to depict sea-fights, and for that purpose accompanied the Dutch fleet during the war with England He went to England in 1672 with his son, WILLEM VAN DE VELDE II (1633–1707), a native of Amsterdam, and pupil of his father and of the marine-painter, Simon de Vlieger Both artists were employed by Charles II, and afterwards by James I, at a salary of £100 each "for taking and making draughts of sea-fights," the son's part being to reproduce in colour the drawings of the father Willem the elder died at Greenwich in 1693 His epitaph in St. James's church records that he was "a painter of sea-fights to their Majesties" Willem the younger was made court painter in 1677 His first works represent views off the coast of Holland, with Dutch shipping He died in London on April 6, 1707.

VAN DE VELDE, HENRI (1863–), Belgian architect, was born at Antwerp in 1863 After studying in Brussels he went in 1892 to Paris where he interested himself in contemporary artistic movement At the beginning of the 20th century he spent some considerable time in Germany, where he founded the present Dessauer Bauhaus at Weimar He built in that country the Fakwang museum, Hagen (1901); the Haus Esche, Chemnitz (1903), the interior decoration and furniture of which he also designed; the Kunstgewerbliches Institut, Weimar (1906), the Ernst Abbe monument, Jena (1910), and the Werkbund theatre, Cologne (1914) During this period he interested himself very deeply in decorative art, and is now director of the Institute of Decorative Arts in Brussels, and professor at the University of Ghent. Although Van de Velde has been markedly receptive and encouraging to new ideas and tendencies, his own work is not only loosed from tradition but singularly personal and unaffected by contemporary doctrine His publications include *Die Renaissance im modernen Kunstgewerbe* (1901) and *Der Neue Stil im Frankreich* (1925)

See G A Platz, *Baukunst der neuesten Zeit* (1927).

VAN DYCK, SIR ANTHONY (1599–1641), Flemish painter, was born in Antwerp on March 22, 1599 Though the name of Van Dyck is frequently met with in the list of Antwerp painters, Anthony's pedigree cannot be traced beyond his grandparents, who were silk mercers of some standing He was the seventh of twelve children of Frans Van Dyck, an Antwerp merchant His mother, Maria Cupers, who died when he was eight years of age, attained a certain degree of excellence in art needlework The boy was little over ten when he was apprenticed to Hendrick Van Balen, the painter of many delicate little pictures and the master of Snyders From a document in the state paper office at Brussels, relating to a lawsuit between a picture dealer and an Antwerp churchman, which arose out of the sale, in 1660, of a series of Apostles' heads ascribed to Van Dyck, it appears that, as far back as 1615, Van Dyck had worked independently, with pupils of his own, and that his pictures were greatly valued by artists and amateurs Professor Woermann has identified several of the Apostles' heads here spoken of with some paintings in the gallery at Dresden Others probably belonging to a second series executed by pupils and retouched by the master are in the possession of Earl Spencer at Althorp

Early Works.—Before he was nineteen (February 1618) Van Dyck became a full member of the Antwerp gild of painters, and some idea of his ability at the time may be gained from the excellent portraits of an old lady and gentleman, formerly ascribed to Rubens, in the Dresden gallery But the same admiration cannot be accorded to the earliest religious composition known to have been painted by him—"Christ falling under the Cross," in St Paul's at Antwerp At first sight it seems also that with him, as with most other Flemish painters of the period, every conception, whether sacred or profane, needed to be cast in the mould of Rubens It would be too much, however, to assert that Van Dyck at this time stood under the guidance of that master; their association, indeed, does not seem to have begun until 1619, and Bellori (1672), who got his information from Sir Kenelm Digby, Van Dyck's bosom friend, tells us that he was first employed in making drawings (probably also chiaroscuros) for the use of the great master's engravers, and that

among works of the kind one of the first was the "Battle of the Amazons" (1619).

In 1620 Van Dyck was working with Rubens, for on March 20, in making arrangements with the Antwerp Jesuits for the decoration of their church, the master is allowed to avail himself of his pupil's assistance, and obtains for him the promise of a picture Van Dyck left for England in the autumn of 1620. There is evidence in the order books of the exchequer of Van Dyck's presence in London till the end of February 1621. What Van Dyck did in London is not known That he was at the time a portrait painter of the rarest merit may easily be seen from the portrait of "Van der Geest" in the National Gallery (London), and from his own likenesses of himself when still quite young and beardless, in the National Gallery, in the Pinakothek at Munich and, as Paris, in the Wallace Collection

Residence in Italy.—Van Dyck's next journey was to Italy He left Antwerp on Oct. 3, 1621, and arrived at Genoa on Nov 21. Though Van Dyck unquestionably first became acquainted with the masterpieces of the great Venetian colourists in Rubens's *atelier*, most of the pictures which were formerly ascribed to his earliest period probably date from the years of his Italian journey In fact, studies for some of them can be found in the Chatsworth sketch-book Among these early works are the "Martyrdom of St Peter" (Brussels), the "Crowning with Thorns" (Berlin), and the "Betrayal of Christ" (Madrid, a replica formerly Lord Methuen's is now in America) A sketch of the same subject is at Doughty House, Richmond), "St Martin dividing his Cloak" (Windsor Castle),—a magnificent production On a reduced scale, and with the omission of two or three figures, the "St Martin" at Saventhem church is a reproduction of the picture at Windsor Castle

With the exception of a short visit to Antwerp at the time of his father's death in 1622, Van Dyck spent the next five years in Italy There can be no doubt as to the great influence exerted by the works of Titian, Paul Veronese and other masters of the Venetian school in the development of his genius, still the individuality of the painter remains a striking feature of what may be termed his Italian works, especially portraits Their peculiar character seems to originate even more in the stateliness of his sitters than in any desire to follow individual predilection or prevailing fashion It is difficult to trace with certainty the course of the artist's travels in Italy He made a prolonged stay at Venice; at Rome, he resided with Cardinal Guido Bentivoglio, who had been papal nuncio in Flanders from 1607 to 1617 For this patron were painted several important works, the most renowned being the prelate's own portrait, now in the Pitti Palace at Florence Another work was a "Crucifixion" spoken of by Bellori—but which cannot be identified with certainty among the many replicas of the subject existing at Antwerp Genoa, Vienna and Munich He also painted religious subjects and portraits, such as the portrait of Duquesnoy, better known as Fiammingo, the famous sculptor, and those of Sir Robert Shirley and his wife, in Persian attire In the company of Lady Arundel he travelled to Turin, but he was eager to reach Genoa here he probably painted the portraits of Luke and Cornelis de Wael, now in the Pinacoteca Capitolina at Rome (a monochrome replica at Cassel) Genoa can still boast of a good number of his most attractive productions, portraits of the beautiful ladies and haughty cavaliers of the noble houses of Doria, Brignole Sale, Pallavicini, Balbi, Cattaneo, Spinola, Lommelini and Grimaldi It would scarcely be possible to speak too highly of such works as the portrait of the lady in white satin and the Durazzo children at the Durazzo Palace, the Balbi children from Panshanger now lent to the National Gallery, the Marchesa Balbi, formerly at Dorchester House, the equally beautiful portraits of the Lommelini and of the knight in black armour, buff jacket and boots in the Scottish National Gallery at Edinburgh, or the Marchesa Brignole Sale (Warwick Castle). Van Dyck's Genoese portraits are remarkable for their richness of tonality and what might be called royal splendour, perhaps never before attained in works of the kind. This we may suppose to have had its origin, not only in his recent study of Titian but also in decorative necessities—the size of the palatial galleries and the rich hues of the Genoese velvets, on which these portraits were to find their place, obliging the painter to find a most uncommon strength of contrast In Italy, moreover, he found those gorgeous backgrounds—flowing draperies, beautiful gardens, ornamental pillars, marble terraces and balustrades—which elsewhere must be regarded as fictions merely. Here, finally, he was called upon to paint some of his grandest equestrian portraits, and the often-recurring grey steed with flowing mane (an admirable study of which belongs to Lord Brownlow) was first employed for the portrait of Antonio Giulio Brignole (still at Genoa) As with Rubens, Titian seems to have been paramount in Van Dyck's regard We know he possessed copies of the master's best works, and several little sketches in the British Museum and in the Chatsworth sketch-book bear proof of his devout study of the great Venetian Some of Van Dyck's earlier paintings, religious and mythological—the "Tribute Money" (Palazzo Bianco), "Holy Family" (Turin), "Virgin and Saints" (Louvre), "Virgin" (Grosvenor House), are certainly Titianesque in the extreme

In 1624 Van Dyck sailed from Genoa to Palermo and there painted several persons of rank, including the viceroy, Emmanuel Philibert of Savoy While in Sicily he became acquainted with the painter Sofonisba Anguisciola (or Angussola), who was then ninety-six years of age and blind, and he was wont to say that he had received more valuable information from a blind woman than from many a seeing man There is a "Virgin and Child" by Van Dyck at S Caterina in Palermo, and a "Virgin and Child with Saints" in the same city Bellori tells us that plague compelled him to leave abruptly, taking with him an unfinished picture of St Rosalia completed in Genoa The composition was repeated in Antwerp for the Bachelor's Brotherhood, a picture now in Vienna Van Dyck most probably remained in Genoa till 1626, and here in all likelihood he painted the De Jodes, father and son the celebrated engravers, who are represented together in a masterly portrait in the Capitol at Rome

Traversing the Mont Cenis pass, Van Dyck stopped at Aix with Peiresc, the famous scholar and friend of Rubens, and probably proceeded straight to Antwerp His beautiful portrait of Langlois, the Paris print-seller, from which it was conjectured that he spent some time at Paris, was unquestionably painted in Genoa By March 3, 1628 he was back at Antwerp One of his sisters had died in a convent the year before, and he now made a will in favour of Susan and Isabella, two other sisters, also nuns That Van Dyck was in Antwerp on May 18, is proved by a letter from Lord Carlisle to Buckingham (Sainsbury, ciii).

The Antwerp Period.—Great as may have been the strength of Italian reminiscence, from the moment Van Dyck again trod Flemish soil the influence of Rubens became predominant Among the earliest works after his return to Antwerp is the "Crucifixion," given to the Dominican nuns, in accordance with the wish expressed by the painter's dying father, and now in the Antwerp museum. The figures are life-size, and at the foot of the cross, besides a weeping angel, are St. Catherine of Siena and St Dominic Neither in type nor in general effect does it suggest the master's immediately preceding works. As a new feature we observe a kind of elegance, not entirely free from mannerism, which is often conspicuous with Van Dyck even when the technical excellence commands our warmest admiration Inspiration was far more limited with Van Dyck than with Rubens His delicate nature led him to restrain his conceptions within the bounds of an academic evenness To Van Dyck's second—more justly speaking third—manner belong some of his best religious works. The "Crucifixion" in the cathedral at Mechlin is termed by Sir Joshua Reynolds one of the finest pictures in the world. Still finer are the two works painted for the Antwerp Jesuits and now at Vienna—"The Mystic Marriage of the Blessed Herman Joseph" and "St Rosalia Crowned by the Infant Saviour." To this period likewise belong the celebrated "Elevation of the Cross" at Courtrai and the "St. Augustine in Ecstacy," in the church of the Jesuits at Antwerp; the general effect of this last, according to Reynolds, is inferior to that of the beautiful engraving by De Jode, and also to the earl of Northbrook's mag-

nificent sketch. Van Dyck's Flemish portraits indicate, technically speaking, a further step towards perfection The darkness of the Genoese portraits has vanished; broad daylight now freely illuminates the model, and such works as the portraits of Francisco de Moncada (Louvre) and of the Count de Bergh (Prado) are perhaps as close to material excellence as any painting could be. The full-length likenesses of Philip Le Roy (1630) and his wife (1631) (Wallace Collection) and of Mary Louisa of Tassis (Prince Liechtenstein, Vienna) deserve to rank among the most beautiful portraits ever painted The "Snyders" at Castle Howard is regarded by Waagen as not inferior to the most celebrated Raphaels, Titians or Holbeins, and of almost equal excellence are the "Wife of Colin de Nole" in the Munich gallery, the "Lady and her Daughter" at the Louvre, and the "Lady in Black" at Cassel.

Rapidly rising to honour and wealth, Van Dyck shared with Rubens the official title of court painter, and he painted numerous portraits of the infanta in her monastic garb (Paris, Vienna, Turin, Parma etc) When Marie de Medici fled from France to Brussels (1631), she several times commissioned Van Dyck to paint her likeness, as well as those of Gaston of Orleans and his wife Margaret of Lorraine, and several of the personages of their court From Gerbier's letters we learn that Van Dyck at this time was contemplating a journey to England, and desired commissions from the infanta and the queen of France to take over their portraits as presents for the king and royal family He soon travelled to The Hague to paint the prince and princess of Orange and their son Early in 1632 Constantine Huygens, who was then living at The Hague, inscribes in his diary, "pingor a Van Dyckio " When, in March, Van Dyck sailed for England, he took these portraits with him

Settles in London.—Gerbier's letters show that the king had personally desired his presence in London As early as March 1629 Endymion Porter had been commissioned to order a picture from Van Dyck, "Rinaldo and Armida " The canvas, now belonging to the duke of Newcastle, is one of the master's finest creations Besides the title of painter in ordinary, and an annual pension of £200, he received a knighthood (July 5 1632) He rapidly achieved popularity, and, as Walpole says, his works are so frequent in England that to most Englishmen it is difficult to avoid thinking of him as their countryman

Few artists, whether in England or elsewhere, have more richly endowed their models with distinction of feature and elegance in bearing Charles I and Henrietta Maria, although pictured by several other painters, are known to posterity almost exclusively through Van Dyck, because of a particular power of expression and bearing which once seen, it is impossible to forget The artist was given a summer residence at Eltham Palace, and was frequently visited by the king at his studio at Blackfriars Portraits now followed each other with great rapidity His mode of living and his love of pleasure sufficiently explain his great need of money. During his first year in England he painted the king and queen a dozen times The first of these noble portraits is the admirable full-length of Charles I, with the queen and their two eldest children, at Windsor Castle The style he adopted in England is generally termed his third manner; we might better say his fourth, as he already had a very particular style before he set out on his Italian journey. De Piles gives us some account of Van Dyck's methods at this period of his career He began with a small sketch on grey paper with black and white chalks, or a monochrome in oils. This study was passed on to assistants in order to be copied on the required scale When the clothes were sufficiently advanced by the pupils from those sent by the model, as well as the background and accessories, the master was enabled in a few sittings of an hour each to complete the work Van Dyck excelled in painting the hands; he is said to have kept special models for this part of his work. It need hardly be said that a system of this kind, although employed by Rubens for his larger creations, was exceedingly ill adapted to portrait painting In Van Dyck's later productions we too often detect marks of haste, as if the brush were becoming a mere implement of trade

Visit to the Netherlands.—Nearly the whole of 1634 and 1635 were spent by Van Dyck in the Netherlands, whence his brother, an Antwerp priest, had been called over by the queen to act as her chaplain. The archduchess died Dec. 1, 1633, and Van Dyck wished to get his official title renewed by her successor, Ferdinand of Austria, brother of Philip IV On the arrival of the new governor Van Dyck was immediately called upon to paint his likeness (Madrid gallery). Another portrait of Ferdinand on horseback belongs to Mr Mainwaring, Oteley Park, Shropshire The most important of Van Dyck's works, at any rate as a portrait painter, belong to this period The picture representing in life-size the members of the Brussels corporation, which was destroyed by fire during the siege of 1695, is spoken of with intense admiration by several writers Bullart, for instance, is very enthusiastic about its fine colour and life-like qualities Among the religious paintings of undisputed excellence belonging to the same period are the "Adoration of the Shepherds" in the church at Termonde, and the "Deposition," where the body of Christ rests upon the lap of the Virgin, in the Antwerp museum Among the portraits are the admirable full-length of Scaglia, the king's frequent agent in the Netherlands (formerly at Dorchester House), the equestrian portrait of Albert of Arenberg (Holkham Hall), and a portrait of the same nobleman on foot, in the black velvet Spanish dress with golden chamberlain's key (Althorp), an admirable half-length of a lady in black (Vienna gallery), and above all the grandiose picture in which John of Nassau is represented at full-length, with his wife and children.

Returns to London.—After being chosen honorary president of the Antwerp gild of St Luke, Van Dyck returned to London before the end of 1635 In spite of the vast number of his later portraits, some of them deserve to be ranked among the most celebrated of his productions The group of three English royal children in the gallery at Turin (1635), the portraits of Charles I in the Louvre and in the National Gallery, London the picture of the Pembroke family at Wilton House, Sir George and Sir Francis Villiers at Windsor and in the National Gallery and the earls of Bristol and Bedford, at Althorp, all belong to the years following the master's return from the Netherlands

He married, about the end of 1639, Lady Mary Ruthven, daughter of Sir Patrick Ruthven and granddaughter of the earl of Gowrie There are several portraits of her by her husband, the most important being in the Munich gallery, in which she is represented in white satin, playing on the violoncello There is a capital engraving of her by Bolswert In another picture (J C Harford, London) a handsome lady said to be Mary Ruthven, is represented as "Herminia Putting on Clarinda's Armour" There can be no doubt as to the model having been Margaret Lemon, a celebrated beauty, whose portrait was engraved by W Hollar and J Morin and painted by Van Dyck at Hampton Court She was the most beautiful and celebrated, though far from being the only mistress of Van Dyck

When the news of Rubens's death reached London (June 1640) Van Dyck contemplated a return to his native country, and a letter from Ferdinand of Austria to Philip IV speaks of his intended journey to Antwerp on St Luke's Day (Oct 18) Rubens had left unfinished a series of paintings commanded by the king of Spain, and Van Dyck had been thought of to give them the finishing touch But he refused It was then agreed that he should paint an independent canvas destined to complete the series Whether Van Dyck found it possible to work during his short stay in the Netherlands is doubtful It has been suggested that Van Dyck's principal object in travelling to the continent was to be entrusted with the decoration of one of the galleries of the Louvre Unfortunately the great painter was thwarted in his aspirations His health was beginning to fail

The portraits of William II of Orange and the Princess Mary, now in the museum at Amsterdam, are the last Van Dyck painted in England. Of works dated 1639 the portrait of the Countess of Portland (Darmstadt) is a fine example, and to the same year belongs a full-length portrait of Arthur Goodwin at Chatsworth. Van Dyck sailed in September, and probably spent some time with his Antwerp friends Early in November he reached Paris but on Nov 16 he was compelled to resign his commissions

on account of the state of his health. Scarcely three weeks later (Dec. 9, 1641) he died at his residence at Blackfriars Van Dyck was buried in old St. Paul's, where a Latin inscription was placed on his tomb by Charles I

An elegy in Cowley's *Miscellanies* speaks, not only of the painter's talent, but of his amiable disposition We may perhaps point to the coincidence that a Mrs. Cowley is in Van Dyck's will (of Dec '1) named guardian of his child, Justiniana Anna, born only eight days before her father's death The painter had in the Netherlands an illegitimate daughter, Maria Theresia, who was entrusted to his sister, and to whom he bequeathed £4,000. Lady Van Dyck became the second wife of Sir Richard Pryse of Gogerddan in Cardiganshire. She was dead in 1645. Justiniana Van Dyck, who was married when scarcely twelve years old to Sir John Stepney of Prendergast, painted a "Crucifixion," with four angels receiving Christ's blood in chalices After the Restoration a pension of £200 for life was granted to Justiniana Van Dyck, who died before 1690

Properly speaking, Van Dyck cannot be said to have formed a school He was followed to London by some of his earlier collaborators, and there soon met a considerable number of others. Jan van Reyn, David Beek, Adrian Hanneman, Mathew Merian, John Bockhorst (Lang Jan), Remy van Leemput and Peter Thys were foremost among foreigners, Henry Stone and William Dobson among Englishmen To their assistance the master owed much; but they are also responsible for the vast number of constantly recurring copies which go by his name. It often requires a very discriminating eye to distinguish some of these copies from the original paintings. No school more strikingly reflects the influence of Van Dyck than the British school. Stone, Dobson, George Jameson, Robert Walker and Samuel Cooper were the most fortunate of his continuators, and such masters as Reynolds, Gainsborough, Lawrence and Raeburn owe much to their study of his works

Though Van Dyck's reputation greatly suffered through the numerous copies he allowed his pupils to take from his works, the case is otherwise with engraving. Vorsterman, Pontius, Peter de Jode, P Balliu and S Bolswert were seldom more fortunate than when under his guidance. De Jode's "St. Augustine," Bolswert's "Ecce Homo" and "Crucifixion," Vorsterman's "Deposition," and especially Pontius's "Herman Joseph" rank among the masterpieces of the art of engraving Van Dyck was himself an incomparable etcher. The art of portrait etching, scarcely in existence before his time, reached the highest point of excellence in his work. He etched some 18 plates for a collection of portraits generally called "the Iconography" Such prints as the portraits of Vorsterman, John de Wael, Snyders, Josse de Momper, Adam van Noort, and above all his own effigy, display a manner fresh and personal admirably suited to the medium Print collectors pay extravagant prices for a first proof taken from the plates engraved by Van Dyck himself Van Dyck also employed some of the best engravers of his time for this collection of illustrious heads Whether the whole series had been published before 1645 when it was issued by Hendrick is uncertain Martin van der Enden, whose name appears on some of the plates was probably only a printer, who issued the plates separately as the work proceeded Hendrick's edition contains 99 plates. He used as a frontispiece the portrait of Van Dyck, with the following inscription. *Icones principum, virorum doctorum, &c &c, numero centum ab Antonio Van Dyck pictore ad vivum expressae eiusq sumptibus aeri incisae*, 1645. Seventeen editions were published, the last in 1759, with 124 plates Many of the plates are the property of the French Government, and belong to the Chalcographie Nationale in Paris A relic of great importance is a sketch-book obviously used by the painter in Italy containing but few original compositions and chiefly studies of the Italian masters. This book, once in the possession of Sir Peter Lely, is now at Chatsworth.

LITERATURE—*See* W H Carpenter, *Pictorial Notices, consisting of a Memoir of Sir Anthony Van Dyck, with a descriptive catalogue of the etchings executed by him* (1844); John Smith, *A Catalogue Raisonné of the Works of the most Eminent Dutch, Flemish, and French Painters*, part iii. (1831); J. Guiffrey, *Antoine Van Dyck, sa vie et son oeuvre* (1882); A. Michiels, *Ant. Van Dyck et ses élèves* (1881); I. v. Szwykowski, *A. Van Dycks Bildnisse bekannter Personen* (Leipzig, 1858); Fr. Wibiral, *L'Iconographie d'A. Van Dyck d'après les recherches de H Weber* (Leipzig, 1877); Lionel Cust, *Anthony Van Dyck* (1900), an abridgment with emendations, *Van Dyck* (1906), and *A Description of the Sketch-Book by Sir Anthony Van Dyck . . . at Chatsworth* (1902); *A. v. Dyck, a Further Study* (1911); Max Rooses, *Chefs-d'oeuvres d'Antoine van Dyck* (Antwerp, 1901), *Antoine Van Dyck* (Paris, 1902), Frank Newbolt, *Etchings of Van Dyck* (1906); E. Schaeffer, *Van Dyck* (Stuttgart and Leipzig, 1909, one of the series of Klassiker der Kunst). (H Hy ; X.)

VAN DYKE, HENRY (1852–), American writer, was born in Germantown (Pa.), Nov 10, 1852 He studied at the Brooklyn Polytechnic Institute, Princeton university (M A., 1876), the Princeton Theological School, and the university of Berlin In 1879 he entered the Presbyterian ministry, becoming pastor at Newport, Rhode Island; in 1883 he became pastor of the Brick Presbyterian Church, New York City. In this capacity his preaching gave him a national reputation

In 1900 he became professor of English literature at Princeton. During 1902–3 he served as moderator of the Presbyterian Church in the United States. In 1908–9 he was American lecturer at the Sorbonne In 1913 President Wilson appointed him minister to Holland and Luxembourg, but he resigned in 1917

Among his best works are his "outdoor essays," especially *Little Rivers* (1895) and *Fisherman's Luck* (1899). His short stories, notably *The Other Wise Man* (1896) and the collections *The Ruling Passion* (1901) and *The Blue Flower* (1902), were extremely popular. His other publications include *The Reality of Religion* (1884), *Days Off* (1907); *Out-of-Doors in the Holy Land* (1908), *Collected Poems* (1911); *Fighting for Peace* (1917), *The Valley of Vision* (1919); *Companionable Books* (1922), and (with Tertius Van Dyke) *Light My Candle* (1926).

VANE, SIR HENRY (1589–1654), English secretary of state, born at Hadlow, Kent, on Feb 18, 1589, was educated at Brasenose College, Oxford, entered Gray's Inn in 1606, and was knighted in 1611. He purchased various court offices, and sat in parliament for various constituencies from 1614 onwards Vane was sent on many foreign missions, and in 1630 became one of the king's chief advisers He was made a commissioner of the Admiralty in 1632 and for the colonies in 1636 He was one of the eight privy councillors appointed to manage affairs in Scotland on the outbreak of the troubles there, and on Feb 3, 1640, through the influence of the queen and of the marquis of Hamilton and in opposition to the wishes of Strafford, he was made secretary of state in the room of Sir John Coke.

In the Short Parliament, which assembled in April, it fell to Vane to demand supplies He proposed that the king should give up ship-money and receive in return twelve subsidies Parliament proved intractable and was dissolved on May 5 to prevent a vote against the continuance of the war with the Scots In the impeachment of Strafford, Vane asserted that Strafford had advised the king at a meeting of the privy council to employ the Irish army against England He was on bad terms with Strafford, who had opposed his appointment to office Vane was accused of collusion and treachery, and there is no doubt that he desired Strafford's removal, believing that his sacrifice would satisfy the demands of the parliament. Nevertheless, the charge that he deliberately compassed his destruction is not proved Suspicions of his fidelity, however, increased, and after accompanying the king to Scotland in August 1641, he was dismissed from all his appointments on Nov. 4, on Charles's return.

Vane immediately joined the parliament, he was placed on the committee for Irish affairs on Dec. 13, was made lord lieutenant of Durham on Feb 10, 1642, became a member of the committee of both kingdoms on Feb 7, 1644, and in this capacity attended the Scots army in 1645, while the parliament in the treaty of Uxbridge demanded for him from Charles a barony and the repayment of his losses. He adhered to the parliament after the king's death, and in the first parliament of the Protectorate he was returned for Kent, but the House had refused to appoint him a member of the council of state in February 1650 He died in 1654

VANE, SIR HENRY (1613–1662), English statesman and author, known as "the younger" to distinguish him from his father,

Sir Henry Vane (*q.v.*), was baptized on May 26, 1613, at Debden, Essex. After an education at Westminster, and at Magdalen Hall, Oxford, he was attached successively to the embassies at Vienna, Leiden and Geneva. He had already acquired strong Puritan views, and, in 1635, in order to obtain the free exercise of his religion, he emigrated to Massachusetts, where he was elected governor in 1636. After one year in office, he was defeated by Winthrop.

Vane returned to England in August 1637. He was made joint-treasurer of the navy with Sir W Russell in January 1639, was elected for Hull in the Short and Long parliaments, and was knighted on June 23, 1640 He at once became one of the leaders of the parliamentary party, and in 1643 he was the leading man among the commissioners sent to treat for a league with the Scots. Vane, who was bitterly opposed to the tyranny of the Presbyterian system, succeeded in getting the proposed bond between the parties termed the Solemn League and Covenant, and further in substituting the whole expression "*according to the word of God and* the example of the best Reformed churches" for the latter part alone He succeeded to the leadership of the party on Pym's death and was engaged in all the principal negotiations which followed His leadership ended when the Presbyterian party obtained the supremacy in parliament in 1646 During the subsequent struggle he was one of the six commissioners appointed to treat with the army by the parliament, and endeavoured to effect a compromise, but failed, being distrusted by both the Levellers and the Presbyterians His views of government may be studied in *The People's Case Stated*, written shortly before his death

In spite, however, of these free opinions, Vane still desired the maintenance of the monarchy and the constitution He supported the renewal of negotiations with the king and was appointed in 1648 one of the commissioners for the treaty of Newport. He showed a desire to come to terms on the foundation of toleration and a "moderate episcopacy," of which Cromwell greatly disapproved, and opposed the shaking off of the conferences He remained in retirement until after the king's death On Feb 14, 1649 he was placed on the council of state, though he refused to take the oath approving the king's execution Vane served on innumerable committees of importance, and was assiduous in his attendance. He furnished the supplies for Cromwell's expedition to Scotland, and was one of the commissioners to negotiate a union between the two countries He was a leading member of the committee dealing with foreign affairs, and in 1651 went on a secret mission to negotiate with Cardinal de Retz To Vane, as chief commissioner of the navy, belongs largely the credit of the victories obtained against Van Tromp.

In domestic politics Vane continued to urge his views of toleration and his opposition to a state church On Jan. 9, 1650 he brought forward as chairman the report of a committee for the reform of the franchise on the property basis, the disfranchisement of certain existing boroughs, and increased representation to the large towns, the sitting members, however, were to retain their seats But Cromwell desired an entirely new parliament and the supremacy of the army representation On April 20 Cromwell forcibly dissolved the Long Parliament while in the act of passing Vane's bill. On the latter's protesting, "This is not honest; yea, it is against morality and common honesty," Cromwell fell a-railing at him, crying out with a loud voice, "O Sir Henry Vane, Sir Henry Vane; the Lord deliver me from Sir Henry Vane!" (Ludlow, *Mem.* i 353) Hitherto they had lived on intimate terms of friendship, but this incident created a permanent breach In his seclusion at Raby he now wrote the *Retired Man's Meditations* (1655). In 1656 he proposed in *A Healing Question* (reprinted in the "Somers Tracts," vol vi, ed Scott) a new form of government, insisting as before upon a Puritan parliament supreme over the army The seditious movements of the Anabaptists were attributed to his influence, and on July 29, 1656 he was summoned before the council. Refusing to give security, he was a prisoner at Carisbrooke Castle from September to the end of the year. In the parliament of Richard Cromwell he was elected for Whitchurch, when he urged that the protector's power should be strictly limited.

He allied himself with the officers in setting aside the protectorate and in restoring the Long Parliament, and on Richard Cromwell's abdication he became a member of the committee of safety and of the council of state appointed in May, was commissioner for the navy and for the appointment of army officers, managed foreign affairs and superintended finance He adhered to Lambert, remained a member of the government after the latter had turned out the Long Parliament, and endeavoured to maintain it by reconciling the disputing generals and by negotiating with the navy, which first deserted the cause In consequence, at the restoration of the Long Parliament he was expelled from the House and ordered to retire to Raby.

At the Restoration, Vane was imprisoned in the Tower by the king's order After several conferences between the houses of parliament, it was agreed that he should be excepted from the indemnity bill, but that a petition should be sent to Charles asking that his life might be spared. The petition was granted. But the new parliament of 1661 demanded his trial on the capital charge, and Vane was taken back to the Tower in April 1662 from the Scilly Isles, where he had been imprisoned On June 2 he appeared before the king's bench to answer the charge of high treason, when he made a bold and skilful defence, asserting the sovereign power of parliament in justification of his conduct He was found guilty, and executed on June 14, 1662

Bibliography.—Article by C H Firth in *Dict of Nat Biog*; S R Gardiner's *Hist of England*, his *Great Civil War* and his *Commonwealth*, and Clarendon's *Hist. of the Rebellion*, and the contemporary memoirs and diaries, Hist MSS Comm MSS of duke of Buccleuch, ii pt ii 756, Masson's *Life of Milton*, iv 442 and *passim*; the sonnet addressed by Milton to Vane, and W. W Ireland, *Life of Sir Henry Vane the Younger* (1907).

VAN GOGH: *see* Gogh, Vincent van

VAN HORNE, SIR WILLIAM CORNELIUS (1843–1915), Canadian financier, was born in Will county, Illinois, U S A, Feb 3, 1843, of Dutch descent. He was educated in the common schools of the state, and in 1857 began work as office boy in a railway station. In 1881 he was appointed general manager of the Canadian Pacific railway. For the successful completion of this great road his strong will and mental grasp were largely responsible, and he controlled and extended its operations. In 1884 he became vice-president of the line, in 1888 president, and in 1899 chairman of the board of directors. After the Spanish-American War (1898) he became one of the chief promoters of railway and industrial enterprises in Cuba. He died at Montreal on Sept. 11, 1915

BY COURTESY OF THOMAS LEE

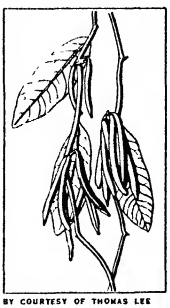
THE VANILLA VINE, AS IT IS CULTIVATED IN MEXICO

VANILLA, a flavouring agent largely used in the manufacture of chocolate, in confectionery and in perfumery. It consists of the fermented and dried pods of several species of orchids belonging to the genus *Vanilla.* The name of the genus comes from the Spanish *Vainilla,* a diminutive of *vaina,* a pod. The great bulk of the commercial article is the produce of *V planifolia,* a native of south-eastern Mexico, but now largely cultivated in several tropical countries, especially in Bourbon, the Seychelles, Tahiti and Java. The plant has a long fleshy stem and attaches itself by its aerial rootlets to trees; the roots also penetrate the soil The leaves are alternate, oval-lanceolate and fleshy; the light greenish flowers form axillary spikes The fruit is a pod from 6 to 10 in. long, when mature, about half an inch in diameter The wild plant yields a smaller and less aromatic fruit, distinguished in Mexico as *Baynilla cimarona,* the cultivated vanilla being known as *B. corriente.*

Mexican vanilla is principally consumed in the United States In Bourbon large areas are under cultivation, the crop is sent to Bordeaux, the chief centre of the trade in France. Its odour is

said to differ from the Mexican variety in having a suggestion of tonka bean

The best varieties of vanilla pods are of a very dark chocolate brown or nearly black colour, and are covered with a crystalline efflorescence technically known as *givre*, the presence of which is taken as a criterion of quality The peculiar fragrance of vanilla is due to vanillin, $C_8H_8O_3$, which forms this efflorescence. Chemically speaking, it is the aldehyde of methyl-protocatechuic acid It is not naturally present in the fleshy exterior of the pod, but is secreted by hair-like papillae lining its three internal angles, and ultimately becomes diffused through the viscid oily liquid surrounding the seeds Besides vanillin, the pods contain vanillic acid (which is odourless), about 11% of fixed oil, 2.3% of soft resin, sugar, gum and oxalate of lime



BY COURTESY OF THOMAS LEE

VANILLA (VANILLA PLANIFOLIA) BRANCH WITH FRUITS

Vanillin forms crystalline needles, melting at 81° C, and soluble in alcohol, ether and oils, hardly soluble in cold, but more so in boiling water Vanillin has been found in Siam benzoin and in raw sugar, and has been prepared artificially from coniferin, a glucoside found in the sapwood of fir-trees, from asafoetida, and from a constituent of oil of cloves named eugenol It is now prepared synthetically on a commercial scale in Germany

VANINI, LUCILIO, or, as he styled himself in his works, GIULIO CESARE (1585–1619), Italian free-thinker, was born at Taurisano, near Naples He studied at Rome, Naples, and at Padua, and was ordained priest Subsequently he led a roving life in France, Switzerland and the Low Countries

Vanini was obliged to flee from Lyons to England in 1614, but was imprisoned in London for some reason for forty-nine days Returning to Italy he made an attempt to teach in Genoa, but was driven once more to France, where he tried to clear himself of suspicion by publishing a book against atheists, *Amphitheatrum aeternae providentiae divino-magicum* (1615) Though the definitions of God are somewhat pantheistic, the book is sufficiently orthodox, but the arguments are largely ironical, and cannot be taken as expounding his real views Vanini expressly tells us so in his second (and only other published) work, *De admirandis naturae reginae deaeque mortalium arcanis* (Paris, 1616), which, originally certified by two doctors of the Sorbonne, was afterwards re-examined and condemned Vanini then left Paris, where he had been staying as chaplain to the maréchal de Bassompierre, and began to teach in Toulouse In Nov. 1618 he was arrested, and after a prolonged trial was condemned as an atheist He was burnt on Feb 9, 1619

See Cousin, *Fragments de philosophie cartésienne*, i. (Brussels, 1838–40); French trans M X Rousselot (Paris, 1842); J Owen, *Skeptics of the Italian Renaissance* (1893), 345–419, J Toulan, *Étude sur L. Vanini* (Strasbourg, 1869), Cesare Cantu, *Gli Eretici d' Italia*, iii (Turin, 1867). Fuhrmann, *Leben und Schicksale* (Leipzig, 1800), Vaisse, *L Vanini* (1871), Palumbo, *Vanini, e i suoi tempi* (Naples, 1878).

VANLOO, CHARLES ANDREW (1705–1765), subject painter, a younger brother of John Baptist Vanloo (1684–1745), a well known portrait painter, was born at Nice on Feb 15, 1705. He received some instruction from his brother, and like him studied in Rome under Luti In 1734 he settled in Paris, and in 1735 became a member of the French Academy, and he was decorated with the order of St Michael and appointed principal painter to the king He died in Paris on July 15, 1765

VANNES, a town of western France, capital of the department of Morbihan, 84 m N W of Nantes on the railway to Brest. Pop (1926) 16,577. Vannes (*Dariorigum*), the capital of the Veneti (whence *Gwened*, the Breton name of the town), led the Armorican league against Julius Caesar, who in 56 B C overcame their fleet and opened up their country by six roads St. Paternus, the first bishop, was consecrated in 465 In the 5th century Vannes was ruled for a time by independent counts, but soon came under the yoke of the Franks Nomenoé the lieutenant of Louis I., the Pious, in Brittany, assumed the title of king in 843, and one of his brothers was the founder of a line of counts who resisted the Normans in the 9th and 10th centuries Vannes became part of the duchy of Brittany at the end of the 10th century The estates of Brittany met there for the first time in 1203. In the course of the War of Succession the town was besieged in 1342 Duke John IV built here the castle of L'Hermine and made it his habitual residence In 1487 the town was for a year in the hands of Charles VIII of France. In 1532 Brittany was definitively united to France

Vannes is situated 10 m from the open sea, at the confluence of two streams forming the Vannes river, which opens into the land-locked gulf of Morbihan about a mile below the town The old town, lying on a hill facing the south, is surrounded by fortifications of the 14th, 15th and 17th centuries, pierced by four gates and flanked by nine towers and five bastions, connected by battlements. In the Constable's tower Olivier de Clisson was confined in 1387 The modern suburbs, with the port and public buildings, surround the old town The archaeological museum includes one of the richest collections of prehistoric remains in Europe The cathedral of St Peter, burnt by the Normans in the 10th century, was rebuilt in the 13th, 15th and 18th centuries It has remains of a cloister The curious round Chapelle du Pardon to the left of the nave was built in 1537 in the Italian style Among the industries are tanning and cotton-weaving The port of Vannes, to the south of the town, is formed by the Vannes river and is accessible only to small vessels.

VAN RENSSELAER, STEPHEN (1764–1839), American political leader and soldier, "last of the patroons," was born at New York city, Nov. 1, 1764 He was fifth in descent from Killian Van Rensselaer, original patroon of Rensselaerwyk, New York He was a member of the New York assembly 1789–90, 1808–10, and in 1818; a member of the State senate 1791–95 and of the national House of Representatives 1822–29 He served as a major-general in the second war with Great Britain, commanding the First Division of the detached militia of the state of New York, and on the 13th of October 1812 was defeated at the battle of Queenston Heights As he was a Federalist he was severely criticised and censured for this defeat and resigned from the army At the close of the war the Erie Canal project was renewed, and from 1816 till his death he was a member of the board of canal commissioners, and for nearly fifteen years was its president In 1818 he was again elected to the Assembly, in 1819 he became a regent of the State university of which he was for a time chancellor From 1822 to 1829 he was a member of the National House of Representatives, and there voted for John Quincy Adams for the presidency He died at Albany (N Y), Jan 26, 1839

VANSITTART, HENRY (1732–1770 or 1771), Anglo-Indian governor, was born in London on June 3, 1732, and educated at Reading school and Winchester college He joined the society of the Franciscans, or the "Hell-fire club" at Medmenham In 1745 he entered the service of the East India company and sailed for Fort St David In 1760 he went to Bengal as president of the council and governor of Fort William, deposing the subadar of Bengal, Mir Jafar, he replaced him by his son-in-law, Mir Kasim In 1762 he made a treaty with Mir Kasim, checking the system of private trading by the company's servants. The repudiation by the council of this treaty led to war with the subadar, and Vansittart resigned and returned to England in 1764 In 1769 he was made a director of the company, and left England for India, but his ship was lost at sea in 1770 or 1771

VAN'T HOFF, JACOBUS HENRICUS (1852–1911), Dutch physical chemist, was born in Rotterdam on Aug. 30, 1852 He studied at the Polytechnic at Delft, at the University of Leyden, then under Kekulé at Bonn, Wurtz at Paris and, finally, with Mulder at Utrecht, where he obtained his doctorate. In 1876 he became lecturer in physics at the veterinary school, Utrecht, and in 1878 he was appointed professor of chemistry, mineralogy and geology in Amsterdam university. In 1896 he went to Berlin as professor to the Prussian academy of sciences but as this position involved no teaching duties he accepted an

honorary professorship in the university so that he might lecture if he wished. He was elected a foreign member of the Royal Society in 1897 and awarded its Davy medal in 1893; he received the Nobel prize in 1901 and died on March 1, 1911, at Steglitz.

Van't Hoff's first research was on cyanacetic and malonic acids but his earliest important contribution to science was made in 1874. Starting with the results of the work of Wislicenus (*q v*) on the lactic acids, van't Hoff showed that the four valencies of the carbon atom were probably directed in space towards the four corners of a regular tetrahedron; in this way optical activity, shown to be always associated with an "asymmetric carbon atom," could readily be explained An identical idea was put forward two months later (Nov 1874), quite independently, by J. A Le Bel, whose name is generally linked with that of van't Hoff in connection with the theory of asymmetric carbon. The concept was attacked by Kolbe (*q.v*), but its value was soon universally realized and it laid the foundation stone of the science of stereochemistry (*q.v*). In 1884 was published van't Hoff's second important work; it dealt with the application of thermo-dynamics to chemical reactions, and was probably his greatest contribution to physical chemistry He developed the principles of chemical kinetics, described a new method of determining the order of a reaction, and applied thermodynamics to chemical equilibria; in the course of this work he deduced the connection between the equilibrium constant of a reaction and the temperature, in the form of an equation known as the "van't Hoff isochore." He generalized this in the form of the "principle of mobile equilibrium," a special case of the principle developed by Le Chatelier at the same time (1884) In the course of the same study van't Hoff introduced the modern concept of chemical affinity as the maximum work obtainable as the result of a reaction and showed how it may be calculated from measurements of osmotic pressure, gas pressure and the e m f. of reversible galvanic cells. In 1886 he published the results of his study of dilute solutions and showed the analogy existing between them and gases, since both obey equations of the type pv = RT During the next nine years he developed this work in connection with the theory of electrolytic dissociation enunciated by Arrhenius (*q v*) in 1887 As part of this work he carried out a series of researches on the conditions of formation and decomposition of double salts, and on his translation to Berlin in 1896, he developed this into the important study of the formation of oceanic salt deposits with special reference to those at Stassfurt, Saxony With W Ostwald (*q v*) he started the important *Zeitschrift fur physikalische Chemie* in 1887 and the first volume contained the famous paper by Arrhenius on electrolytic dissociation. Van't Hoff's publications include *La Chimie dans l'Espace* (1875), German edition 1876, and English 1898; *Etudes de dynamique chimique* (1884), revised and extended by E Cohen as *Studien zur Chemischen Dynamik* (1896). *Vorlesungen uber Bildung und Spaltung Doppelsalzen* (1897); and *Zur Bildung der Ozeaniachen Salz ablagerangen* (i, 1905, ii, 1909)

See E Cohen, *Jacobus Henricus van't Hoff, Sein Leben und Werken* (Leipzig, 1912); also obituary notice in *Proc Roy Soc*, vol. 86

VAN WERT, a city of western Ohio, U S.A, the county seat of Van Wert county, on the Lincoln highway, 34 m S E of Fort Wayne (Indiana) It is served by the Cincinnati Northern, the Pennsylvania and electric railways Pop (1920) 8,100 (97% native white) It is in a rich grain-growing region, and has railroad shops and various other manufacturing industries. Van Wert was settled about 1840, incorporated as a town in 1848 and as a city in 1903

VAPEREAU, LOUIS GUSTAVE (1819–1906), French man of letters and lexicographer, was born at Orleans on April 4, 1819. After 1870 he was appointed prefect of Cantal (1870) and of Tarn et Garonne (1871–73) From 1877 to 1888 he was inspector-general of public instruction. He was the author of some excellent editions of the classics, and of works on political and social questions, but he is famous for his valuable *Dictionnaire universel des contemporains* (1858; 6th ed., 1893), brought up to date in 1895 by a supplementary volume. He also drew up a *Dictionnaire universel des littérateurs* (1876) He died in 1906

VAPHIO, an ancient site in Laconia, Greece, on the right bank of the Eurotas, some 5 m S of Sparta, famous for its "bee-hive" tomb, excavated in 1889 by Dr. Tsountas A walled approach, or δρόμος, about 97 ft long, leads to a corbel-vaulted chamber 33 ft. in diameter, in the floor of which the grave was cut The tomb, which probably belonged to Amyclae rather than to Pharis, as is commonly stated, is now almost entirely destroyed Its contents (in the National Museum in Athens) are typical of the "First Late Minoan" period (about 1500 B C) and include engraved gems and amethyst beads, articles in gold, silver, bronze, lead, amber and crystal; also an iron ring, unusual at this early date. By far the finest objects are two golden cups with scenes in relief, picturing the capture of bulls

See C Tsountas, Ἐφημερὶς Ἀρχαιολογική (1889), 136–172; J G. Frazer, *Pausanias's Description of Greece*, iii 135 f (with full bibliography), R C Bosanquet, *Journal of Hellenic Studies* (1904), xxiv. 317 ff, A Riegl, *Jahreshefte d osterr arch Institutes* (1906), ix. 1 ff

VAPORIZATION, a general term denoting the change of state of any substance from solid or liquid to vapour The converse change from vapour to liquid or solid is most often called condensation, though there are many other special terms employed in particular cases The general phenomena of change of state as affected by heat have been described in the article HEAT The most accurate methods of measuring the latent heat of vaporization or condensation are discussed in the article CALORIMETRY, and the application of the laws of thermodynamics to the subject is included in the article THERMODYNAMICS Important practical applications of the properties of vapours will be found in other articles, such as LIQUEFACTION OF GASES; DISTILLATION, STEAM, and STEAM-ENGINE, TURBINE The chief object of the present article is to discuss the *physical* explanation of the phenomena, and to show how the various properties of vapours can be represented by equations, so that the effects to be expected under any conditions can be calculated

Gases and Vapours.—In effect all gases may be regarded as vapours, since all may be liquefied and solidified under suitable conditions Conversely we should expect that all vapours would behave as gases under conditions sufficiently far removed from those at which the corresponding liquid can exist This is found to be the case for all stable vapours, which approximate more and more closely to the gas equation $aPV = RT$ as the temperature is raised or the pressure reduced In this equation V represents the volume occupied by unit mass at a temperature T on the absolute scale, and pressure P in any convenient units The constant a is the factor required for reducing PV to heat units, and the value of the constant R in heat-units per degree is $1{\cdot}985/m$, where m is the molecular weight corresponding to the chemical formula for the molecule of the vapour considered. At any temperature below the boiling-point of the liquid, if the volume of the vapour is reduced, the deviations from Boyle's law will seldom exceed 1 per cent But a sharp limit is set to the application of the gas equation by the *saturation-pressure* at which the vapour begins to condense The pressure then remains constant, as the volume is further reduced at constant temperature, until the whole of the vapour is condensed By experiments of this kind, Dalton established the law of saturation pressure, that for each vapour there is a unique relation between pressure and temperature defining the state in which alone the liquid and vapour can exist together in equilibrium

Empirical Formulae for Saturation Pressure

$\log p = A + BT$	Dalton, 1800
$\log p = C \log (A + BT)$	Young, 1820
$\log p = AT/(B + CT)$	Roche, 1830
$\log p = A + Bb^t + Cc^t$	Biot, 1844
$\log p = A + B \log t + C \log (T + c)$	Bertrand, 1887
$\log p = A - B/T - C(365 - t)^4/T$	Thiesen, 1903
$\log p = A - B/T - C \log t - DT + ET^2 + FT^3 + GT^4$	Goodenough, 1915

Biot's formula, though apparently the most ungainly and difficult to work, possesses some practical interest because it was adopted by Regnault (1847) for representing his observations on the saturation pressures of steam, which were made with a mercury manometer 70 ft high, and were much the most accurate

obtained for many years. In spite of the five empirical constants in Biot's formula, Regnault found it necessary to use different formulae above and below 100° C. At that time the laws of thermodynamics had not been elucidated sufficiently to permit their application to the problem, but some theoretical basis might have been expected in the case of the later formulae.

Theoretical Equation of Saturation Pressure.—The law according to which the saturation pressure of any vapour varied with the temperature was discovered by Carnot in 1824 by the direct application of his principle to the case of vaporization, and was first stated in the form —"The increase of saturation pressure per degree is equal to the latent heat per unit increase of volume in vaporization multiplied by a function of the temperature (Carnot's function) which is the same for all substances" The law could not be applied until the form of this function had been determined. Accordingly Carnot utilized the relation in the first instance for calculating values of his function from the very scanty and inaccurate data available for the latent heats of various substances. But this failed to give any conclusive result owing to the poverty of the data (*See* THERMODYNAMICS) Clapeyron (1834) first stated the equation in the analytical form in which it is generally known as Clapeyron's equation,

$$L\ F't = (V-v)\ (dp/dt)_s \qquad (1)$$

in which L is the latent heat of vaporization corresponding to the increase of volume $V-v$ from liquid to vapour, $F't$ is Carnot's function of the temperature and $(dp/dt)_s$ denotes the increase of the saturation pressure per degree Ultimately, as the result of Joule's experiments on the mechanical equivalent of heat, denoted by J, and of Regnault's experiments on the gas-scale of temperature, denoted by T, it gradually became obvious (*see* HEAT) that Carnot's function must be very nearly equal to J/T. The absolute scale of temperature T was accordingly defined on Kelvin's suggestion by the condition $T = J\ F't$, in which it is understood that the appropriate numerical value of J must be employed, depending on the units in terms of which heat and work are measured in the equation Putting a for $1/J$, Clapeyron's equation may be written in the form,

$$L/ap(V-v) = (T/p)\ (dp/dT)_s \qquad (2)$$

The expression on the left is the ratio of the latent heat L to the equivalent $ap(V-v)$ of the external work of vaporization in heat units. The expression on the right is the most convenient method of stating the rate of increase of saturation pressure with temperature, since it has the same numerical value, for a given substance under given conditions, in all systems of units. To find the expression for p in terms of T, we have merely to integrate equation (2) after substituting appropriate expressions for L and V in terms of p and T

Rankine (1851) was the first to show that the total heat of an ideal vapour reckoned from the state of liquid at 0° C should be $H = L_o + St$, where S is the specific heat of the vapour at constant pressure, and L_o the latent heat of vaporization at 0° C The total heat of the *liquid* reckoned from 0° C is simply $h = st$, where s is specific heat of the liquid, and is taken as constant Hence the latent heat L at any temperature t will be approximately,

$$L = H - h = L_o + (S-s)t \qquad (3)$$

If the vapour also satisfies the gas law, as is generally the case at low pressures, we may substitute $apV = RT$ in (2), and neglect v, which is generally less than a thousandth of V at atmospheric pressure Equation (2) then reduces to the simple form, $L/RT^2 = (dp/dt)/p$, which is easily integrated with the value of L from (3), and gives a theoretical equation for p,

$$\log_e p = A - B/T - C \log_e T \qquad (4)$$

where $B = L_o/R + (s-S)T_o/R$, $C = (s-S)/R$, and A is the constant of integration. This equation must necessarily give a good first approximation to the saturation pressures if the values of the constants L_o, s, and S are correct Thus in the case of steam, if we take $L_o = 594.3$, $s = 0.9967$ (the minimum specific heat of water) $S = 0.4772 = 13R/3$, equation (4) gives values at low pressures which are correct to 0·1° C at a temperature as high as 60° C. Beyond this point the approximation begins to fail, chiefly in the first instance because apV begins to deviate appreciably from the ideal value RT above assumed At 100° C the value of p given by (4) is already about 1·5% too small, corresponding to a defect of the same order of magnitude in the value of V This agreement verifies Clapeyron's equation (2), and the assumption $apV = RT$ at low pressures, as well as equation (3) for L, but it is necessary to obtain consistent expressions for the defect of both L and V from these ideal values before equation (4) can be extended to higher pressures. Rankine, who first gave a correct deduction of (4) (Trans R S.E. 1865), came to the conclusion that both L and V must show an increasing defect from their ideal values as the pressure increased, but he was unable to trace the required connection between them Equation (4) is generally attributed to Dupré (1869), who deduced it by assuming a linear formula for the latent heat, and used it as a purely empirical formula by calculating the coefficients from observations at high pressures Bertrand, in his treatise on Thermodynamics, followed the same course, which is necessarily unsatisfactory, because it does not comply with the theoretical conditions, or give the true relations of the constants B and C to L and S

Deviations of a Vapour from the Ideal State.—The manner in which a gas passes into a vapour and finally condenses, must be studied in the first instance by observing the gradual deviations from the gas law $aPV = RT$, as the pressure is increased The simplest way of doing this is to find the departure from Boyle's law at various constant temperatures, which gives the whole story if the range of temperatures is sufficiently extended Regnault (1847) was the first to make observations of this kind with sufficient accuracy in the case of CO_2 Rankine (1854) succeeded in representing these experimental results by a fairly simple equation in a convenient form,

$$P + A/V^2T = RT/aV \qquad (5)$$

The second term, in which A is an empirical constant, represents the deviations from the gas law, and tends to vanish when V or T is large. It is of the dimensions of a pressure, and may be interpreted as an internal pressure, varying as the square of the density, which is added to the external pressure P, and tends to reduce V below the ideal value According to Boyle's law, the product PV of the observed values of P and V at various pressures should be constant at each temperature at which observations are made, and should give a horizontal straight line when PV is plotted against P Equation (5) when plotted in this manner, gives a series of parabolas, each with its axis horizontal and its vertex at a height equal to half the initial value of PV This is easily seen by multiplying equation (5) by PV^2, which gives it in the form of a quadratic in (PV),

$$(PV)^2 - (PV)(RT/a) + AP/T = 0 \qquad (5)a$$

the two roots of which become equal when $P = RT/2aV$, and are imaginary at higher pressures The equation would evidently fail before this point was reached, but was found to be quite satisfactory for the restricted range of Regnault's experiments. It also represented his observations on the pressure-coefficient of CO_2 very closely, and Joule and Thomson found that it also satisfied their results for the cooling effect in expansion through a porous plug. They found however that (5) was very inconvenient in form for their purpose, because it gave P as a quadratic function of $1/V$, whereas they wanted V explicitly as a function of P They therefore transformed equation (5) by multiplying throughout by V/P, and making the approximation $PV = RT/a$ in the small term A/PVT, thus obtaining,

$$V = RT/aP - Aa/RT^2 \qquad (6)$$

The small term Aa/RT^2 is now of the dimensions of a volume, and may be interpreted as a first approximation to the reduction of volume A/PVT due to the internal pressure A/V^2T, as in equation (5). It also might be interpreted on the kinetic theory (which was expressly designed to explain the pressure of gases and vapours without assuming imaginary forces of attraction or repulsion between the molecules) as being due to a reduction in the

effective *number* of molecules per unit mass owing to the formation of multiple or complex molecules by coaggregation. This process is well known to occur in analogous chemical problems, where the proportions of different molecules existing in a gas mixture can be analysed and verified. On this view, the reduction of V below the ideal value RT/aP is due to a corresponding reduction in the number of *effective* molecules, and the formation of complex molecules is regarded as the first stage in the transition from the state of vapour to the state of liquid, in which nearly all the molecules are coaggregated. The reduction of volume Aa/RT^2 given by the Joule-Thomson equation (6) is a function of the temperature only, and should be a very good first approximation to the coaggregation at low pressures according to the kinetic theory. If the isothermals are plotted on the $PV-P$ diagram, they will all be straight lines, as is easily seen by multiplying (6) by P, so as to give the product PV. The slope of successive isothermals is proportional to $1/T^2$, and diminishes with rise of temperature. The diminution of slope with rise of temperature is to be expected on thermodynamic grounds, if the molecules combine with evolution of heat, which would afford the most natural explanation of the latent heat of condensation. The term A/PVT representing the reduction of volume according to Rankine's equation, though fitting exactly with the hypothesis of an internal pressure varying as the square of the density, might equally well represent the effect of coaggregation. We might expect that the complex molecules would begin to combine *with each other* as the proportion of such molecules in the mixture increased with increase of density, and that the slope of each isothermal would increase accordingly, giving the parabolic form (5)*a* in place of the rectilinear-isothermals given by (6). This is certainly true at high pressures near saturation, though the isothermals approximate more nearly to straight lines at temperatures above the critical point; but neither of these equations could be expected to apply to the liquid state, or even to the vapour in extreme cases, beyond the limits of the observations on which they were founded.

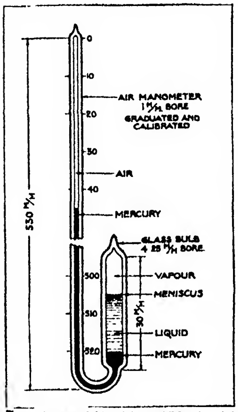


FIG 1.—BARON COGNIARD DE LA TOUR APPARATUS USED IN THE DISCOVERY OF THE CRITICAL POINT

The Continuity of State.—The theory of the continuity of state, which is now so familiar as an explanation of the relations between liquid and vapour, appears to have originated from the experiments of Andrews (*Phil Trans* 1869) on the properties of carbonic acid (CO_2) between the temperatures of 13° and 48° C, including the critical region. The vapour was confined in a capillary tube by a pellet of mercury, and the apparatus was arranged so that the volume could be varied by means of a screw plunger, while the tube was maintained at a steady temperature in a water bath. A similar capillary containing air subject to the same pressure was employed as a manometer (for details of apparatus *see* article LIQUEFACTION OF GASES). The isothermal curves obtained by plotting simultaneous values of P and V observed at the temperatures of 13·1°, 21·5°, 31·1°, 35·5° and 48·1° C, are shown in fig 1B. They showed the well known discontinuities, required by Dalton's law, at the commencement and conclusion of condensation, but the sharp corners were rounded off at these high pressures, and the pressure did not remain quite constant during condensation, but showed a rise of about 2 per cent attributed by Andrews to an impurity of about 2 parts of air in 1,000 of CO_2. The dotted line shown in the figure has been added to Andrews' original diagram to indicate the saturation lines for the liquid and vapour, meeting at the critical point 31·1°, with the critical isothermal as a common tangent. At any point within the dotted boundary, *e g*, at 21·5°, the fluid exists partly in the state of vapour and partly in that of liquid, in stable equilibrium with the vapour, as is usually observed during the condensation of a vapour by compression at constant temperature. But Andrews showed very conclusively that a vapour could be transformed into a liquid by a continuous process without any breach of homogeneity, or separation into the two states of liquid and vapour, provided that the change was effected along any path on the diagram which did not intersect the dotted boundary curve. Thus if the vapour were taken at a temperature of 48°, and at a pressure of 80 atmospheres, and were then cooled *at constant pressure* to a temperature of 13°, at which it was certainly liquid, the fluid remained homogeneous throughout the process, and showed no sign of separation into two states at any point. He concluded from these experiments that "The gaseous and liquid states are only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption or breach of continuity."

James Thomson (*Proc R S* 1871) extended this view to the region included by the boundary curve. He maintained that the discontinuities ordinarily shown at the beginning and end of condensation, were apparent rather than real. He quoted Donny's experiments as showing that, in the absence of dissolved air, the liquid curve AB in fig 2 A, could be traced along the extension BM to pressures far below the saturation line BCD, without any formation of vapour. It was possible to imagine the vapour curve ED similarly extended in the direction DN to pressures above saturation. This had been suggested by Kelvin (*Phil Mag* 1870) on theoretical grounds, though it had not then been proved by experiment. The two curves thus extended might be joined into one continuous isothermal by the intermediate branch MCN. This branch would involve unstable conditions (V increasing with P) and could not be realized in practice, though it might be represented by some type of equation such as a cubic. If this could be done, it would have the great advantage of representing both liquid and vapour by a single equation of state, which would take account of all possible modes of transformation.

The Equation of van der Waals.—The continuous isothermal of James Thomson was first realized in the form of an equation by van der Waals in his famous essay *On the Continuity of the Liquid and Gaseous States* (Leyden, 1873), which put the whole theory in a more definite form. He assumed that the cohesion of the liquid, shown by Donny's experiments, could be attributed to an internal pressure, such as that invoked by Laplace to account for the surface tension. He considered that this internal pressure should depend on the attraction of contiguous parts of the fluid for each other, and should vary as the square of the density, or as $1/V^2$. It would then also explain the deviations of the vapour from the ideal state, as in Rankine's equation for CO_2. Thus both liquid and vapour would be represented by the same equation, which implied that the molecules were identical, and that the two states differed only in density. The only modification necessary in Rankine's equation was the inclusion of the co-volume b in the last term, to represent the irreducible volume of the molecules themselves at high pressures, as demonstrated by Natterer (1854). This also had the effect of transforming the equation into a cubic in V as required by the theory of the James Thomson isothermal. We thus obtain the equation,

$$P+A/V^2=RT/a(V-b) \qquad (7)$$

The factor T in Rankine's expression for the internal pressure was omitted by van der Waals on the ground that an internal pressure, representing a force of attraction between the molecules, should be independent of the temperature. But this does not make any material difference to the critical relations. It will be evident that, for given values of P and T, equation (7) gives a cubic in V, and may have three real roots within certain limits representing the points of intersection, B,C,D, in fig 1A, of the isothermal of T with the line of constant pressure P. The smallest of these roots, given by the point B, may be identified with the volume of the liquid, v, and the largest, given by the point D, with that of

the vapour, V, the middle root C corresponding to the unstable intermediate state imagined by James Thomson The isothermal curve shown in the figure 1A, corresponds roughly with that given by equation (7) at 21·5° C, or T=294·6 As the temperature is raised towards the critical point at 31·1° C, the line BCD becomes rapidly shorter, and the three roots finally coalesce at the critical point, where the isothermal has a point of inflection with a hori-

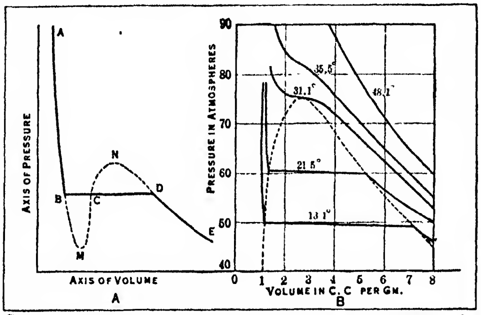


FIG 2—(A) JAMES THOMSON ISOTHERMAL (B) ISOTHERMALS OF CO_2 (ANDREWS)

zontal tangent as shown in Andrews' diagram, fig 1B The condition for three equal roots at this point gives the critical relations,

$$V=v=3b,\ P=A/27b^2,\ T=8A/27bR, \tag{8}$$

as given by van der Waals, omitting the reduction factor a These relations give the values of V, P and T, at the critical point in terms of the constants A, b and R, or *vice versa* It will be seen that the results depend mainly on the value assigned to b, which is very small, and could not be determined satisfactorily from Regnault's observations at comparatively low pressures The value of the constant A was taken from Regnault's observations, following Rankine's procedure, but that of b was selected to fit the critical temperature, T=304°, which was known with a fair degree of accuracy The calculated values of the critical pressure and volume did not agree very well with Andrews' observations, but these were somewhat uncertain The *qualitative* agreement was incredibly perfect in all essential respects with the James Thomson theory, and the equation of van der Waals was immediately accepted as the true and final solution of the problem

Maxwell's Theorem.—The continuous isothermals represented by equation (7) could easily be plotted on the PV diagram as shown in fig 2, but an exact *quantitative* comparison was difficult, because van der Waals' theory, as originally presented, gave no indication of the manner in which the line BCD, representing the saturation pressure, should be drawn in relation to the continuous isothermal This question was first solved by J C Maxwell (1875), who showed by a simple application of Carnot's principle, that the work of vaporization must be the same along either path, or that the line BCD at each temperature must cut off positive and negative loops of equal area from the continuous isothermal The work of vaporization along BCD is simply $p(V-v)$, that along the curve is the integral of $p\,dV$ from (7) between the same limits The integration is easy, and gives the condition,

$$p(V-v)=(RT/a)\log_e(V-b)/(v-b)+A/V-A/v \tag{9}$$

Fig 3 shows the saturation lines correctly drawn in accordance with Maxwell's rule in relation to the isothermal curves given by (7) for the temperatures 0°, 10°, 20° and 30° C Below 0° down to −50° C, the saturation pressures given by (7) are marked on the saturation line aC_w for the liquid. The dotted curve AC shows the saturation line for the liquid and the saturation pressures as actually observed. Comparing the two curves, we see at once that the values of v calculated from (9) are all nearly 100% too large, and that the actual increase of saturation pressure between 10° and 30° C is nearly double that given by (7). This was not noticed at the time, because the saturation pressures were difficult to calculate from (9), and the volumes of the liquid were considered to be of little importance. Equation (7) gives a very simple expression for the internal latent heat L_1 regarded as being equivalent to the work done against the internal pressure A/V^2 when the volume is increased from v to V at constant temperature We find immediately, $L_1=A/v-A/V$ in work units The work-equivalent of the latent heat L as ordinarily measured is obtained by adding to L_1 the external work $p(V-v)$. L could also be calculated directly from Clapeyron's first relation (*see* article on THERMODYNAMICS, equation 29) by integrating $T(dp/dt)_v$ from v to V, along the continuous isothermal given by (7). We thus obtain, in work units, a quite different expression, namely, $L=(RT/a)\log_e(V-b)/(v-b)$; but it is easy to see that the two expressions for L are equal and exactly consistent with Maxwell's condition (9). These expressions show that any error in v will entail a corresponding error in L as calculated from (7), as is found to be the case on comparison with actual measurements of L which have since become available.

Clausius' Equations for Carbonic Acid and Steam.—To deduce the equation of saturation pressure from (9) in the form of a relation between p and T, as in (4), it would be necessary to eliminate V and v with the aid of (7), which is satisfied by both This proved to be extremely difficult, as is often the case with transcendental equations Clausius (*Phil. Mag.* 1882) first succeeded in finding a practical solution in the form of a table of corresponding states, giving the values of p, V and v, as fractions of the critical pressure and volume, in terms of the temperature expressed as a fraction of the critical temperature The table in this form could be applied to any equation of the type (7) provided that A were a function of the temperature only If A were constant, as assumed by van der Waals, the saturation pressures given by the table could not be made to agree at all with observation But by choosing a suitable expression for A as a function of the temperature, the saturation pressures could always

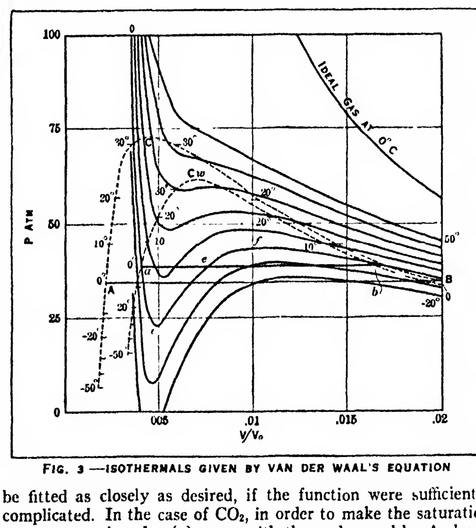


FIG. 3—ISOTHERMALS GIVEN BY VAN DER WAAL'S EQUATION

be fitted as closely as desired, if the function were sufficiently complicated. In the case of CO_2, in order to make the saturation pressures as given by (7) agree with those observed by Andrews over the very limited range of his experiments, it sufficed to replace Rankine's T in the expression for the internal pressure, making it A/V^2T as in (5) In order to make the equation represent the volumes of the liquid more closely, Clausius also found it necessary to replace V^2 in this term by $(V+b'')^2$, the empirical constant b'' being chosen to make the calculated value of v agree with observation at 20° C. The equation thus modified and

developed normally takes the form shown in (10),

$$P + A/T(V+b'')^2 = RT/a(V-b') \qquad (10)$$

which is still often quoted as applicable to CO_2, and gives fair agreement with observation from 0° to 30° C. But in spite of these additional complications, the equation would be of little use for practical purposes at low temperatures (where it is most

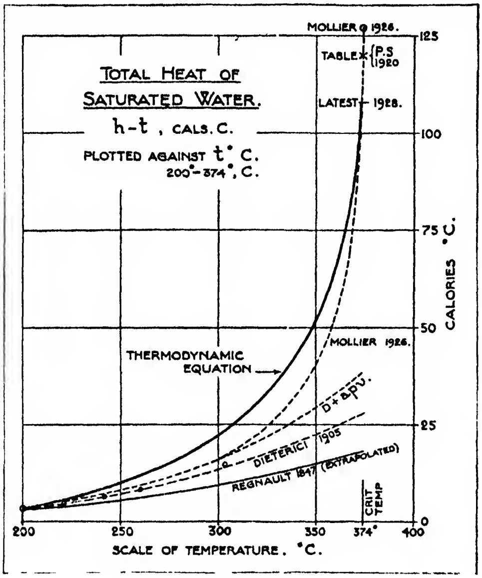


FIG 4

often required at the present day in the use of CO_2 for refrigerating plant), as it would make the saturation pressure about 50 per cent too small, and the volume of the liquid about 35 per cent too small at −50° C. Clausius could undoubtedly have made a much better approximation to the saturation pressures, if accurate observations of p had been available over a wider range, but the volumes of the liquid, and the values of the latent heat (which are most important for practical purposes) would still have been most unsatisfactory.

Owing to the restricted range of the observations available for CO_2, Clausius also applied his method to steam, for which Regnault's values of the saturation pressures were above suspicion, and extended over a much wider range. Having succeeded in representing the observed steam-pressures over the range 0° to 230° C by means of an equation similar to (10), but with a somewhat more complicated expression for A as a function of the temperature, Clausius was able to calculate the values of the critical temperature and pressure from the critical relations, which were very similar in form to (8). These gave the values, $t = 332°$ C, and $p = 134$ atmos., and should have afforded a good test of the theory, but no satisfactory observations were available for comparison. The old estimate, $t = 362°$ C, made by de La Tour, for a solution of soda, might not apply to pure water, and the temperature was somewhat doubtful. The values given by Clausius brought the properties of steam more nearly into correspondence with those of CO_2, and the theory of the continuity of state was by that time so firmly established that everyone assumed that all the other properties of the fluid must fall naturally into line if the saturation pressures were correct. The value of the constant b'' was adjusted, as in the case of CO_2, to make the calculated value of v correct at 20° C, but the value given by the equation was nearly 100% too large at 300° C. This was regarded as unimportant, because engineers at that time were in the habit of neglecting the volume of the liquid, but the discrepancy would necessarily make a corresponding error in the calculated values of the latent heat according to van der Waals' theory. Some ten years later Cailletet and Colardeau succeeded in measuring the saturation pressures of steam up to the critical point, which they estimated as 365° C, confirming the old value given by de La Tour. They found the critical pressure at this point to be nearly 200 atmospheres, which greatly exceeded the value given by Clausius. Meanwhile more and more complicated equations on the lines of van der Waals' theory, were still being evolved by mathematicians, who were strongly attracted by the conception of an internal pressure applying equally to the gaseous and liquid states, but were not greatly concerned with the practical question of agreement with actuality. The qualitative agreement with the properties of the vapour were sufficiently striking to arrest attention, while the discrepancies with regard to the properties of the liquid and the latent heat entirely escaped notice owing to the extraordinary difficulties involved in the experimental measurement.

Thermodynamic Equation for the Liquid.—The failure of so many ingenious attempts to construct an equation of the van der Waals' type capable of representing the properties of the liquid satisfactorily, might be taken as strong presumptive evidence that his fundamental assumption of identity of molecular structure was unsound. The proved facts with regard to the continuous transition from vapour to liquid, or *vice versa*, at high pressures might just as well be explained on the hypothesis that the fluid consisted of a mixture of molecules of different types, the composition of the mixture being capable of continuous variation according to the conditions of temperature and pressure. If two phases or mixtures of different molecular composition were capable of coexistence in thermodynamic equilibrium under any given conditions, the fluid would tend to separate into two parts according to general laws, which were first comprehensively stated by J. Willard Gibbs (1875) in his papers on the equilibrium of heterogeneous substances. That a simple substance like water might possibly contain molecules of different types, was first suggested by Rowland as an explanation of the remarkable variation of the specific heat of water near the freezing point, which he attributed to the presence of a small proportion of *ice* molecules. The measurement of the specific heat of water up to 100° C by the continuous electric method (*see* CALORIMETRY) suggested that the variation at higher temperatures could be explained by supposing that water contained its own volume v of saturated steam which would contribute the fraction $v/(V-v)$ of the latent heat of vaporization L to the total heat h of the water. This gave the very simple and convenient expression for h (*Phil. Trans.* 1902)

$$h = st + vL/(V-v) = st + avT(dp/dt) \qquad (11)$$

which appeared to be capable of taking account of the variation of specific heat of the liquid at higher temperatures, and at the same time fitted perfectly with Clapeyron's equation, (2), and with all the properties of the liquid in relation to the vapour. Thus if we add L to both sides of (11) we obtain,

$$H = st + VL/(V-v) = st + aVT(dp/dt) \qquad (12)$$

which gives the corresponding relation for the total heat H of the saturated vapour at the same temperature. Moreover it gives equally simple and exact expressions for the entropy of the liquid and vapour in equilibrium, namely,

$$\Phi = s\log_e(T/T_0) + vL/T(V-v) \qquad (13)$$

$$\Phi = s\log_e(T/T_0) + VL/T(V-v) \qquad (14)$$

From (11) and (12) we obtain a very useful relation between the volumes and total heats of the liquid and vapour at saturation,

$$v/V = (h-st)/(H-st) \qquad (15)$$

and from (11) and (13) we obtain a simple expression for the Gibbs' function, $G = T\phi_w - h$, which has the same value for water at saturation as for wet steam of any quality at the same temperature and pressure, namely,

$$G = T\phi_w - h = sT\log_e(T/T_0) - st \qquad (16)$$

One of the chief advantages of (11) is that it completely solves the problem of finding the theoretical equation of saturation pressure so far as the liquid is concerned. As indicated above, Rankine had to neglect v entirely and to assume that s was constant. Whereas in (11) s denotes the constant minimum specific heat of the liquid, and the second term takes complete account of the variation of h in terms of the volume v. This term is exactly eliminated by adding the expression for L from Clapeyron's equation, leaving (12) as the equation to be integrated, from which the troublesome terms representing the volume of the liquid, and the variation of its specific heat, have both automatically disappeared. We have only to find consistent expressions for H and V, and the equation must be the exact differential of the corresponding equation of saturation pressure. The equation for the liquid was verified indirectly by the fact that this method gave correct values of the saturation pressures of steam up to 200° C, when the defect of H from Rankine's ideal value was determined by the differential throttling method. The corresponding values of V, as given by the Joule Thomson equation (6), were verified up to the same limit by the subsequent observations of Knoblauch (1905).

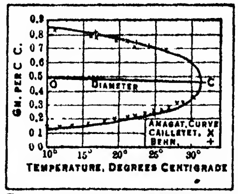


FIG 5.—AMAGAT'S DENSITY DIAGRAM FOR CO_2 NEAR THE CRITICAL POINT

Another method, which appears simpler at first sight, but requires equivalent integrations, is to find a consistent expression for the entropy Φ_s, from those for H and V, by integrating $(dH/T)-a(V/T)dP=dQ/T$. The value of $T\Phi_s-H$ for the vapour is then equated to the Gibbs' function (16) for the liquid. This necessarily gives the same result as integrating Clapeyron's equation in the form (12). It was also found that, if an equation of the van der Waals type, giving consistent values of H and V for the vapour, were combined with equation (11) for the liquid (instead of assuming *the same* equation for liquid and vapour), the combination would give much better results for L, and even for p itself, than Clausius' method. This afforded further presumptive evidence in favour of (11) as a suitable equation for the liquid.

Modified Joule-Thomson Equation.—The modification (6) of Rankine's equation which was adopted by Joule and Thomson to represent the deviations of gases from the ideal state, proved more convenient in practice than that of van der Waals, because it gave V directly in terms of P and T, instead of giving P as a cubic function of V, and also gave a much better account of the properties of CO_2 at moderate pressures. In applying the same equation to steam and other gases and vapours (*Proc R S.* June 1900, *Phil. Mag* Jan 1903) it was put in the more general form,

$$V-b=RT/aP-c \qquad (17)$$

in which b is the covolume as in van der Waals's equation, and c represents the reduction of volume due to coaggregation or pairing of molecules To a first approximation, c is a function of the temperature only, as in the original Joule-Thomson equation (6), but it may vary with temperature in different ways for molecules of different types Thus in the case of steam, in order to satisfy the adiabatic equation, $P/T^{13/3}=$ constant, cP/T must be constant along any adiabatic, in which case c must vary as $1/T^{10/3}$ The value of c was determined by the throttling method on this assumption, and found to be 26.3 c.c./gm. at 100° C. The equation in this simple form gave very convenient expressions for the total heat H, and the entropy Φ of the dry vapour. (*See* THERMODYNAMICS.) When taken in conjunction with equation (16) for the liquid, it appeared that the effect of coaggregation on the saturation pressures could be represented by simply adding the term $a(c-b)p/RT$ to Rankine's theoretical equation (4) for an ideal vapour, which was about 1·5% in error at 100° C without this addition, though agreeing closely with observation at low pressures The addition of the term required by (18) to represent the coaggregation, brought the values of p into good agreement with Regnault's observations up to 200° C Beyond this point the values of p given by the modified equation (4) began to deviate gradually from observation, until they were about 15% too small at 365° C according to the observations of Cailletet and Colardeau It was evident that the first approximation, represented by c, though very good at moderate pressures, or at high superheats, would necessarily fail at high pressures near saturation, because it took no account of the higher degrees of coaggregation due to the combination of the complex molecules with each other. This effect could most easily be represented by employing, in place of c for the coaggregation, a series of the form,

$$c(1+Z+Z^2+Z^3+\text{ etc. . . . })=c/(1-Z) \qquad (18)$$

representing a geometrical progression with first term c and common ratio Z, where $Z=kcP/T$, being proportional to the mass of the coaggregated molecules present in the vapour. It was found however that, in order to represent the values of p satisfactorily at pressures up to 200 lb., the second term Z in this series must be absent, and that the common ratio should be Z^2 instead of Z, giving the sum of the series in the form $c/(1-Z^2)$ This was confirmed by the observations on the values of V up to the critical point described in the preceding section Unfortunately the value of Z thus found would not necessarily give correct values of H, unless the adiabatic equation, which required an expression of this type for the coaggregation, remained true up to the critical point. No values of H were at that time available beyond 200° C, and the series suggested by the observations of V was quite inconsistent with the orthodox theory of the critical state, which could not be questioned without the most conclusive experimental evidence. The only practicable method of verifying the adiabatic at such high pressures would be to measure the values of H and h, in addition to those of V and v, which would be a very laborious

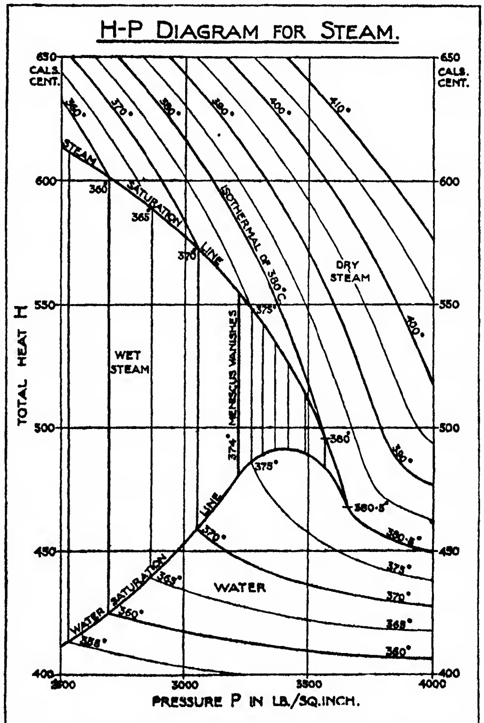


FIG. 6

and expensive undertaking

The probability of this solution was first suggested by measurements of the saturation volumes of water and steam in sealed tubes of quartz-glass, which showed that the meniscus vanished at 374° C, and that the densities did *not* become equal at this point, as commonly assumed, but were 0·438 gm./c.c. for the liquid and 0·264 gm./c.c. for the vapour Moreover, the difference of density could be traced nearly up to 380° C, with suitable illumination, under favourable conditions, and the coefficients of expansion remained finite These phenomena could not be reconciled with van der Waals's theory, but could be represented satisfactorily by the modified equation (17) with the series $c/(1-Z^2)$ in place of c. Many other stable liquids showed similar effects when carefully purified, but the equilibrium under these critical conditions might be completely upset by small traces of air or other impurities. In order to complete the proof, it was necessary to measure the total heats of both water and steam in the critical region. This had not previously been attempted, owing to grave experimental difficulties, but was successfully accomplished by the jacketed condenser method as described in the article CALORIMETRY.

H-P Diagram for Steam.—The application of the method described above proved to be less troublesome than in the case of water, because no air cushion was required to protect the gauge from vibration, since the steam itself acted as a perfect cushion, and the gauge readings were always steady. It was most important however to keep a continuous check on the purity of the water, and especially on the absence of air, which appeared to have a profound effect on the attainment of true equilibrium between the complex molecules at high pressures near the critical point The apparatus required for *eliminating air* was very simple and effective The water for supplying the pump was passed through two boilers in series, which were kept boiling with a free escape of steam Before reaching the first boiler the water was heated nearly to the boiling point by passing through a regenerator Most of the air was carried off with the steam from the first boiler, the remainder, to a very small fraction, was eliminated by the second The air-free water then returned through the regenerator, and was further cooled to atmospheric temperature before being delivered to the pump With ordinary distilled water, which may contain from a tenth to a twentieth of its volume of air at atmospheric pressure (about 1 part in 10,000 by weight) an almost continuous stream of bubbles could be observed issuing with the condensate through the glass inspection tube attached to the outlet of the condenser. It was impossible under these conditions to obtain consistent values of H owing to accidental fluctuations in the air content of the water. With the air-free apparatus in action, not a single bubble could be seen in the course of an hour's run, and the observations near saturation became incredibly more consistent. The elimination of air appeared to be just as important as in the case of the observations on the saturation volumes in the quartz tubes by the static method It was also important to keep the fluid in the superheater at a steady temperature for a sufficient time to permit the attainment of true equilibrium before passing into the high-pressure pocket where its initial temperature and pressure were measured It was then throttled to atmospheric pressure before entering the condenser, where its *total heat* was measured by observing the rise of temperature of a steady stream of cooling water, and deducing the increase of total heat as explained in the article CALORIMETRY.

The results thus obtained on the basis of the above are exhibited in the annexed figure 3, in which the observed values of the total heats are plotted against the pressure, and the temperatures are indicated by isothermal lines. The observations of H and h confirmed those of the saturation volumes by showing that the *saturation lines* for water and steam could be traced beyond 374° C and appeared to meet in a sharp cusp tangential to the isothermal of 380·5° C, which made an abrupt bend at this point, and became parallel to the lower isothermals of water, showing that all the active molecules of steam were condensed. Taking $V-b$ from the modified equation (17), the observed values of H for dry steam were found to agree with the fundamental relation,

$$H-B=(13/3)aP(V-b)+a\theta P, \qquad (19)$$

as required by the equation for the adiabatic (*See* THERMODYNAMICS.) The observations of h for the liquid verified equation (11), which explains the peculiar form of the water saturation line, since it requires that the active molecules of steam in the liquid must be condensed with increase of pressure at the same rate per unit volume as in the vapour

A further verification of the system of equations (11), (17), and (19), was afforded by calculating the values of the saturation pressure from the theoretical equation given by (11) and (17) as above explained. These agreed with the pressures previously observed by Holborn and Baumann (1910) to within 0·3° C on the average over the whole range from 0° to 374° C. But the equation went further and continued to give values of p agreeing with observation up to 380·5° C, where it came to a stop, and refused to give any solution at higher temperatures, thus verifying the limit observed by direct experiment. (*Proc. Roy. Soc.* Sept 1928.)

The theory of the continuity of state, though very fascinating, was most artificial, and was founded on a somewhat inadequate experimental basis It has now served its turn, and may have to give place to an experimental study of the molecular structure of liquids as affording a more natural explanation of the phenomena of change of state (H L C.)

VAR, a department of France, formed in 1790 of a part of Lower Provence, but in 1860 reduced by the transfer of the district of Grasse to the newly formed department of the Alpes Maritimes, which is the reason why the Var does not now flow in the department to which it gives its name. It is bounded north by the department of the Basses Alpes (the Verdon river forming the boundary), east by that of the Alpes Maritimes (the Siagne stream forming the limit), south by the Mediterranean, and west by the department of the Bouches du Rhône. Pop. (1926) 347,932. Area 2,333 sq. miles.

The east of the department is built up of the Estérel and the Massif des Maures, a block of Archaean and Palaeozoic rocks, the two parts named being separated by the Argens river; this massif reaches a height of 2,500 feet The rest of the department is mostly made up of the east-to-west lines of the Alpes de Provence which include the chain of Sainte Beaume (3,786 ft) in the west, but rise to 5,620 ft. at the Signal des Chens in the north-east The valley lines for the most part run east and west between the hills, but the Gapeau river makes its way to the coast southwards between the outliers of Sainte Beaume and the Massif des Maures, and other streams have north-to-south sections cutting through lines of hills. The coast shows evidences everywhere of a recent sinking movement and has numerous islands, notably the Iles d'Hyères, Porquerolles, Île de Riou, etc. The harbour of Toulon is a famous case of a sunken valley. The climate is mild on the coast, St Raphael and Hyères being much frequented winter resorts. The department now forms the bishopric of Fréjus (4th century) which is in the ecclesiastical province of Aix en Provence.

The chief industries are spinning and weaving of silk, manufacture of soap, paper, cork, pottery and tanning. Tobacco is grown and there is much fishing for tunny and anchovy Trade is in wood and coal Cut flowers are largely exported from Hyères The department forms the bishopric of Fréjus (4th century), under Aix en Provence. It is in the académie (educational division) of Aix, where is its court of appeal, and is in the region of the XIII army corp There are two arrondissements (Draguignan and Toulon), 30 cantons and 149 communes. The principal towns are Toulon, La Seyne, Hyères, Draguignan, its political capital, Brignoles and Fréjus.

VARALLO SESIA, a town of Piedmont, Italy, in the province of Novara, from which it is 34 m. N N W. by rail, situated in the valley of the Sesia, 1,480 ft. above sea-level. Pop. (1921) 4,036 (town); 4,386 (commune). The churches of S Gaudenzio, S. Maria delle Grazie and S. Maria di Loreto, all contain works by Gaudenzio Ferrari (1471–1546), who was born in the neighbouring Val Duggia, while the Sacro Monte, a place of pilgrimage rising above the town (1,995 ft.), is approached by a path leading past 45 chapels.

VARAŽDIN, a town of Croatia, Yugoslavia Pop (1921) 13,645 Varaždin is the seat of a district court, and possesses an old castle, a cathedral, several churches, monasteries and schools, and a popular university. There are woollen mills, and trade in timber, wine, pigs, fruit, tobacco, spirits, stoneware and silk. Coal is mined in the Varaždin Mts. The celebrated sulphur baths of Constantins-Bad or Toplitz, known to the Romans as Thermae Constantianae, are about 10 m. S

VARDANES, the name of two Parthian kings.

VARDANES I succeeded Artabanus II, probably his father, in A D 40 (Joseph *Ant* xx 3, 4), but had continually to fight against his rival Gotarzes (*q.v*) The coins show that he was in full possession of the throne from 42 to 45 In 43 he forced Seleucia on the Tigris to submit to the Parthians again after a rebellion of seven years (Tac *Ann* xi 9) Ctesiphon, the residence of the kings on the left bank of the Tigris, opposite to Seleucia, naturally profited by this war, and Vardanes is therefore called founder of Ctesiphon by Ammianus Marc xxiii 6, 23 He also prepared for a war against Rome, with the aim of reconquering Armenia (*cf* Joseph. *Ant* xx 3, 4), but did not dare to face the Roman legions (Tac *Ann* xi 10) In a new war with Gotarzes he gained a great success against the eastern nomads In the summer of 45 he was assassinated while hunting, and Gotarzes became king again

VARDANES II rebelled against his father Vologaeses I in A D 54 (Tac. *Ann* xiii 7) We know nothing more about him and it is not certain whether the coins of a young beardless king, which are generally attributed to him, really belong to him (Wroth, *Catalogue of the Coins of Parthia*, p L ff)

VARENIUS, BERNHARDUS [BERNHARD VAREN] (1622–1650), German geographer, was born at Hitzacker on the Elbe, in the Luneburg district of Hanover Varenius studied medicine at Konigsberg and Leyden universities intending to practise at Amsterdam But the recent discoveries of Tasman, Schouten and other Dutch navigators, and his friendship for Blaeu and other geographers, attracted Varenius to geography He died in 1650

In 1649 he published, through L Elzevir of Amsterdam, his *Descriptio Regni Japoniae* which included a Latin translation of part of Jodocus Schouten's account of Siam (*Appendix de religione Siamensium, ex Descriptione Belgica Iodoci Schoutenii*), and chapters on the religions of various peoples In 1650 appeared, also through Elzevir, his best-known work, *Geographia Generalis,* in which he endeavoured to lay down the general principles of the subject on a wide scientific basis The work is divided into—(1) absolute geography, (2) relative geography and (3) comparative geography The first investigates mathematical facts relating to the earth as a whole, its figure, dimensions, motions, their measurement, etc The second part considers the earth as affected by the sun and stars, climates, seasons, the difference of apparent time at different places, variations in the length of the day, etc The third part treats briefly of the actual divisions of the surface of the earth, their relative positions, globe and map-construction, longitude, navigation, etc

Varenius, with the materials at his command, dealt with the subject in a truly philosophic spirit, and his work long held its position as the best treatise in existence on scientific and comparative geography The work went through many editions Sir Isaac Newton introduced several important improvements into the Cambridge edition of 1672; in 1715 Dr Jurin issued another Cambridge edition with a valuable appendix; in 1733 the whole work was translated into English by Dugdale; and in 1736 Dugdale's second edition was revised by Shaw. In 1716 an Italian edition appeared at Naples; in 1750 a Dutch translation followed; and in 1755 a French version, from Shaw's edition, came out at Paris

See Breusing, "Lebensnachrichten von Bernhard Varenius" (*Geogr. Mittheil*, 1880); H. Blink's paper on Varenius in *Tijdschr. van het Nederl Aandrijksk Genotschap* (1887), ser ii. pt 3; and F Ratzel's article "Bernhard Varenius," in *Allgemeine Deutsche Biographie,* vol. xxxix (Leipzig, 1895).

VARESE, a town and provincial capital of Lombardy, Italy, 18 m by rail W. of Como, and 37 m N.W. of Milan, 1,253 ft. above sea-level Pop (1921) 16,201 (town); 23,864 (commune). It is a favourite summer and autumn resort of the Milanese The church of S Victor has an ancient baptistery (dating from the 9th century but rebuilt in the 13th). The fine campanile of the church is 246 ft. high. There is an archaeological museum with prehistoric antiquities from the lake-dwellings on an island in the Lake of Varese. To the north-west is the pilgrimage church of the Madonna del Monte (2,885 ft.). Varese is the seat of active silk-spinning, tanning and paper-making.

VARIA (mod. Vicovaro), an ancient village of Latium, Italy, in the valley of the Anio, on its right bank, and on the Via Valeria, 8 m. N E. of Tibur (Tivoli) It was probably an independent town and not within the territory of Tibur, and Horace speaks of it as Sabine Some remains of its walls, in rectangular blocks of travertine, still exist, and there is a chapel of S Giacomo with beautiful carvings by Domenico Capodistria (d 1464 here) and Giovanni Dalmata One mile to the east is a picturesque gorge of the Anio, in which may be seen remains of the ancient aqueducts which supplied Rome, consisting partly of rock-cut channels and partly of ruined bridges above it is the monastery of S Cosimato Close to this point begins the valley of the Digentia (mod Licenza) in which Horace's Sabine farm was situated On the hill at the east of the entrance is the village of Cantalupo, which has now assumed the name of Mandela, being identified thus (correctly) with Horace's *"rugosus frigore pagus."*

About 3 m up the valley, close to the road on the west (right) bank of the stream, remains of what is undoubtedly the house which he occupied have been excavated

For a full description *see* G Lugli in *Monumenti dei Lincei* xxxi (1924) 457 *sqq*, and for a short account, G H Hallam, *Horace at Tibur and the Sabine Farm* (Harrow, 1927)

VARIABLES, CEPHEID: *see* STAR *Variable Stars; Cepheid Variables*

VARIABLE TRANSMISSION GEARS: *see* POWER TRANSMISSION; VARIABLE GEARS

VARIATION. All kinds of living organisms vary It is the business of the biologist to find out the range of such variation in wild and domesticated animals and plants, to decide what share of variation is due to hereditary and what to environmental causes, and to see whether heritable variations, which are the raw material of evolution, can be artificially produced in the laboratory. (*See* also SELECTION, EVOLUTION; HEREDITY.) (X)

VARIATION IN NATURE

The variation of animals and plants in nature is, so far as known, subject to the fundamental laws revealed by experiment and pedigree-breedings (*see* HEREDITY). Only by such experiments and culture is it possible to decide authoritatively how a given variation is produced and whether it is heritable or not Nevertheless it is desirable to know—(a) the actual kinds of variation that occur in nature, (b) which of these we may assume to be heritable and (c) the effect which isolation (topographical, habitudinal, etc) and interbreeding may have on the distribution of variant characters in nature. Variation in the habits of animals, the food they eat, their breeding-seasons and all their complex inter-relationships is moreover of cardinal importance in evolutionary studies and can only be effectively observed among animals in nature.

The kinds of structural variation that occur in nature will be best illustrated by means of the following classification which, although it is not exhaustive, will show the circumstances in which such variation typically occurs

1 Variation regularly occurring in the presence of a given environmental condition or factor.

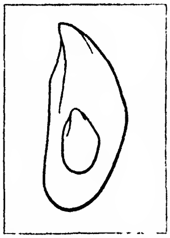
(a) Gross variation in form and size associated with the excess or deficiency of some tissue-forming substance.

The periwinkle, clam and mussel when living in water of reduced salinity (*e.g*, in the Baltic Sea) are found to be smaller than in normal sea-water. Low night-temperature and inferior soil render various hawkweeds (*Hieracium*) living at high altitudes more stunted than those living at lower altitudes.

(b) Special modifications.

The tail-lamellae of the brine shrimp (*Artemia salina*) are reduced in water of high salinity The shape of the common cockle (*Cardium edule*) is more elongate in water of salinity above

that of normal sea-water Terrestrial animals living in damp situations or in humid atmosphere are often darker than representatives of the same species which live in drier conditions This is recorded among slugs (Leydig), birds (Swarth) and mammals (Sumner) The greater part of the variation exemplified by (a) and (b) is in all probability non-heritable. Experiment has however shown that in a few cases variation induced by external causes may be inherited either permanently (Lepidoptera, *Harrison and Garrett*) or temporarily (Amphibia, *Kammerer;* Crustacea, *Agar*). Similarly the colour-differences recorded by Sumner (*see* above) have been shown to be hereditary.



FROM GRIMPE AND WAGLER DIE TIERWELT DER NORD UND OSTSEE (AKADEMISCHE VERLAGSGESELLSCHAFT, LEIPZIG)

FIG 1 —SPECIMEN OF NORTH SEA AND BALTIC MUSSELS THE SMALL FORM BEING CHARACTERISTIC OF THE BALTIC SEA

A series of allied varieties or races which replace each other in succession, either in time or place, will sometimes exhibit progressive modification. Such variation may be simply correlated with a change in geographical position, the causes of structural change being obscure

2. Variation resulting from adaptation to diverse conditions

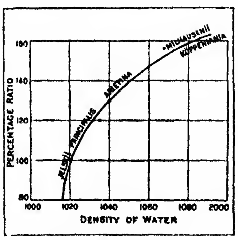
In the arrow head (*Sagittaria*) the same plant may have some leaves adapted for aerial and others for aquatic conditions Protective "mimicry" affords some striking examples of this type of variation among animals (*see* MIMICRY)

3. Variation known to be heritable but not referable to known external causes

Many variations in colour, form and pattern that are known by experiment to be hereditarily stable have been recognized in nature Such variations may be distributed at random through a large natural population, or the latter may be divided into topographically isolated races or colonies, each of which has a more or less distinct appearance These divergences may likewise be associated with other modes of isolation, *e g*, with mutual sterility, difference in breeding-period, etc. Other examples of this kind of variation are to be found in the "colour-phases" of mammals (*e g*, foxes) and birds. Stresemann's important work on the occurrence and heredity of such colour-phases in the latter should be consulted (Bibliography) It is also known in flowers

4. Variation due to accident, interference with growth-processes, etc.

It is not always easy to differentiate between this type of variation and that described in (1) For example the shells of the water snail *Planorbis* seem to assume the uncoiled ("scalariform") form in water of unusually high temperature This may be described as an accidental malformation, but it is actually produced by a particular state of the medium in which these snails live Scalariformity is more obviously "accidental" when produced in the Gastropod *Trochus* by parasitic infection Plant lice sometimes produce green colour in flowers and the attacks of a rust fungus (*Aecidium*) produce shorter and broader leaves in *Euphorbia cyparissias*



FROM THOMPSON, "GROWTH & FORM" (UNIVERSITY OF BUDAPEST)

FIG 2 —VARIATION IN BRINE SHRIMPS (ARTEMIA), SHOWING INCREASE IN RATIO AS WATER BECOMES MORE SALINE

5. Seasonal Variation

This is a familiar phenomenon among vertebrate animals, and is also known among invertebrates (Insects, Cephalopods). The change of coat-colour in the mountain hare from "smoky-brown" in summer to white or "blue" in winter is a notable example. In the rufous horseshoe bat of India (*Rhinolophus rouxii*) the fur after the spring and autumn moults is mouse-brown on the upper surfaces. This changes in course of time into brighter colours, probably owing to oxidation of the pigment.

6 Variation due to sexual dimorphism and growth-changes

Strictly speaking this should not come under the rubric of variation as described here; but it is important to notice that some of the differences in size, colour and shape among animals of the same species may be due to these causes

The data presented above relate only to the structure of animals and plants Although the distinction between structural characters and those of physiological constitution and habits is arbitrary, it is convenient to retain the distinction in a survey of this kind Our knowledge concerning modes of variation other than that of structure is less complete Each species is probably as variable in its physiological constitution as it is in its structure. This has been shown by exact tests, and also may be inferred from such facts as the infection of hosts belonging to different families and genera by individuals of the same species of parasite, the occupation by members of the same species of habitats radically different in physical and bionomic factors, varying susceptibility to disease and so on The variability of habits may be illustrated by Darwin's observations on the behaviour of the great titmouse, certain individuals of which species sometimes behave as birds of prey

A number of highly important considerations are omitted from this discussion The problem of intermediacy, the degree of variability in different species of the same genus, the relation between natural variation and classificatory units, observations on the effect of Natural Selection and on the first appearance, increase or decrease of variant individuals are dealt with in the undermentioned works

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(G C R)

EXPERIMENTAL VARIATION

The Types of Variation.—Not everything differentiating an offspring from its parents can be handed down to later generations (*see* above) Only the alterations occurring in the hereditary determiners, or *genes* (*q v*), can furnish actually new materials for the permanent fabric of a race, and these changes in the genes, called *gene-mutations*, are remarkably rare However, after the mutations have occurred, the changed or mutant genes enter into varying combinations with each other and with the old genes, in successive generations, and so the actual degree of variation becomes increased Individuals having assortments of characteristics different from their parents are thus formed, by *recombination*, in somewhat the same way as, by drawing some cards out of each of two given hands, we might obtain new hands, having one or another new assortment of cards Besides the above two kinds of variation, which involve the genes, there are also many important variations not due to the genes, but to the environment. These variations may be grouped together under the term *modifications*. For detailed consideration we may best treat these three classes of variations in an order the reverse of the above.

Modifications Caused by Environment.—The common question, "Which is more important, heredity or environment?" permits of no answer, except that both are equally and absolutely essential. We are related to our heredity and environment more nearly as an arithmetical product of the two than as a sum, and, with either annulled, the product must be zero. The genes provide the egg, not with the guarantees of developing certain characters, but only with the possibilities of reacting in certain ways so as to produce given adult structures and peculiarities, provided food and other conditions are appropriate Change the environment (it cannot really be abolished completely) and these genes may exercise their possibilities of reacting in very different ways, to produce a different type of development, or disintegration

It is, however, more pertinent to put our question in the form, "Which set of factors are ordinarily responsible for a larger part

of the *variation* which actually occurs, *differences* in heredity or *differences* in environment?" If, now, we take variation in the larger sense, to include differences between all living things, it is obvious that, all in all, differences in environment are an insignificant cause of the existing variation as compared with hereditary differences, and this is usually true even of two individuals chosen from closely related yet different species. On the other hand, within a given population of one species, the variation due to environment is sometimes comparable to, or even much greater than, that dependent on the genes. Which sort of variation predominates, and to what extent will depend on many circumstances, and to answer our question will therefore require separate study, and often elaborate experimentation and measurement, in the case of each population considered and even in the case of different characteristics in the same population. The unravelling of any intimate combination of hereditary and environmental effects will usually demand either that we hold the effective features of the environment constant (often an impossible operation), or else that we secure a set of individuals identical in their genes (as a result of inbreeding, twinning or asexual reproduction); under such circumstances the residual variation, due to the influence that was not held constant, may then be ascertained.

It is especially desirable to discover not only the extent of variation due to environmental differences, but the principles governing the production of this variation This quest, however, leads to a study of all the intricacies of embryonic development, physiology and mechanistic biology in general. Although the details of the chemistry and physics comprised in these phenomena are for the most part scarcely guessed, we at least know, from our observations on the grosser visible occurrences, that the processes whereby most adult organs and characteristics are formed are highly involved, interdependent in a complicated way and composed of many successive reactions. Make one change, and effect follows effect until the final result bears no resemblance to the initial one. So, for example, a quantitative change in some primary process may appear in the adult as a qualitative change, and vice versa It should also be observed that there are often regulatory mechanisms which automatically compensate for effects produced, as in regeneration of a lost limb or in the accelerated growth of a child following temporary stunting.

Genetics has adduced cogent evidence that, despite the strong influence of the environment in modifying the body as a whole, and even the protoplasm of its cells, the genes within the germ-cells of that body retain their original structure without specific alterations caused by the modification of the body, so that when the modified-individual reproduces it transmits to its offspring genes unaffected by its own "acquired characters." The offspring, then, will not tend to repeat the parental modifications, unless the same peculiar environment is itself repeated Our sins and our successes are not reborn in our children, though the latter may inherit our original tendency and capacity for these Modifications, therefore, unlike mutations, cannot be a cause of biological evolution or degeneration Now, if modifications acquired before the conception of children are not visited upon the latter, it certainly holds true that any modifications acquired by the mother after the embryos are partly developed, but prior to their birth, would not be transmitted to them Mothers may rest assured that there is no more ground either *a priori* or in observation, for supposing that a fright received during pregnancy (or before) will give their child a fearsome disposition than that it will give him spots.

Variation Due to Segregation and Recombination of Genes.—Whenever an individual breeds, having received a different hereditary contribution from its two parents, its offspring will tend to vary from one another. Thus, if we had received a gene for brown eyes from our mother, and one for blue eyes from our father, then, although we ourselves would have brownish eyes (brown being said to be "dominant" and blue "recessive"), nevertheless we would transmit our gene for brown only to half of our reproductive cells, and the gene for blue, unalloyed by brown, to the remainder. This process of separation is called segregation (*see* HEREDITY). If our parents had given us different genes for hair-form also, we would produce reproductive cells having all the possible assortments of the two pairs of genes, namely, some having "brown curly," others "blue straight," still others "brown straight" and the rest "blue curly." This phenomenon is recombination. Since such variation can be produced in our children only in respect to genes which already differed from one another in our parents, it is evident that the primary cause of this variation lies in the events whereby these genes came to differ in the first place, that is, in the gene-mutations such as originally changed a gene for brown eyes into the gene for blue These mutations, that make possible the recombinations of to-day, may have happened in the remote past

The explanation of segregation and recombination is to be found in the behaviour of the chromosomes, those tiny separate filamentous bodies, visible under the microscope, which contain the invisible genes "linked" together within them, like beads in so many separate chains. Several or many chromosomes, each probably containing hundreds of different genes of distinctive natures and effects, are contained in each of the two uniting reproductive cells derived from the two parents. While the majority of the genes from one parent are always like those from the other, since the parents are in general similar organisms, yet in the case of most matings there are some gene-differences, and these give an opportunity for the operation of the segregation and recombination processes above mentioned, after the individual formed by the union of the two cells in question develops and reproduces reproductive cells for a still later generation

It will be seen that the more gene-differences exist the more different combinations can then be formed The numerical relations resulting from recombination are calculable according to definite laws, provided the effects of the genes concerned, and their positions in the chromosomes, have been determined by prior experimentation The character-effects of untried combinations cannot, however, be predicted with certainty, as unexpected developmental results, including even new traits, are occasionally produced by recombination. As some new combinations may be more advantageous for the race than the original combinations, the function of recombination, of segregation, and in fact of sexual reproduction itself, becomes explained in terms of their value in evolution.

The development of most characters depends on the combined action of numerous genes. A difference in any one of these genes may affect either the quality, or the degree of development of the character in question. Now, when a number of mutations, in different genes all concerned with the same character (*e g.*, stature), have some time previously occurred in a population, random crossing and recombination will result in the transmission, to different offspring, of many different assortments of the mutated and non-mutated genes Thus the population may tend to exhibit many different grades of expression of the character. These grades will often differ only by small steps, which become blurred into an apparently continuous gradient through the effect of environic modifications Such quantitative variation, as well as all other variation of recombinational origin, is of course especially evident when individuals are bred which resulted from the crossing of widely different stocks, in which many differing gene-mutations had become established since these stocks diverged from their common ancestor.

Many abnormal types of recombination occasionally occur, owing to such disturbances of chromosome-behaviour as the loss or reduplication of a chromosome or section of a chromosome, or the reduplication of one or more entire sets of chromosomes. When such an occurrence alters the proportions existing between the different kinds of genes (by changing the numbers of some and not of others) there generally results a combination of various (usually detrimental) abnormalities at once. At other times, a chromosome may become broken in two, or two chromosomes unite to form one, or a piece broken off one chromosome and united to another. The genes thereby become rearranged, but the characteristics of the individual probably remain little affected, since they depend rather on the kind and numbers of

different genes present than on their arrangement. X-rays, cold and other influences are known to induce such disturbances of chromosome-behaviour.

Mutations in the Genes.—It has been found in fruit-flies (*Drosophila*) that any given gene, existing in a fly at the present day, has probably remained constant in its composition for several thousand years. This stability is not passive, for, as every organism grows and reproduces through a process of repeated cell-growth and cell-division, each gene must repeatedly reproduce itself, and in so doing it must each time construct a daughter-gene that possesses exactly its own peculiar structure Occasionally, however, something goes wrong, and either the mother-gene becomes altered in its composition or else the daughter-gene is not formed exactly in the image of the old gene. As a result of this mutation there arises a new type of gene, having a different effect upon the organism, and this mutant gene is then capable of reduplicating its own new type—a process which it usually performs with as constant accuracy as that which the old gene had exhibited. It is this peculiarity of the gene—its retention of the power of self-reduplication despite the occurrence of alternations (mutations) in its composition—which makes *heritable* variations possible, and hence organic evolution

There is evidence that, when one gene in a cell mutates, the thousands of others, even including the similar or identical gene derived from the other parent, remain unaffected and constant The mutation, then, may be regarded as an "accident" of submicroscopic dimensions, dependent on the occurrence of certain "chance" configurations of atoms, electrons and energy-quanta within or near to the gene in question It is not strange, in view of this, that it has not yet been proved possible, by particular external conditions, to dictate the occurrence of specified types of gene-mutations in preference to others.

Though the kind of mutation which shall occur has not been brought under control, experiments with a number of different organisms have shown that heavy treatment with X-rays will make the mutational accidents in general occur far more frequently than otherwise, so that gene-mutations of varied kinds may be produced at a rate in some cases over a hundred times higher than that at which they previously were found to occur. This raises the conjecture, as yet untested, that possibly the γ-rays (related to X-rays) which originate in minerals of the earth's crust have played an essential rôle in the causation of the varied "natural" mutations through which evolution has come about However, there is evidence that temperature, genetic composition, and perhaps other factors, also affect the general frequency of gene-mutations No particular stage in the life-cycle is known to be especially favourable for the occurrence of gene-mutations; certainly they may happen either in embryos or in adults, and in somatic as well as in germinal tissue, though of course only mutations in germ-cells can be inherited.

Though most gene-mutations seem, in the sense above explained, to be accidents, some genes appear to be less stable than others, and a few are definitely known to be exceedingly mutable ("ever-sporting"). In the latter cases, which may represent changes of a different sort from most gene-mutations, the stability of the mutable gene may be much affected by specific conditions. These effective conditions differ in different cases. Some are determined by the nature of the tissue and developmental stage in question, others by the external environment, and still others by the genetic composition.

A given gene has the capability of mutating in various ways, so as to form a number of different kinds of genes ("multiple allelomorphs"). Usually the effects of these differing changes in a given gene resemble each other strongly, and often, though not always, the discernible differences between them lie chiefly in the *degree* of change produced. There are also numerous cases on record of mutations that seem quite identical in kind with other mutations which occurred independently in homologous genes of other individuals belonging to the same or a related species. Not infrequently, too, different kinds of genes (non-homologous) will, on mutating, produce similar or indistinguishable final effects on the characteristics of the organism. In this connection it is found that certain character-changes can be produced by mutations in a greater number of different genes, and hence tend to occur more commonly, than others.

The most frequently produced effect, so far as known, is the lethal effect; that is, mutant genes are usually so deleterious in their action that they tend to kill the organism. When they are not positively lethal they are usually retrograde in direction, and hinder rather than help the organism to fulfil the functions of its existence. Such results are to be expected of accidental changes occurring in any complicated organization A race, therefore, will tend gradually to undergo degeneration in any respect in which selection (natural or artificial) does not persistently weed out the degenerative mutations that continue to occur It can be only the rare mutations that are helpful which furnish material for evolution These latter, however, when they show, will tend to multiply

As a matter of fact, most gene-mutations never show. For most (though not all) mutant genes are recessive to the type from which they arose, and in their cases an obviously mutant individual cannot appear unless—usually many generations subsequently to the original gene-mutation—two reproductive cells, each bearing the identical mutant gene, meet in fertilization.

Both conspicuous and inconspicuous, minor and major, fundamental and superficial, character-changes are produced by gene-mutation, and either one character or several at once may be altered by a single gene-change. The more far-reaching the change, the more apt it is to be deleterious rather than advantageous Hence geneticists are returning to a view essentially similar to Charles Darwin's (though now much more highly elaborated), namely, that the origin of one species from another usually involves the accumulation of numerous selected small steps of heritable variation

See ANIMAL BREEDING; BREEDS AND BREEDING, CHROMOSOME; CYTOLOGY; GENE, HEREDITY; PLANT BREEDING

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VARIATIONAL PSYCHOLOGY: *see* DIFFERENTIAL PSYCHOLOGY.

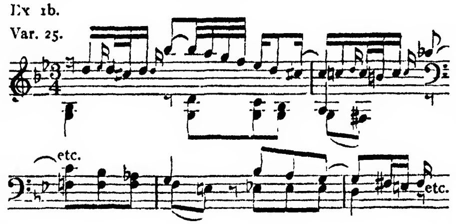
VARIATIONS, in music, the term given to groups of progressively developed versions of a complete self-contained theme, retaining the form of that theme though not necessarily its melody This is the classical sense of the term, but there are modern developments of the variation form to which this definition is at once too broad and too precise to apply The aesthetic principle of variations appeared at very early stages of music. During the 16th century an artistically mature variation-form automatically rose in the polyphonic treatment of Gregorian hymns verse by verse Accordingly, the hymns and Magnificats of Palestrina might be described as contrapuntal sets of variations on ecclesiastical tunes, like rich and free examples on the simple plan shown later by Haydn's variations on his Austrian national anthem in the "Emperor" quartet (op. 76, No 3). Already in the 16th century instrumental music was climbing up the trellis of a primitive variation-form A favourite plan (*see* the *Fitzwilliam Virginal Book, passim*) was to put together several popular or original tunes, with an ornamental variation sandwiched between. Sometimes sets of variations on a single tune were produced, with excellent effect, as in Byrd's variations on "The Carman's Whistle" Such variations were naturally grouped in order of increasing brilliance, and they often include passages that would catch the greatest pianoforte players.

In the 17th century a highly artistic form of variation solved with great simplicity the problem of expanding instrumental pieces to a length admitting of growth to a big climax This was the ground-bass, a single phrase placed in the bass and repeating itself *ad infinitum*. It originated in the dance forms of the *passacaglia*

and the *chaconne*. Both were in slow triple time, the chaconne having a strong accent on the second beat, while the passacaglia, by some chance, developed the liberty to transfer its theme to other parts than the bass. The genius of Purcell was cruelly hampered by the non-existence of large musical forms in his time, and he seized upon the ground-bass with avidity. By the time of Bach and Handel lighter sets of variations, consisting essentially of embroidery on a melody, had come into vogue. Bach's *Aria variata alla maniera Italiana* tells us where this fashion began; and in France the *air et doubles* was taken over from early English virginal music. Doubles are variations each of which divides the rhythm into quicker notes than the one before. The most familiar example is that known as "The Harmonious Blacksmith" in Handel's E major suite. Sometimes the air itself was stated in a tangle of ornamentation, while the doubles simplified the melody and varied the accompaniment. But Bach had meanwhile applied the principle of the ground-bass to variations on a complete symmetrical movement in binary form. His Air and 30 Variations, commonly known as the "Goldberg" variations, is (with the exception of Beethoven's 33 *Veränderungen* on a waltz by Diabelli) the most gigantic set of variations in the world. A melodically interesting ground-bass could not be maintained on so large a scale; but the 32 bars of Bach's theme are so many clear harmonic steps which can be represented by many analogous progressions, without loss of identity. (Ex. 1a) There is no question of retaining or varying the melody of the aria, which is a tissue of ornaments that will bear neither development nor simplification.

Ex. 1a Harmonic theme. (BACH "*Goldberg*" *Variations*)

Ex. 1b.
Var. 25.



The rise of the sonata style again brought the melodic embroidery variation into prominence, for in sonata forms we identify themes entirely by their melodies. Now, with not more than three or four exceptions, the best sets of variations by Mozart and Haydn are movements in their sonata works; and their independent sets are either early or perfunctory exercises and encore-pieces. Two common mistakes of professional and amateur criticism are, first, the judging of Haydn's and Mozart's variations by these parerga, and secondly, the much graver error of despising the embroidery variation on principle. It is either vulgar or sublime. And it is handled lovingly by precisely the greatest masters of deep harmonic and rhythmic variation, Beethoven and Brahms. Haydn is fond of a special form first known in Philipp Emanuel Bach. It consists of alternating variations on two themes, alternately major and minor; the first a rich and complete binary melody, and the other a shorter binary melody, often beginning with the same figure as the first. The first theme usually returns as if it were going to be unvaried, but its first repeat is an ornamental variation. The form is rarely worked out far enough to include more than one variation of the second theme; and sometimes (as in the famous "Gypsy" trio) there are new episodes instead of variations of the second theme, so that the form becomes a sectional rondo. The only strict example of Haydn's type of alternating variations in later music is the first allegretto of Beethoven's pianoforte trio in E flat (op. 70, No. 2), but a magnificent application of it, without change of mode, though with a wide range of key, is shown in the slow movement of his C minor symphony.

Beethoven, in his last works, invented another variation-form on two themes, of which the second is in a different key and time. The examples of this are the slow movement of the 9th symphony and the Lydian figured chorale in the A minor quartet. In the slow movement of Brahms's F major string quintet (op. 88), the alternation of the two keys gives rise, in the last line of the movement, to one of the most astonishing dramatic strokes in all music. Beethoven uses embroidery variations as means of obtaining extraordinary repose in slow movements. The extreme case of this is the slow movement of the sonata op. 57 (commonly called "Appassionata"), which is described in the article on SONATA FORMS. In this, and in many other instances, his method is that of the *air et doubles,* which grows to a natural climax which can subside into the rhythm of the plain theme. Until his latest works, such sets of variations are never finished. Their dramatic intent is that of a repose which is too unearthly to last; and at the first sign of dramatic motion or change of key the sublime vision "fades into the light of common day," a light which Beethoven is far too great an idealist to despise. *See* the andante of the B flat trio (op. 97); and the slow movement of the violin concerto, which contains two episodic themes in the same key. In his later works Beethoven found means, by striking out into foreign keys, of organizing a coda which finally spins down in fragmentary new variations, or even returns to the plain theme. Thus he was able to end his sonatas, opp. 109 and 111, with solemn slow movements.

Beethoven also found other applications of the variation forms. Thus the finale of the Eroica symphony has not only the theme but many other ideas in common with the brilliant set of variations and fugue for pianoforte on a theme from *Prometheus* (op. 35); and the fantasia for pianoforte, chorus and orchestra, and the choral finale of the 9th symphony, are sets of melodic variations with freely-developed connecting links and episodes. In the case of the 9th symphony, a second thematic idea eventually combines with the figures of the first theme in double fugue.

But Beethoven's highest art in variation-form is independent of the sonata. From his earliest display of pianoforte playing, the wonderful 24 variations on a theme by Righini, to his supreme variation-work, the 33 on Diabelli's waltz, he uses and transcends every older means of variation and adds his own discoveries. Before Beethoven the basis of variations might be a ground bass, a melody or a harmonic scheme. Beethoven discovered that rhythm and form can, with a suitable theme, be a solid basis for variations. The aria of Bach's Goldberg variations is in its phrasing as uniform as a chess-board; and if its harmonies had not a one-to-one correspondence with each variation the form would be lost. But there are themes, such as Haydn's Chorale St. Antoni, which Brahms varied, where the phrasing is interesting in itself. A similar example is the following theme by Paganini which inspired Brahms to compose two complete sets on it.

The climax in the history of variations dates from the moment when Beethoven was just about to begin his 9th symphony, and received from A. Diabelli a waltz which that publisher was sending round to all the musicians in Austria, so that each might contribute a variation to be published for the benefit of the sufferers in the late Napoleonic wars. Diabelli's theme was absurdly prosaic, but it happened to be, perhaps, the sturdiest piece of musical anatomy that Beethoven (or any composer since) ever saw; and it moved Beethoven to defer his work on the 9th symphony! The shape of Diabelli's waltz may be illustrated by a diagram which represents its first 16 bars; the upright strokes (not the spaces) being the bars, and the brackets and dots (together with the names underneath) indicating the rhythmic groups. The sec-

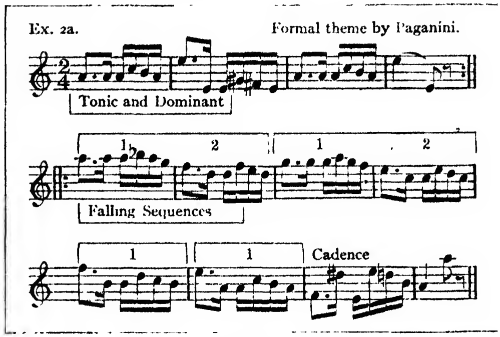
ond part also consists of 16 bars, moving harmonically back from the dominant to the tonic, and rhythmically the same as the first part. This plan is astonishingly elastic The alternation of tonic and dominant in the first eight bars may be represented by another familiar form in which three bars of tonic and a fourth of dominant are answered by three bars of dominant and a fourth of tonic, as in variation 14 (which must be reckoned in half-bars). Again, when the theme answers the tonic by the dominant it raises the first melodic figure by one step, and this may be translated by the answer on the supertonic harmony In the course of 50 minutes a few of these 33 variations become vague as to more than the beginnings and cadences of the theme; and there are three simple variations on which one would like to ask Beethoven whether he had not inadvertently omitted a bar; but the momentum of the theme is never lost, and after a group of three slow and rather free variations this momentum breaks into an entirely free fugue (variation 32) on a salient feature of what must by courtesy be called Diabelli's melody A free fugue is a favourite solution of the problem of the coda in a set of variations. The momentum produced by the revolution of true variations in the orbit of the theme gives the key to the whole problem A fugue solves it by flying off at a tangent Very sublime is the way in which Beethoven, after letting his fugue run its torrential course, returns to the orbit of his theme in an ethereal little minuet with a short coda of its own which, 16 bars before the end, shows signs of beginning to revolve again

Again, let us regard the period of the theme not as an orbit but as diurnal rotation We can then describe the codas of Brahms's Paganini-variations as produced by accelerating the spin till it breaks away for a while and then resumes for a few final catastrophic whirls; exactly like a dying top (though this, of course, does not accelerate its spin). Without acceleration Beethoven ended his wonderful C minor variations (most perfect of passacaglias) in this way. Brahms found in Haydn's Chorale St Antoni the opportunity for another method He took the first five bars as a ground-bass, within which narrow orbit the finale moves until its climax broadens out into the rest of the glorious theme, and so rounds off the whole work.

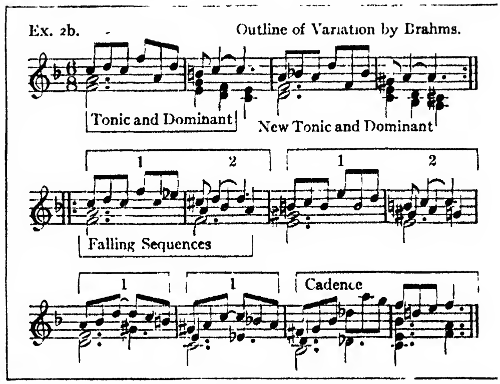
Bach poised the contrasts and climaxes of the Goldberg variations so accurately that the ending of the whole by a simple *da capo* of the theme is astonishingly effective It is as if a charming old ancestress of a living line of great folk were to step from the frame of her Holbein portrait and bow to her assembled posterity

To speak of the progress in variation-form since Beethoven is like speaking of the progress in reinforced concrete since the Parthenon. The classical variation-form is limited only by the composer's imagination and technique; and the removal of its foundations does not enlarge it at all There is no reason to condemn other kinds of variation; and many great and beautiful works in non-classical variation-form exist, from Schumann's *Études Symphoniques* to Elgar's "Enigma" variations and Dohnany's Variations on a Nursery Song. But no "free" variation that breaks down the phrasing of its theme and follows its own discursive ways will ever achieve anything externally so unlike the theme as a strict harmonic and rhythmic variation on classical lines. (*See* Ex. 2b) Nor will a series of such variations acquire anything like the classical momentum. On the contrary, in clumsy hands the free variation becomes apologetic in the way in which it offers raw chunks of the original melody as evidence that it has not forgotten its duty, like Lewis Carroll's poetic *Tema con Variazioni*, the preface to which is an unconscious epitome of modern misunderstandings of the form.

Variation writers may be scientifically classified into those who know their theme and those who do not. There is no reasonable doubt that many very clever composers, from Mendelssohn on-



Ex. 2a. Formal theme by Paganini.



Ex. 2b. Outline of Variation by Brahms.

wards, have completely misunderstood the nature of the deepe classical variations, and have thought that anything so unlike the original tune must be quite independent of it. Mendelssohn's *Variations sérieuses* have a beautiful theme with a structure tha might have given rise to splendid features, but Mendelssohn simply ignores this structure and replaces it by weaker things in almost every variation. Schumann shows more insight He ha no great grip of his theme, but he tries to distinguish by titles those variations which are true from those which are episodic; thus in the *Études Symphoniques* the etudes are numbered separately from the variations, the andante of the F major quartet i called *quasi variozioni;* and the strictest set he ever wrote (on a theme by Clara Wieck) is called Impromptus

Brahms stands alone in his grip of his theme Reger is no neare the classical form in his variations than in his other works The present state of the form seems to indicate that if the compose does not aim at strict variations his most vital results will be on the line of melodic development, as in the above-mentioned works of Elgar and Dohnányi, the Symphonic Variations o Dvořák, and those variations of Reger which are closest to thi type. (D. F. T.)

VARIATIONS, CALCULUS OF: *see* CALCULUS OF VARIATIONS.

VARICOSE VEINS, a condition of the veins which mostly occurs in those parts of the blood-stream which are farthest from the heart, occupy a dependent position and are relatively unsupported by surrounding tissues. Thus they are found, superficially in the legs and thighs; in the lowest part of the bowel (piles; *see* HAEMORRHOIDS), and in the spermatic cord (varicocele). Any condition which hinders the return of blood from the veins is ap to cause their permanent dilatation; thus is explained the occurrence of varicose veins in the leg from the wearing of a tigh garter, and of piles as the result of the pressure of an ovaria

tumour or of a pregnant uterus, or of disease of the liver.

Sometimes the trouble is begun by a direct injury to the vein, which, by setting up inflammation, weakens the coats of the vein, which then yield under the pressure of the blood-stream. In the case of varicocele, the dilatation of the veins is probably of developmental origin, many other causes are given, but not one of them appears satisfactory Examination of a varicose vein shows that it is increased in length as well as in capacity, and that the valves are atrophied and functionless In some parts of its course the vein has its coats much thickened, but at those places where there is most dilatation the walls are very thin Veins thus affected give rise to pains and achings, and they are, moreover, liable to attacks of inflammation which end in clotting of the blood (*thrombosis*, *q v*). This is a dangerous condition, as a sudden or violent movement is apt to cause the detachment of a piece of the clot, which, carried up to the brain or the lung, may cause sudden death Less serious results of varicose veins are swelling of the parts below (*oedema*), ulceration and abscess.

As regards treatment, the wearing of a well-fitting elastic stocking will prove beneficial in the case of a moderate dilatation of the veins of the leg; the individual must avoid long standing and fatigue. It is well also to have the foot of the bed raised three or four inches, so that during the night the veins may be kept as empty as possible If the case is more serious, the thinned veins threatening to give way, it will be advisable, provided the dilatations are fairly well localized, and the general condition of the patient permits, to excise the diseased parts, tying the cut ends of the veins, and closing the surface wounds with fine sutures. Should a varicose vein be plugged with clot, it will be advisable to tie it high up where the coats are healthy, and to remove the lower part by dissection. This will render the person safe from the very serious risk of a piece of the clot being carried to the heart, and will also permanently rid him of his trouble It may be said generally that any operative treatment for varicose veins in the lower extremity is best associated with the application of a ligature upon the large surface vein just before it enters the common femoral vein below the fold of the groin This operation removes the risk of the downward pressure of blood in the veins whose dilatation has rendered the valves useless Recently, a method of internal coagulation by means of injections (*e.g*, salicylic acid) into the vein has been adopted with success

In the case of a varicose vein being opened by accident or disease, it is quite possible for the individual to bleed to death. The first-aid treatment for the serious haemorrhage should consist in laying the patient on the floor, raising the limb upon the seat of a chair, and fixing a pad over the open vessel by a handkerchief or bandage.

Varicose veins of the spermatic cord (*varicocele*) of the left side are met with in adolescents. The dilatation is, in all probability, of developmental origin, making its appearance at puberty. It is, as a rule of no serious moment, and, unless present in an extreme degree, had best be treated merely by a suspension bandage. If, however, it is causing real physical distress, it may be treated by excision of an inch or two of the bunch of dilated veins. The presence of varicocele is apt to cause inconvenience or even discomfort to men living in India or the tropics, but the Englishman who intends spending his life in temperate climes will do well to ignore a varicocele. It will become less and less noticeable as time goes on. (E. O.)

VARIETY THEATRE: *see* MUSIC HALL.

VARIOLITE, in petrology a basaltic or doleritic rock with prominent spherulitic (variolitic) texture, the spherulites or varioles consisting usually of radial aggregates of feldspar. These varioles, especially on weathered surfaces, appear as pale coloured spots, giving the rock a pock-marked appearance The name is from Lat. *variola*, smallpox, in allusion to this characteristic feature The variolitic texture of the basic rocks is closely akin to the spherulitic texture of the acid lavas, as seen in rhyolites, etc.

Variolites frequently form the tachylytic selvages of dolerite dykes (*see* TACHYLYTE), and also appear in the form of pillow lavas (*see* SPILITE). The varioles are usually rounded in outline and are often about ½ in. in diameter, but may much exceed this size. With few exceptions they are built up of divergent fibres of feldspar embedded in dark brown glass. As variolites are frequently much decomposed, the glassy matrix is represented by secondary alteration products or has been devitrified. (C. E. T.)

VARLEY, JOHN (1778–1842), English water-colour painter, was born at Hackney, London, on Aug. 17, 1778. His father discouraged his leanings towards art, and placed him under a silversmith. But after his father's death the lad found work with an architectural draughtsman, who employed him to sketch the principal buildings in the towns they visited. His spare hours were employed in sketching from nature, and in the evenings he was permitted, like Turner and Girtin, to study in the house of Dr. Munro. In 1798 he exhibited his first work, a "View of Peterborough Cathedral," in the Royal Academy. In 1804 he became a foundation member of the Royal Society of Painters in Water-Colours, and contributed over forty works to its first exhibition. He died in London on Nov. 17, 1842.

VARNA, a fortress, seaport, departmental capital and episcopal city of Bulgaria; on the bay of Varna, an inlet of the Black sea, in 40° 12′ N. and 27° 56′ E. Pop (1926) 60,787. Varna is built on the hilly north shore of the bay, overlooking the estuary of the river Devna It is the eastern terminus of the railway to Rustchuk and Sofia. The "Varna quadrilateral," so important in Bulgarian military history, consists of the fortresses of Varna, Shumla, Rustchuk and Silistra (*q.v.*) Varna ranks with Burgas as one of the two principal seaports of Bulgaria Its deep and capacious bay is sheltered from northerly and north-easterly winds, and the harbour works are modern. The principal exports are cattle and dairy produce, grain, lamb and goat skins, and cloth (*shayak*); the imports include coal, iron and machinery, textiles, petroleum and chemicals In 1921 the port was entered by 906 vessels of 684,931 tons, comprising 55% of Bulgaria's Black Sea trade It is the headquarters of the Bulgarian Steamship Co, which trades with Turkey, Greece and Russia Its trade has been affected by the cession of the Dobruja to Rumania, but it is a growing sea-side resort.

Varna was the ancient Milesian colony of *Odessos*, founded 585 B.C Close by was fought in 1444 the battle in which Murad II. slew Wladislaus III. of Poland and Hungary, and routed his forces under Hunyadi János. Varna was occupied in 1828 by the Russians, in 1854 by the allies, who here organized the invasion of the Crimea, and in 1877 by the Egyptian troops summoned to the defence of Turkey against the Russians. By the treaty of Berlin (1878) it was ceded to Bulgaria. It has long been the seat of a Greek metropolitan and since 1870 of a Bulgarian bishop.

VARNHAGEN VON ENSE, KARL AUGUST (1785–1858), German biographer, was born at Düsseldorf on Feb. 21, 1785. He studied at Berlin, Halle and Tübingen. He began his literary career in 1804 as joint-editor with Adelbert von Chamisso (*q v.*) of a *Musenalmanach.* In 1809 he joined the Austrian army, and was wounded at the battle of Wagram. Soon afterwards he accompanied his superior officer, Prince Bentheim, to Paris, where he carried on his studies. In 1812 he entered the Prussian civil service at Berlin, but in the following year resumed his military career, this time as a captain in the Russian army. He accompanied Tettenborn, as adjutant to Hamburg and Paris, and his experiences were recorded in his *Geschichte der Hamburger Ereignisse* (London, 1813), and his *Geschichte der Kriegszüge des Generals von Tettenborn* (1815). At Paris he entered the diplomatic service of Prussia, and in 1814 acted under Hardenberg at the congress of Vienna. He also accompanied Hardenberg to Paris in 1815. He was resident minister for some time at Karlsruhe, but was recalled in 1819, after which, with the title of "Geheimer Legationsrat," he lived chiefly at Berlin. He had no fixed official appointment, but was often employed in important political business. In 1814 he married Rahel Levin (1771–1833) sister of the poet, Ludwig Robert (1778–1832). By birth she was a Jewess; but before her marriage she made profession of Christianity. She was a woman of remarkable intellectual

qualities, and exercised a powerful influence on many men of high ability. After her death her husband published a selection from her papers, and afterwards much of her correspondence was printed. Varnhagen von Ense died suddenly in Berlin on Oct 10, 1858.

He made some reputation as an imaginative and critical writer, but he is famous chiefly as a biographer. He possessed a remarkable power of grouping facts so as to bring out their essential significance, and his style is distinguished for its strength, grace and purity Among his principal works are *Goethe in den Zeugnissen der Mitlebenden* (1824); *Biographische Denkmale* (5 vols., 1824–30; 3rd ed., 1872); and biographies of General von Seydlitz (1834), Sophia Charlotte, queen of Prussia (1837), Field-Marshal Schwerin (1841), Field-Marshal Keith (1844), and General Bulow von Dennewitz (1853) His *Denkwürdigkeiten und vermischte Schriften* appeared in 9 vols. in 1843–59, the two last volumes appearing after his death His niece, Ludmilla Assing, between 1860 and 1867, edited several volumes of his correspondence with eminent men, and his *Tagebucher* (14 vols, 1861–70). *Blätter aus der preussischen Geschichte* appeared in 5 vols. (1868–69); his correspondence with Rahel in 6 vols (1874–75); and with Carlyle (1892) His selected writings appeared in 19 vols. in 1871–76. There is also an extensive literature dealing with Rahel Varnhagen von Ense; *see* especially her husband's *Rahel, ein Buch des Andenkens* (3 vols., 1834), *Aus Rahels Herzensleben* (1877); E Schmidt-Weissenfels, *Rahel und ihre Zeit* (1857); *Briefwechsel zwischen Karoline von Humboldt, Rahel und Varnhagen von Ense* (1896); O. Berdrow, *Rahel Varnhagen* (1900).

VARNISH. A homogeneous liquid, which when thinly applied, dries, on exposure to air, to a hard film giving decorative effect and protective action to the surface to which it is applied.

The use of varnish dates back to great antiquity; the ancient Egyptians were acquainted with the softer resins, such as sandarac, mastic, etc, which they melted up in oil to form a varnish which was applied warm with the finger or a knife On the mummy cases in the British Museum the varnish still retains its lustre and its surface is uncracked and undamaged But it is not until the middle of the 18th century that any description can be traced of linseed oil varnish thinned with oil of turpentine, and incorporating litharge as a drier.

Varnishes may be classified broadly into two varieties, (1) oil varnishes and (2) spirit varnishes (including cellulose varnishes) Oil varnishes are composed of hard gum resins, a drying oil—usually linseed oil—and a volatile solvent such as turpentine; on application the volatile solvent first evaporates leaving a soft oil-resin film which subsequently dries by absorption of oxygen from the air. Spirit varnishes are solutions of soft resins dissolved in a volatile solvent and on evaporation leave hard dry resinous films.

Manufacture of Oil Varnish.—The chief components of an oil varnish are hard fossil gums, oils and a volatile thinner—usually turpentine The gums are the fossilized exudations of ancient trees; in the course of centuries the original soft gums and resins have become hard, brittle and lustrous They are found in many different parts of the world as follows.—kauri gum from New Zealand, animi from Zanzibar, Angola and Congo, copals from West Africa and Pontianac and Manila gums from the Dutch Indies

The first process in the manufacture of an oil varnish is the selection and grading of the gums according to colour, hardness, etc, only the palest gums being used for the highest grade varnishes. These gums are put through a crusher so as to reduce them to a uniform size. The crushed gums are placed in a copper or aluminium varnish pot, provided with a hood or cover which is connected to a flue to take away the fumes given off during the "running" or melting process. The cover has a hole in the centre to allow the introduction of a copper or aluminium stirrer. The charge of gum—which varies from 50 lb. to 120 lb.—is put into the pot which is then placed over a hot coke or gas fire and gradually heated up to a temperature of about 300° C. When the gums are all melted and in a thin liquid condition, linseed oil—previously heated up to 300° C—is gradually added and the mixture thoroughly stirred; the heating is continued until complete amalgamation has taken place; this is indicated when a portion on being taken out and put on a piece of glass appears bright and transparent. The driers which consist of lead and manganese salts are next introduced and the mixture boiled until they are thoroughly incorporated. The pot is then removed from the fire to the thinning shop and when it has cooled down sufficiently, turpentine or white spirit is gradually added, the mixture being continually stirred so as to reduce the mass to a suitable consistency The varnish is then strained to remove any dirt and pumped into storage tanks where it is left to mature.

A large number of varieties of oil varnishes are made, each having its own special use The most important varieties are, coach-builders' varnishes, including finishing and hard drying body varnish, elastic carriage varnish and flatting or rubbing varnish, decorators' varnishes, such as copal oak varnish for inside and outside work, church oak varnish and French oil varnish A special type of varnish known as japan goldsize is made for gilders' use and as a binder for coach colours; it dries in two hours or less Other types of varnish made for specialized uses include, egg-shell flat varnish which dries with a mat surface, stoving or baking varnishes for tin printing work, and insulating varnishes for electrical purposes Oil varnishes are sometimes classified as long and short oil varnishes based upon the relative amounts of gum and oil used; that is on the number of gallons of oil per 100 lb of gum The general formulae for oil varnishes may be summarized as follows.—

	Gum	Oil	Thinner
	Lb.	Gals	Gals
Best finishing body varnish	50	14	15
Elastic carriage varnish	50	12	13
Hard carriage varnish	50	10	12
Flatting or rubbing varnish	50	5	10
Front door varnish	50	13	15
Best elastic oak varnish	50	11	12
Hard copal oak varnish	50	9	13
Japan goldsize	50	4	12

Spirit Varnishes.—These are simple solutions of soft recent resins—such as shellac, sandarac, dammar, mastic, etc, in a volatile solvent or mixtures of solvents such as methylated spirit, turpentine or acetone. When a spirit varnish is applied the volatile solvent rapidly evaporates leaving a thin coating of resin covering the object The manufacture of a spirit varnish is a comparatively simple matter, the process consists in placing the resin and solvent in a barrel or churn which is rotated at a slow speed for a period of about 12 to 48 hours until the resin is completely dissolved. The varnish is then strained to remove any dirt or other insoluble matter, into suitable containers where it is left to stand for a few days, and it is then ready for use The most important spirit varnish is French polish (*q v.*). White polish which is used for polishing very light woods such as satinwood is made by dissolving bleached shellac in methylated spirit—usually 2 lb of shellac to 1 gallon of methylated spirit White and brown hard spirit varnish which is largely used as a quick-drying varnish for woodwork, basket work, chairs and other articles of furniture is made by dissolving 4 to 5 lb of soluble manila gum in one gallon of methylated spirit. By the addition of various aniline dyestuffs to these varnishes, a large range of coloured varnish stains may be obtained which are used on woodwork to imitate mahogany, oak, walnut, etc

The chief spirit varnish in which turpentine is the volatile solvent is crystal paper varnish, made by dissolving 7 to 8 lb. of white dammar gum in one gallon of turpentine. This varnish is water-white in colour and is used for varnishing wallpapers and delicate interior work Other spirit varnishes include mastic varnish used for varnishing oil paintings and sandarac used as bookbinders and negative varnish.

Cellulose Varnish.—This consists of a base, usually cellulose nitrate, dissolved in suitable solvents. A large number of solvents may be used for dissolving cellulose nitrate, but those most commonly employed are acetone, amyl acetate, butyl alcohol and ethyl lactate. As these cellulose nitrate solvents are very expensive it is usual to substitute as far as possible cheaper diluents such as benzol, alcohol and light petroleum ether; these diluents while not in themselves solvents for nitro-cellulose nevertheless when mixed with the other solvents yield a good solution When cellulose varnish is applied to a surface the solvents evaporate leaving

the cellulose nitrate behind as a thin film These nitro-cellulose films are very brittle and do not adhere well to the surface and it is therefore necessary to add to the varnish a proportion of softening agent, or "plasticizer" in order to prevent shrinking and to toughen them, an addition of certain gums such as kauri, resin, ester gum, dammar, etc., is also made to promote adhesion of the film

The process of manufacture of cellulose varnish or lacquer is comparatively simple and consists in adding the cellulose-nitrate to the mixed solvents and stirring until complete solution has taken place, the gums and plasticizers being incorporated during the mixing process. The finished varnish is then strained off into suitable airtight containers and is ready for use.

Cellulose varnishes are perfectly clear and transparent, dry quickly leaving tough, hard films, which wear well and are remarkably resistant to alcohol, petrol and the effects of heat. They are largely used as wood finishes on tables, pianos and furniture generally; they have the advantage over French polish in that they can be more quickly applied and the resultant finish is not damaged when in contact with hot articles such as tea-pots, hot plates, etc These varnishes may be coloured with aniline dyestuffs giving coloured lacquers which are used for the colouring and protection of metal and other surfaces.

By the addition of strong staining pigments to the transparent cellulose varnishes the so-called opaque cellulose enamels are obtained which are largely used in the painting of motor-cars, etc. The pigments are ground in the varnish to a very fine state of division, but the amount which can be safely used without injuring the film is very limited The finish obtained from these cellulose enamels has neither the full gloss nor the opacity given by oil enamels, and if a high gloss finish is required it is necessary to use a final oil or wax polishing process The rapid rate of drying, hardness of finish and speedy rate of application by the spray process has resulted in their being extensively used

Natural Varnishes.—A reference should be made in conclusion to the natural varnishes which are the liquid saps of the varnish tree (Tsi-chou) indigenous to China and Japan These natural varnishes are obtained by tapping the trees and are thick, milky emulsions which have the peculiar property of drying only in a moist atmosphere The coatings given by them are exceedingly hard and durable and are unaffected by water They are largely used by the Chinese and Japanese for executing the beautiful lacquer work for which they are famous (*See* also BLACK VARNISH, and WOOD FINISHES, PAINTS, VARNISHES)

See J G. Bearn, *The Chemistry of Paints, Pigments and Varnishes*, bibl. (1925); Max Bottler and A. H Sabin, *German and American Varnish Making* (1912); Ch Coffignier, *Varnishes, Their Chemistry and Manufacture* (1923), J. G. McIntosh, *The Manufacture of Varnishes* (1922). (J. G. Bl)

VARNISHES, CHEMISTRY OF. The drying oil most commonly used is linseed oil, obtained from the seeds of *linum usitatissimum* containing 35–40% of oil, cultivated in temperate zones, especially in Russia, Hungary, France, the United States, Canada and North India This oil consists of mixed glycerides (*q v.*) of linolenic, linolic, and oleic acids, with small quantities of palmitic and stearic. The glycerides are derived from open-chain acids containing 18 carbon atoms which absorb oxygen in proportion to their unsaturation to give a gel (linoxyn) consisting of the oxidised glyceride in a colloidal form Another drying oil now in demand is China-wood oil (*tung* oil) extracted from the fruit of *Aleurites fordii* or *Acordate* (China and Japan) containing the glyceride of another 18 carbon-atom open-chain acid (elaeostearic acid) isomeric with linolic or linolenic acids. The annual production of this oil is 100,000 tons, compared with 700,000 tons of linseed oil

In the drying of linseed or tung oil, oxygen is at first slowly absorbed with a considerable induction period, and subsequently more rapidly, and then progressively diminishing as the process approaches completion. At the ordinary temperature 20–30 days are required for linseed oil with an induction period of 1–3 days. At 100° C, 67 hours are required, with an induction period of less than ½ hour The linseed oil acids behave similarly, but the oxidised films are of inferior durability. If small percentages (0·1–0·3%) of lead, manganese or cobalt as linoleates or resinates be present, the period of oxidation is much reduced A peroxide is formed in both absence and presence of the catalyst, and this undergoes change to a polymerised modification in which the glyceryl group remains intact but molecular rearrangement with loss of the peroxide and condensation have occurred The metals and peroxides function as oxygen carriers, and comparison with similar systems would indicate polymerisation of a monoxide type of glyceride or condensation according to the following scheme:

$$\mathrm{X{\cdot}CH{\cdot}CH{\cdot}Y} + \mathrm{O_2} \rightarrow \underset{\mathrm{O-O}}{\mathrm{X{\cdot}CH{\cdot}CH{\cdot}Y}} \begin{array}{l} \nearrow \ \underset{\mathrm{O}}{\mathrm{X{\cdot}CH{\cdot}CH{\cdot}Y}} \text{ (polymerised)} \\ \searrow \ \mathrm{X{\cdot}CHOH{\cdot}CO{\cdot}Y} \text{ (condensed)} \end{array}$$

Treatment of Drying Oils.—The treatment of drying oils for use in paints and varnishes comprises. (1) preliminary refining of the crude oil to remove mucilage and part of the colouring matter, and (2) a further treatment which may either thicken the oil, or partially oxidise it or incorporate in it metallic driers (lead, cobalt or manganese) so that when applied as a film the oil will oxidise and harden rapidly. The refining may be effected by neutralisation of the oil with sufficient alkali in the form of carbonate or caustic, whereby the soap formed carries down with it the mucilage (foots) and a fair amount of the chlorophyll colouring matter, but the use of sulphuric acid to the amount of 2% is cheaper, whereby the mucilage is coagulated in small flakes, and the oil purified by washing with water.

The thickening of drying oils may be brought about by heat (260° C) out of contact with the air, whereby association or polymerisation of the unsaturated components of the glycerides ensues Such heat-thickened oils are known as "litho" or "stand" oils If tung oil be heated similarly, thickening is very rapid, and unless controlled a spongy insoluble gel is produced with great evolution of heat and charring Stand oils are still unsaturated and dry to elastic and durable gels in the presence of metallic driers, yielding a more durable film than linseed oil Sometimes air is passed into the drying oil containing small quantities of cobalt or manganese drier between 60° and 120° C, whereby partial oxidation takes place together with thickening, but these "blown" oils are inferior to stand oils in the durability of their films.

Boiled linseed oil is frequently preferred to raw linseed oil It is obtained by heating the oil to about 90° C, adding driers in the form of lead, cobalt or manganese linoleates or resinates (0·1% Pb or 0·03% Mn or Co), and raising the temperature to 120° C. Agitation with air is continued for 2–3 hours, and the oil allowed to cool It should dry in the form of paint in 10–14 hours Extra-pale, pale boiled, and double boiled are varieties according to colour and viscosity.

Paint and Varnish Thinners.—The thinners used comprise (1) turpentine from varieties of pinus (*P. palustris*, U S.; *P. maritima*, France, *P sylvestris*, Russia). The extraction is by tapping the trees for oleo-resin (gum turpentine) or by steam distillation of the wood in the form of chips (wood turpentine). From the oleo-resin, containing 70% rosin (colophony) and 20% turpentine, the spirit is obtained by steam distillation. All forms of turpentine contain one or more terpene hydrocarbons. American and French turpentine contain pinenes, $C_{10}H_{16}$ (b p. 155–175° C), and thicken and partially oxidize on exposure, but turpentine is not to be considered as a siccative. It is the most reliable solvent or thinner for paints and varnishes. White spirit (b.p. up to 210° C) and kerosene are used to thin paints and varnishes either alone or blended with turpentine. It must be pointed out that the resins or resins and oils will give fluids with petroleum, but addition of excess of the thinner will precipitate the resin-oil as a gel. Benzene and coal-tar naphtha are sometimes used as thinners. The flash point (closed test) of a thinner must not fall below 73° F, so that it may avoid classification among the highly inflammable liquids of the Petroleum Acts (1871–81). The thinners for oil varnishes and paints play no part in the chemical changes during drying, but they may modify the

physical properties of the linoxyn film.

Constituents of Varnishes.—The simplest form of varnish are the spirit varnishes which are a solution of a resin in a volatile solvént; as a class they are generally brittle. Oil varnishes are free from this defect, since the drying oils which they contain bind and soften the resin. The resins employed include copals (Kauri, Manila, Congo), rosin (colophony), and, more recently, synthetic resins (*q v.*). For black varnishes, the solid components are asphaltum, or other forms of pitch (petroleum and stearin), together with carbon black Under the German term *Firniss* is included a drying oil with metallic driers without a resin, and the film is merely an elastic gel of oxidised linseed oil (linoxyn). Litho varnishes are essentially of the same character In the manufacture of a resin oil varnish, the copal resins must be heated to 290°–300° C with a loss of 10–25% in weight before they can be taken up by drying oils. The temperature to which the resins must be heated before they become soluble in oil is higher in the case of the hard fossil resins The drying oils used in oil varnishes are linseed oil with or without tung oil. The resin oil mixture is thinned down with turpentine or white spirit Driers in the form of lead and manganese compounds (*cf.* drying oils) are incorporated in the oil before or after the addition of the thinners. The mixture is left to clarify and to mature. The proportions of resin, oil and thinners vary with the requirements; for coach-work the proportions are 1 2, and for hard coatings 1·1 4 A varnish for exterior work is generally richer in oil than an inside varnish. Recently, soluble forms of cellulose nitrate and acetate in appropriate solvents have been largely used with pigments and plasticisers in the form of enamels for protective coatings of good elasticity and durability The most durable form of varnish known is Japan lacquer, obtained from *rhus vernicifera* (Tsi-chou, varnish tree) It gives a black film on stoving in a moist atmosphere with the formation of an oxidation product of urushiol, the reduction product of which has been synthesised by Japanese chemists (*See* also OILS, FATS AND WAXES)

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VARRO, MARCUS TERENTIUS (116–27 B C), Roman antiquarian and man of letters, was born at Reate He studied at Rome under L. Aelius Stilo, the first Roman grammarian, and at Athens under Antiochus of Ascalon In politics he espoused the side of Pompey. He disapproved, apparently, of the first triumvirate (that of Pompey, Caesar and Crassus, 60 B C), which he ridiculed in a book called *The Three-headed* (Τρικάρανος *cf.* Appian *Civil War*, ii 9. καί τις αὐτῶν τήνδε τὴν συμφροσύνην συγγραφεὺς, Οὐάρρων ἐνὶ βιβλίῳ περιλαβὼν ἐπέγραψε Τρικάρανον). Under Pompey he saw considerable military service and was engaged in several operations during the Civil War. Before the battle of Pharsalia he went to Epirus, and along with Cicero and Cato, he awaited at Dyrrachium the issue of the conflict. His personal relations with Caesar were friendly, and when, after the defeat of Pompey, Caesar secured the restoration of some of Varro's property, which had been seized by Mark Antony, Varro showed his gratitude by dedicating to him the second part of his *Antiquitates.* He also assisted Caesar in collecting Greek and Latin literature for the great public library which he contemplated. On the formation of the second triumvirate (that of Octavianus, Antony and Lepidus 43 B.C.), Varro was proscribed, but through the good offices of Q Fufius Calenus he was able to come to terms with the triumvirs and the remaining years of his long life were spent in study and writing.

Volume of Writings.—Varro was not only the most learned of Romans, but also the most voluminous of Roman writers (*homo* πολυγραφώτατος Cic., *Ad.Att.*, xiii.18). Aulius Gellius, iii., 10 17 quotes Varro as saying that "he had now entered on the 12th hebdomad of years (*i.e.*, was between 78 and 84), and up to that day had written 70 hebdomads (*i.e.*, 490) of books, of which some considerable number had not appeared, his libraries having been plundered when he was proscribed." Jerome's catalogue of his works is preserved in a mutilated form in Rufinus, pref to translation of the homilies of Origen. From this and other evidence Ritschl puts the number of his separate literary works at 74 and the number of "books"—counting, for example, the 150 *Menippean Satires* as 150 "books"—at about 620.

Conspectus of Writings.—His work, which survives only in fragments, with the exception of the *De Lingua Latina,* of which six books are extant, and the *Rerum Rusticarum libri tres* which is extant almost entirely, may be considered under various heads.

1 *Saturae Menippeae* in 150 books These were medleys in prose and verse in the style of Menippus, a Cynic philosopher of the first half of the 3rd century B C. (Aul Gell, ii. 18 6) The titles, often Greek, of the individual Satires are of the most varied kind—sometimes personal names of gods or men, sometimes proverbs, Greek or Latin, *e g*, *Nescis quid vesper serus vehat* (You know not what evening may bring forth), Δὶς παῖδες οἱ γέροντες (Old men are in their second childhood), Γνῶθι σεαυτόν (Know thyself). And the range of subject is no less wide and varied—eating and drinking (*Est modus matulae,* περὶ μέθης, περὶ ἐδεσμάτων, ὑδροκύων), literature (*Parmeno*), philosophy (περίπλους, περὶ αἱρέσεων, *armorum iudicium*), politics (the Τρικάρανος mentioned above), praise of the good old times (*Sexagesis,* Γεροντο-διδάσκαλος, Bimarcus)—in a word, Varro might have said with Juvenal (i. 85). *quidquid agunt homines, votum timor ira voluptas gaudia discursus nostri farrago libelli est* So far as can be judged from the fragments the Menippean Satires had no great merit either of style or content, but the frequency with which they are quoted in later writers suggests that they were the most generally popular of Varro's writings.

2 *Logistoricon libri LXXVI*, treatises on philosophical, historical and other subjects, generally with a double title, *e g.*, *Catus aut de liberis educandis* (Aul Gell, iv 19, *cf* xx 11), *Orestes vel de insania* (Aul Gell., xiii 4); *Pius aut de pace* (Aul. Gell., xvii 18); *Sisenna vel de historia* (Aul Gell, xvi 9).

3 *Imagines* in 15 books This consisted of 700 biographies of famous Greeks and Romans, each biography being accompanied by a portrait of the subject and an explanatory metrical *elogium.* Thus was probably the first Latin illustrated book, but Cratenas, the medical attendant of Mithridates VI (120–63 B C) had shown the way by an illustrated book (Ῥιζοτομικόν) on plants. The number of biographies, 700, is explained by Varro's curious affection for the number 7 (*hebdomas*) *cf.* Aul Gell, iii. 10 1 "M Varro in the first of the books entitled *Hebdomades* or *De Imaginibus* says that the virtues and powers of the number 7, which the Greeks call ἑβδομάς are many and various". *cf* iii 11 3, *M. Varro in primo de Imaginibus, uter* (Homer or Hesiod) *prior sit natus, parum constare dicit*, ibid 6 M Varro in the first book, *de Imaginibus*, placed beside the portrait of Homer this epigram. *Capella Homeri candida haec tumulum indicat Quod hac Ietae mortuo faciunt sacra* (This shining she-goat indicates the tomb of Homer, because it is with a she-goat that the Ietae sacrifice to the dead)

4 On literature and the history of literature he wrote a series of treatises, *e g*, *De poematis, De compositione saturarum, De Poetis* (Aul Gell, i 24.3; xvii. 21, 43 and 45). *De originibus scaenicis, De comoediis Plautinis* (Aul. Gell, iii 3 9 seq), *Quaestionum Plautinarum libri V* In this connection it is to be noted that Varro established the canon of the genuine plays of Plautus, the 21 so-called *Fabulae Varronianae, i.e*, the 21 plays now extant (the *Vidularia* only partially).

5 *Antiquitatum rerum humanarum et divinarum libri XLI* Of this work the first 25 books dealt with *res humanae,* the second part in 16 books, dedicated to Caesar, dealt with the gods For the first part, *cf.* Aul Gell., i 16, i 25, iii 2, v 4, xi 1, xiii 12, xiii 13, xiii.17, xvii 3; for the second part *cf.* Aul Gell, i 18, iii.16, x 15, xv 30, xviii.12. Other works in this sphere written by Varro were *De gente populi Romani libri IV, De vita populi Romani, De familiis Troianis, Tribuum liber, Rerum urbanarum libri III, Aetia* (so called after the Αἴτια of Callimachus).

6. Historical works. *De Pompeio libri III*, *Annalium libri III*, *De sua vita, Legationum libri III.*

7. Encyclopaedic works. *Disciplinarum libri IX* (*cf* Aul Gell.,

i.20, x.1, xviii 15), dealing with the liberal arts, grammar, rhetoric, music, medicine, etc., *De forma philosophiae libri III.*

8. Legal work. *De iure civili libri XV.*

9. Geographical works: *De ora maritima, De aestuariis, Ephemeris navalis.*

10. Grammatical works: *De lingua Latina libri XXV.*, of which books 2–4 were dedicated to P Septimius, the rest to Cicero; *cf.* Aul. Gell., ii 25, vi.11, x 21, xvi 8. Bks. 5–10 are extant in a somewhat mutilated condition. The work was divided into three parts, the first dealing with the etymology of Latin words, the second with inflexion, the third with syntax Other works in this sphere by Varro were *De sermone Latino ad Marcellum libri V.* (*cf* Aul. Gell., xii 6, xii 10, xvi 12, xviii 12); *De similitudine verborum; De utilitate sermonis; περὶ χαρακτήρων; De antiquitate litterarum; De origine linguae Latinae.*

11 *Epistolicae Quaestiones* (Aul. Gell., vi 10, xiv.7, xiv.8) dealing with a variety of subjects

12. *Rerum rusticarum libri III.*, written when Varro was in his 80th year. (*Cf.* the opening words, "If I had leisure, Fundania, I would have written for you more conveniently what I will now set forth as best I can, considering that I must make haste, since, as the saying goes, if man is a bubble, still more so is an old man. My 80th year warns me that I must collect my baggage before I depart from life ") This work (for which *cf.* Aul Gell, ii. 20) is extant practically entire.

Estimate of Contemporaries.—It is a very remarkable fact that Livy nowhere in his extant work alludes to Varro, or gives any evidence of acquaintance with his writings But the reputation which he enjoyed, both in his own day and in later times, is abundantly testified: Cic., *Acad post.*, i.3. "You have revealed to us the age of our fatherland, its chronology, the laws of its religion and priesthoods, the plan of our home and foreign administration, the position of our territories and districts, the titles and descriptions of all things Divine and human, with the duties and principles attaching to them, and you have shed a vast amount of light on our poets and on Latin literature in general and on the Latin vocabulary, while you have yourself composed picturesque and choice poems in almost every metre, and in many passages have touched upon philosophy, so far as to arouse interest, but not sufficiently for full treatment "

Bibliography.—*De lingua Latina*, edit. C D Muller, L. Spengel re-edited by his son (1885), *Res Rusticae*, edit Keil (Leipzig, 1884). On Varro's language and style, Norden, *Rheinisches Museum*, xlviii. (1893); F. Germann, *Die Sogenannten Sententiae Varronis* (1900); M. Schantz, *Gesch. der rom Litteratur*, vol I pt II. (3rd ed, Munich, 1909); J. W Duff, *Literary Hist. of Rome* (1909); R. J. B Walker, *Les Catalogues varroniens* (1927). (A. W. Ma)

VARTHEMA (Barthema, Vertomannus, etc), **LUDOVICO DI,** of Bologna (*fl* 1502–1510), Italian traveller and writer, left Europe near the end of 1502; early in 1503 he reached Alexandria and ascended the Nile to Cairo From Egypt he sailed to Beirut and thence travelled to Tripoli, Aleppo and Damascus, where he managed to get himself enrolled, under the name of Yunas (Jonah), in the Mameluke garrison—doubtless after adopting Islam From Damascus he made the pilgrimage to Mecca and Medina as one of the Mameluke escort of the Hajj caravan (April–June 1503); he describes the sacred cities of Islam and the chief pilgrim sites and ceremonies with remarkable accuracy, almost all his details being confirmed by later writers With the view of reaching India, he embarked at Jidda and sailed down the Red sea and through the Straits of Bab-el-Mandeb to Aden, where he was arrested and imprisoned as a Christian spy. He gained his liberty—after imprisonment both at Aden and Radaa —through the partiality of one of the sultanas of Yemen, made an extensive tour in south-west Arabia (visiting Sana, etc), and took ship at Aden for the Persian Gulf and India. On the way he touched at Zaila and Berbera in Somaliland; he then (early in 1504?) ran across to the Indian port of Diu in Gujarat, afterwards famous as a Portuguese fortress. From Diu he sailed up the Gulf of Cambay to Gogo, and thence turning back towards the Persian Gulf made Julfar (just within the entrance of the gulf), Muscat and Ormuz. From Ormuz he seems to have journeyed across Persia to Herat, returning thence south-west to Shiraz, where he entered into partnership with a Persian merchant, who accompanied him during nearly all his travels in South Asia.

After an unsuccessful attempt to reach Samarkand, the two returned to Shiraz, came down to Ormuz, and took ship for India. From the mouth of the Indus Varthema coasted down the whole west coast of India, touching at Cambay and Chaul; at Goa, whence he made an excursion inland to Bijapur; at Cannanore, from which he again struck into the interior to visit Vijayanagar on the Tungabudra; and Calicut (1505?), where he stopped to describe the society, customs and institutions of Malabar, as well as the topography and trade of the city. Passing on by the "backwater of Cochin," and calling at Kulam (Quilon), he rounded Cape Comorin, and passed over to Ceylon (1506?) Though his stay here was brief (at Colombo?), he learnt a good deal about the island, from which he sailed to Pulicat, slightly north of Madras, then subject to Vijayanagar Thence he crossed over to Tenasserim in the Malay peninsula, to Banghella, perhaps near Chittagong, at the head of the Bay of Bengal, and to Pegu, in the company of his Persian friend and of two Chinese Christians (Nestorians?) whom he met at Banghella. After some successful trading with the king of Pegu, Varthema and his party sailed on to Malacca, crossed over to Pider (Pedir) in Sumatra, and thence proceeded to Bandan (Banda).

From the Moluccas he returned westward, touched at Borneo, and there chartered a vessel for Java, the "largest of islands," as his Christian companions reckoned it He notes the use of compass and chart by the native captain on the transit from Borneo to Java, and preserves a curious, more than half-mythical, reference to supposed Far Southern lands. From Java he crossed over to Malacca, where he and his Persian ally parted from the Chinese Christians; from Malacca he returned to the Coromandel coast

Varthema was now anxious to resume Christianity and return to Europe; after some time he succeeded in deserting to the Portuguese garrison at Cannanore (early in 1506?). He fought for the Portuguese in various engagements, and was knighted by the viceroy Francisco d'Almeida, the navigator Tristan da Cunha being his "sponsor." For a year and a half he acted as Portuguese factor at Cochin, and in 1507 (?) he finally left India for Europe by the Cape route. Sailing from Cannanore, Varthema apparently struck Africa about Malindi, and (probably) coasting by Mombasa and Kilwa arrived at Mozambique, where he notices the Portuguese fortress then building, and describes the negroes of the mainland He finally arrived safely in Lisbon.

Varthema's work (*Itinerario de Ludouico de Varthema Bolognese* . .) was first published in Italian at Rome in 1510 (*ad instãtia de Lodouico de Henricis da Corneto Vicẽtino*) Other Italian editions appeared at Rome, 1517, at Venice, 1518, 1535, 1563, etc The first English translation was of 1576–77 (in Richard Eden's *History of Travayle*); an extract from Varthema was inserted in Samuel Purchas's *Pilgrimage* (1625–26), and in 1863 appeared the Hakluyt Society edition by J W Jones and G. P. Badger (*Travels of Ludovico di Varthema*). (C. R B)

VARUNA, in Vedic Hindu mythology the associate of Mitra, whose individuality faded while Varuna's gained ground by a process still obscure. In contrast to Indra, the war-god, who was supreme, Varuna has no myths related of him But in post-Vedic myth Varuna sinks to the position of a departmental god—of the waters—being replaced by Prajāpati as the supreme.

VASA or **NIKOLAISTAD,** a seaport of Finland in 63° 6′ N, 21° 36′ E., on the east coast of the Gulf of Bothnia. Pop (1925) 24,347 It is the chief town of a department of the same name. Vessels enter from the sea at Rönnskär, 26 m. distant, and the channel is safe for vessels drawing 22 feet. The exports are timber, tar, etc., and the imports coal and salt, and there is a ship-repairing yard The town was founded in 1606, and after its destruction by fire in 1852 was rebuilt nearer the shore.

VASARI, GIORGIO (1511–1571), Italian painter and architect, whose main distinction, however, rests on his valuable history of Italian art, was born at Arezzo on July 30, 1511. At a very early age he became a pupil of Guglielmo da Marcilla, a very skilful painter of stained glass. At the age of thirteen he went to Florence, where he studied under Michelangelo, Andrea

del Sarto and Baccio Bandinelli aided by the patronage of the Medici princes. In 1531 he visited Rome in the suite of Cardinal Ippolito de Medici and studied the works of Raphael and others of his school. The paintings of Vasari were much admired. Vasari's principal works are at Florence, Rome, Naples, Arezzo, Bologna, Bosco (near Alexandria), Lucca, Monte Sansovino, Pisa, Perugia, Pistoja. Many of his pictures still exist, the most important being the wall and ceiling paintings in the great hall of the Palazzo Vecchio in Florence, and his frescoes on the cupola of the cathedral He died at Florence on June 27, 1574, and was buried in the chapel of S. Giorgio in the Pieve of Arezzo

Personally Vasari was a man of upright character, always ready to appreciate the works of others: in spite of the very different taste of his time, he expresses a warm admiration of the works of Giotto, which is very remarkable. As an art historian of his country he must always occupy the highest rank. His great work *Delle Vite de' più eccellenti pittori, scultori, ed architettori,* was first published in 1550, and afterwards partly rewritten and enlarged in 1568 It was dedicated to Cosimo de' Medici, and was printed at Florence by the Giunti; it is a small quarto illustrated with many woodcut portraits This *editio princeps* of the complete work is usually bound in three volumes, and also contains a very valuable treatise on the technical methods employed in all branches of the arts, entitled *Le Tre Arti del disegno, cioè architettura, pittura, e scoltura.* His biographies are written in a very pleasant style, interspersed with amusing stories. With a few exceptions Vasari's judgment is acute and unbiased. The work in any case remains a classic, however it may be supplemented by the more critical research of modern days.

Vasari gives his own biography at the end of his *Vite,* and adds further details about himself and his family in his lives of Lazzaro Vasari and Francesco Salviati The first edition of his *Vite* was issued by the Torrentino Press (1550). The best edition is that published at Florence by Milanesi (1878–1882), which embodies the valuable notes in the earlier edition by Le Monnier (1846). The *Lives* has been translated into French, German and English.

See Sir D Colnaghi, *Dict of Florentine Artists* (1928), on his literary works *see* W Kallab, *Vasaristudien* (Vienna, 1908); and J Schlosser, *Die Kunstliteratur* (Vienna, 1924), which also contains an account of his life.

VASCO DA GAMA: *see* GAMA, VASCO DA.

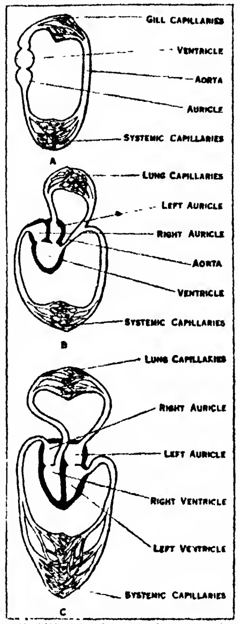
VASCULAR SYSTEM. The unicellular organism receives all the supplies necessary for its growth and maintenance directly from its environment, either by diffusion of substances held in solution, or by direct intake of foodstuffs, which undergo chemical disintegration in vacuoles containing liquid into which the necessary enzymes are secreted In the multicellular organism, such direct intake of foodstuffs by diffusion by every individual cell is impossible, for only the outer layer of cells is in contact with the environment, and this layer is usually protected by some form of membrane which is impermeable to water and food substances.

The vascular system has been developed to convey nutrient materials, etc. to the various parts of the organism, and the blood serves as intermediary between the environment and the organs of the body. This function can be fulfilled only if the blood is in continuous circulation, carrying nutrient materials and oxygen to the tissues, and conveying the waste products of metabolism from the tissues to the places where they are excreted. The heart is the organ which provides the necessary energy for this circulation, and the blood vessels are the channels which convey the blood to and from the tissues.

In the case of most invertebrate animals, the blood or analogous fluid is not all enclosed in blood vessels, and the various tissues lie freely in the fluid; which is kept in constant motion. In the higher animals, however, the blood is entirely enclosed in a system of tubes, and the nutrient substances, etc., are brought into contact with the cells only after their diffusion through the thin walls of the finest blood vessels. By the force of the cardiac contraction, the blood is driven through the tissues by way of thick-walled tubes, the arteries, and back to the heart by a system of thinner-walled vessels, the veins. In the tissues, the blood passes through a fine meshwork of capillaries, the walls of which consist of a single layer of delicate cells, which allow a free interchange of material to take place between the blood within and the tissue fluids outside the vessel.

THE HEART

In fishes (fig 1, A) the heart consists of one auricle and one ventricle The blood is received from the great veins into the auricle. By the contraction of the auricle the blood is forced into the ventricle and this, when it contracts, sends the blood on to the bulbus arteriosus The blood passes through the branchial arteries into the gills, where it takes up oxygen, and then flows on into the aorta, by which it is distributed to the organs of the body. From the capillaries of these organs the blood is collected by the veins and is carried once more back to the auricle The fish heart is thus entirely on the venous side of the vascular system.



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 1—DIAGRAM OF CIRCULATORY SYSTEM IN A, FISH, B AMPHIBIAN (FROG), C MAMMAL, ILLUSTRATING DEVELOPMENT OF VASCULAR SYSTEM AND SEPARATION OF SYSTEMIC CIRCULATION FROM PULMONARY CIRCULATION

In amphibia, such as the frog, the heart consists of two auricles and one ventricle (fig 1, B) The right auricle receives venous blood from the body and forces it by its contraction into the ventricle From the ventricle the blood passes into the aorta, whence it is carried partly by the pulmonary artery to the lungs, partly by other arteries to the different organs of the body The blood, which has passed through the lungs and been arterialised, flows through the pulmonary veins to the left auricle, whence it passes into the ventricle and mixes with the venous blood which is arriving from the right auricle. The pulmonary circulation is thus merely a branch of the general or systemic circulation. The bulbus aortae in the frog is divided into two parts by means of a spiral valve, by which a partial separation of the blood coming from the right and left auricles is effected, and the venous blood from the right auricle is directed especially into the pulmonary artery.

Course of the Circulation in Mammals.—In mammals and birds, the heart has become entirely divided into two halves, right and left, which have no direct communication with one another (fig. 1, C). The right auricle receives the venous blood from all parts of the body From the right auricle, the blood passes to the right ventricle, and from here it is forced into the lungs along the pulmonary artery. In the lungs it takes up oxygen and becomes arterial, and is returned by the pulmonary veins to the left auricle and to the ventricle The left ventricle forces the blood into the aorta, whence by the branching arteries it is carried to all parts of the body.

There are thus two circulations—the one *pulmonary,* from the right side of the heart to the pulmonary artery and the capillaries of the lungs and to the left heart by the pulmonary veins; the other *systemic,* from the left side of the heart, by the aorta, to the arteries and capillaries of the body tissues and organs, from which by the veins to the right side of the heart. A schematic representation of the circulatory system is given in fig. 2 The muscular walls of the right ventricle are much thinner than those of the left ventricle. This is so because the energy required of the left ventricle must exceed that of the right ventricle, as resistance in the systemic circuit exceeds that in the pulmonary circuit

The heart becomes filled with venous blood during its relaxation or *diastole,* and forces the blood into the arteries during its contraction or *systole.* The large arteries are of less capacity than the corresponding veins, and their walls are essentially extensile and elastic. The small arteries and *arterioles* are essentially muscular tubes and can vary considerably in diameter. The arterioles open into the capillaries, and these are so numerous

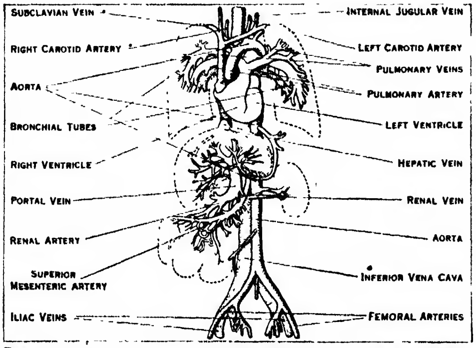


FIG. 2.—GENERAL COURSE OF CIRCULATION AND SOME OF THE PRINCIPAL VESSELS

that each organ may be regarded as a sponge full of blood The skeletal muscles and the muscular walls of the viscera at each contraction express the blood within them and materially influence the circulation. The whole muscular system must therefore be regarded as an accessory pump to the vascular system The veins are of larger calibre than the corresponding arteries, and have tough and inextensile walls The veins are not, as a rule, distended with blood to their full potential capacity. The latter is so great that the whole blood of the body can collect within the veins.

The heart and lungs are placed within the thoracic cavity, the floor of which is formed by the muscular diaphragm; the heart is itself enclosed in a tough inextensile bag, *the pericardium,* the function of which is to check over-dilatation of the heart Below the heart, the pericardium is fixed to the central tendinous part of the diaphragm; above, it is suspended by the mediastinum On account of this fixed position of the pericardium, the heart is prevented from oscillating.

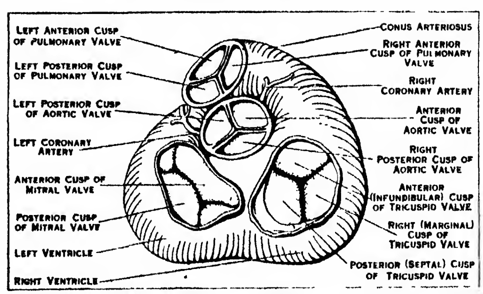
The Valves of the Heart.—As regards the valves of the heart (fig. 3), the tricuspid guards the right auriculo-ventricular opening, and consists of three flaps of fibrous tissue covered, like all the internal surfaces of the heart, with the smooth shining membrane, *the endocardium.* The flaps are continuous at their base, forming an annular membrane surrounding the opening. The bicuspid or mitral valve consists of two cusps, and guards the left auriculo-ventricular opening The under surface and free edge of each cusp of these valves are attached by chordae tendinae to two papillary muscles, these are pillars of muscle which rise up from the inner surface of the ventricles.

The papillary muscles and chordae tendinae pull down the diaphragm formed by the closed valves (the floor of the auricles), thus expanding the auricles and enabling the valvular as well as the muscular parts of the wall of the ventricles to approach together and force out the blood. The ventricles are never completely emptied, for some blood remains in contact with the auriculo-ventricular valves up to the end of systole and ensures their closure. The aortic and pulmonary valves consist of three semilunar, pocket-shaped cusps. A fibrous nodule is placed centrally in the free edge of each cusp, whence numerous tendinous fibres radiate to the attached borders of the cusp. Opposite the cusps are bulgings of the aortic walls—the sinuses of Valsalva. From the anterior one arises the right coronary artery, and from the left posterior the left coronary artery; these vessels supply the substance of the heart with blood.

Foetal Circulation.—The foetus has no independent respiration or digestion and therefore depends entirely on the oxygen and nutritive substances which diffuse through the placenta from the mother's blood. The arterial blood flowing from the placenta along the umbilical vein is partly conveyed to the vena cava ascendens by means of the ductus venosus and partly flows through two trunks which unite with the portal vein returning the blood from the intestine into the liver, thence to be carried back to the vena cava by the hepatic veins. The arterial blood flowing from the placenta becomes mixed in the vena cava with the venous blood which has returned from the trunk and the lower extremities. In the right auricle it would also become freely mixed with the venous blood returning from the head and upper extremities were it not for a special arrangement which impedes but does not entirely prevent this mixture.

On account of the presence of special valves (Eustachian valves), the upward arterial stream is directed into the left side of the heart through the foramen ovale—an opening in the intra-auricular septum—whilst the venous current from the superior vena cava is directed into the right ventricle. When the ventricles contract, the arterial blood contained in the left ventricle is expelled into the ascending aorta and thence to the head and upper extremities, while the venous blood of the right ventricle is expelled into the pulmonary artery and then through the ductus arteriosus (which branches off from the pulmonary artery before it passes into the lungs) into the descending aorta This separation of the two streams is not perfect, but it is responsible for the fact that the upper parts of the foetus receive blood which contains more oxygen than that received by the lower parts This is possibly the reason why the head and the arms of the foetus are always considerably more developed than the pelvis and legs A portion of the blood flowing through the descending aorta enters the two umbilical arteries and is conveyed to the placenta, where it is re-oxygenated.

At birth, the course of circulation undergoes changes As soon as the lungs become distended by the first respiration, a portion of blood is diverted from the pulmonary artery into the lungs As the pulmonary circulation increases, the ductus arteriosus becomes gradually obliterated, and finally disappears. The foramen ovale between the auricles also becomes closed The circulation, which was carried out in the foetus upon the plan of that of the higher reptiles, becomes that of the warm-blooded animal, and the venous blood becomes separated from the arterial blood After birth, the



FROM YOUNG AND ROBINSON IN CUNNINGHAM, "TEXTBOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG 3.—THE BASES OF THE VENTRICLES OF THE HEART, SHOWING AURICULO-VENTRICULAR, AORTIC AND PULMONARY ORIFICES AND VALVES

umbilical arteries and vein shrink and close up and form the ligaments of the bladder, and the ligamentumteres of the liver. The ductus venosus disappears.

Physiological Properties of the Heart.—The cardiac muscle must be regarded as endowed with four fundamental properties, viz., *Rhythmicity,* the function of originating its impulse; *Conductivity,* the function of transmitting the impulse; *Irritability,* the function of responding to stimuli; and *Contractility,* the function of developing tension which may be utilized for performing the work of circulating the blood.

Rhythmicity.—The cause of the heart beat has naturally been one of the most continued subjects of inquiry. H. Allen in 1757 was the first to show that the activity of the heart is not dependent on its connections with the nervous system. The heart is controlled and influenced by the nervous system, but this control is not essential for life. The excised heart of a frog continues to beat rhythmically for days, provided that it is supplied with oxygen and prevented from drying. In the case of the warm-blooded animal, the heart is similarly capable of continuing its rhythmic contractions for some time after excision.

(1) *The Amphibian and Reptilian Heart*—The frog's heart consists of a sinus venosus which receives the venous blood from the body, two auricles, the ventricle and the bulbus arteriosus, which divides into the two aortae. The frog's heart in the body, or after excision from the body, beats regularly, the contractions starting in the sinus, then travelling to the auricles, ventricles and bulbus.

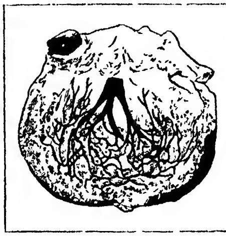
At one time the rhythmic contraction of the heart was attributed to the action of groups of nerve cells in the sinus that were discovered by Robert Remak in 1848. Some experimental support for this theory, which is known as the "neurogenic" theory of the heart beat was given by Stannius, who demonstrated that the auricle and ventricle of the frog's heart cease to beat for some time if the sinus is tied off with a ligature, while the sinus goes on beating regularly. Further experiments have shown however that the beat of the heart cannot be ascribed to the rhythmic activity of these ganglion cells, for every strip of the heart muscle is capable of rhythmic action, whether it contains nerve cells or not. In the developing chick, the heart contracts by the 24–28th hour of incubation, while the nerves do not grow into the heart before the 6th day. The inherent power of rhythmic contraction belongs to the cardiac muscle itself (the "myogenic" theory of the heart beat).

Furthermore, it belongs to every part of the heart, but there is a descending scale of this automatic power, from the sinus where it is highest to the lower parts of the ventricle where it is very slight (Gaskell). The normal sequence of contraction of the four parts is determined by the natural rhythm of these parts, but in the whole heart it is impossible for the ventricle to contract at its own rhythm because before it is ready to beat again, after a preceding contraction, it receives an impulse from the auricle. In the same way, the auricle never beats at its own rhythm; it is always subordinated to the faster rate of impulses coming from the sinus. If, however, the ventricle is electrically stimulated at a rate slightly faster than the beat of the sinus, the normal sequence of contractions becomes reversed, the ventricle now contracting first and the sinus last. All recent experiments tend to confirm the myogenic theory of the heart beat.

(2) *The Mammalian Heart.*—Although the mammalian heart has no sinus venosus, its contractions are as regular, and as independent of the nervous system as those of the lower vertebrates. Both in the heart *in situ* and in the excised heart the two auricles contract together, and after a short interval there follows the contraction of the two ventricles.

In the mammalian heart, within the region where the superior vena cava opens into the right auricle, there lies a club-shaped formation known as the *sino-auricular* or the *S-A node;* functionally it is identical with the sinus of the amphibian and reptilian heart. The node is composed of slender fusiform cells with little striation. It can be considered as definitely proven that, in the normal heart, the sinus serves as the centre in which the stimulus for the cardiac contraction originates. The *S-A* node is, however, by no means the only place in which the impulses for the heart can originate. The seat of these rhythmically recurring impulses may shift to some other portion of the heart since, as in the frog's heart, the function of rhythmicity is potentially present in every part of the heart, and the *S-A* node governs the rate of the whole heart only in virtue of its faster rate of discharge of these impulses. On this account the *S-A* node has often been described as the "pace-maker" of the heart. Other centres in which the impulses sometimes originate, and which in certain cases may gain mastery over the whole heart, are known as *ectopic* centres.

It has been shown that a very distinctive system of muscle fibres lies enclosed within its own sheath beneath the endocardium. This system is known as *the conductive system* of the heart. It begins as a few strands of fibres in the region of the coronary sinus; these strands converge in a thickening which is known as the *auriculo-ventricular* or the *A-V node;* it is composed of the same type of cells as the *S-A* node. The two nodes are not connected with each other, but are divided by the ordinary contractile elements of the auricle. From the *A-V* node, a thin bundle of tissue passes through the auriculo-ventricular septum towards the ventricle. This bundle was first described by His, and is known as *the A-V bundle*. On penetrating the intra-ventricular septum, the bundle divides into two branches, which pass to the right and left ventricle respectively. The two branches in turn divide and subdivide, forming an extensive arborization on the inner surface of the ventricles (fig. 4).



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 4—THE CONDUCTING SYSTEM OF THE HEART

Left ventricle, laid open to show Interventricular system, on which the course of the Auriculo-ventricular Bundle and its ramifications are shown in black (after Tawara)

Various parts of the conductive system may become centres of ectopic rhythms. If the *S-A* node is destroyed or injured, or if the irritability of the *A-V* node is increased, the latter assumes the rôle of initiating the heart beat. Many nervous and other influences may modify the relative irritability of the two nodes, and a shift of the pace-maker from one to the other may occur temporarily even under normal conditions. Destruction of the His bundle is equivalent to a complete functional separation of the ventricles from the auricles. The ventricles develop a rhythm of their own, *the idio-ventricular rhythm*. Both ventricles however continue to contract together, the centre for their activity being localized in the higher part of the bundle. It is probable that still lower centres may assume a rhythmicity, but it is doubtful whether these can ever dominate the rhythm of the whole heart. Their significance consists rather in the fact that they serve to disturb some other dominant rhythm.

Thus we see that every part of the heart may serve as a centre of origin of an impulse. The natural rate of the discharges of these centres is in the following descending order: the *S-A* node, the *A-V* node, the bundle, its branches and muscle. If several centres are active simultaneously, the rate of the heart as a whole will be dominated by that centre which discharges most frequently.

The "Normal" Heart Rate.—The normal heart rate presents considerable variations in different individuals and in different species of animals. For man it may be estimated at 68 to 76 beats per minute, and for woman 74 to 80, but the normal rate for some individuals may be much lower (50) or much higher (90). Small animals as a rule have a higher heart rate than large animals, *e.g.*, elephant 25–28, horse and ox 36–50, sheep 60–80, dog 100–120, rabbit 150–180, mouse 700; small birds like the canary have the extremely high rate of 1,000 beats per minute. Usually in man, under normal conditions, the heart rate declines with age. While at birth it is about 140, it is 100–110 at the age of 5; in childhood it is about 90, and in the adult about 70. In old age it accelerates slightly and becomes about 80.

Conductivity.—The impulses which originate in the *S-A* node spread along the ordinary muscular tissue to every part of the auricles. The rate of conduction in the auricle ranges from 600–1,200 mm. per second. In its fan-like spread, the excitation wave reaches the *A-V* node. There is no indication of a preferential path of conduction between the two nodes, so that the impulse travels at the same rate over the auricle and reaches the *A-V* node about 0·03 second after the origin of the impulse. In the *A-V* node, the rate of conduction is considerably slower, the impulse passing the node at about 150–200 mm. per second. Once it has passed the node, the impulse travels rapidly down the

bundle and its ramifications at the rate of about 5,000 mm per second

The slow conduction in the *A-V* node and the rapid conduction in the bundle tissue ensure two important features of cardiac activity On account of the former, auricular contraction is given time to end before the onset of the ventricular contraction, and on account of the latter the impulse arrives at every part of the ventricle at approximately the same time Thus the whole ventricular muscle contracts approximately at the same time, which is a condition necessary for the development of a high pressure in the ventricular cavities.

Irritability.—When a skeletal muscle is stimulated by an increasing strength of electrical stimulus, it responds by an increasing strength of contraction, until a certain maximum is reached. A heart under the same conditions gives a contraction which is maximal for a given condition of the heart in response to the first effective stimulus; further increase in the strength of the stimulus does not lead to an increase in the strength of the response. This difference between the skeletal and the cardiac muscle is not due to fundamentally different properties, but depends on the fact that in cardiac muscle the muscle fibrils are in free inter-communication with each other, and in this way a stimulus which originates in one part spreads over the whole of the organ, in the skeletal muscle, however, the contractile fibrils are collected into muscle fibres which are separated by the homogeneous coat of the sarcolemma. Since the threshold value of a stimulus which will evoke contraction is different for the different muscle cells, it is only to be expected that a greater number of these cells will contract in the skeletal muscle when the stimulus is strengthened, the result being a stronger total effect of contraction of the muscle In the heart, when a stimulus evokes a contraction of a few fibres, this contraction will spread over the whole heart, so that with increase in the stimulus there is no further strengthening of the contraction. This behaviour of the heart is known as the *All or None Law.* It is most evident in the cardiac muscle, but is not peculiar to it.

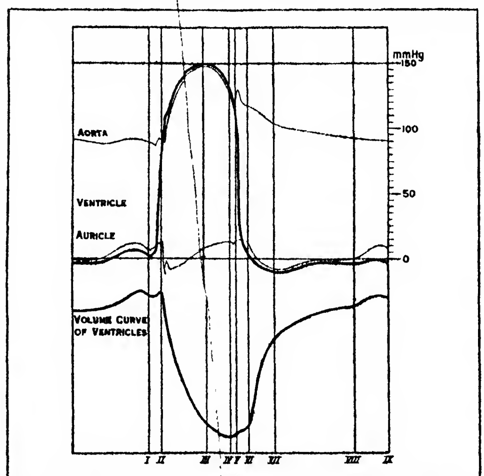
The Refractory Period.—The irritability of the heart undergoes rhythmical variations which are determined by the heart beat itself. Like all excitable tissues, the heart exhibits the phenomenon of the *refractory period,* which is a period of loss of irritability following each impulse which evokes a contractile response In the heart this period is extremely prolonged It lasts as long as the contraction of the heart. If a second stimulus is applied to the heart during the contraction which is evoked as a response to the first stimulus, it is found that it has no effect. In the skeletal muscle, on account of the fact that the refractory period is shorter than the time occupied by the contraction, a second stimulus evokes a second contraction, or a summation of the two contractions. The period of complete loss of irritability is followed by gradual recovery, after which there is a phase of super-normal irritability before it returns to the normal.

The length of the refractory period depends in the first place on the strength of the contraction of the heart. Thus drugs and physiological conditions which strengthen the heart beat also increase its refractory period. Of greater significance, however, is the relation of the refractory period to the rate of the heart beat. Lewis found that the duration of the refractory period of mammalian auricular muscle contracting 100, 130 and 250 times per minute was 0·2, 0·15 and 0·01 sec. respectively.

It is obvious that as a result of the shortening of the refractory period the heart is able to respond to more rapid rates of excitation than would otherwise be possible. As soon, however, as stimuli occur at intervals which are shorter than the refractory period alternate stimuli will fail to evoke any response, the heart beating at a *half-rhythm* or 2:1 response. The change from a 1:1 to a 2:1 response does not occur abruptly. Between these rates there exists a phase in which large and small beats alternate; with further acceleration of the stimulation, some beats are dropped, and with a still further acceleration a regular 2:1 rate sets in. This stage of irregular response is due to the fact that apparently all the parts of the cardiac muscle have not the same minimal refractory period and consequently at some definite rate of excitation parts of the heart will contract in response to every stimulus, while other parts will respond by a 2:1 rate.

Contractility.—The strength of contraction of the heart is independent of the strength of the stimulus It is, however, highly dependent on the condition of the cardiac muscle. Any interference with the nutrition of the heart, inadequacy of the oxygen supply, or accumulation of the products of metabolism such as carbonic acid or lactic acid, will lead to a weakening of the contractile response, and even to a complete loss of contractility.

There is also a physiological factor of primary importance which modifies the strength of contraction Briefly it can be stated that, other conditions being equal, the greater the filling of the heart during diastole, the stronger is the following systole This dependence of strength of contraction is so marked and is of such importance for the whole circulation that Starling named it the "Law of the Heart." It must be remembered, however, that it is not a feature peculiar to the cardiac muscle alone; it belongs to all contractile tissues, whether heart, skeletal muscle or plain muscle, but in the heart it is of a greater immediate vital importance. The practical significance is obvious; it enables the heart to eject the amount of blood which it receives during diastole whether small or large, and thus enables the heart to adapt its beat to considerable variations of the blood flow without changing its rate. A dog's heart weighing 50 grams, can put out 100 or 3,000 cc. of blood per minute without changes of the heart rate.



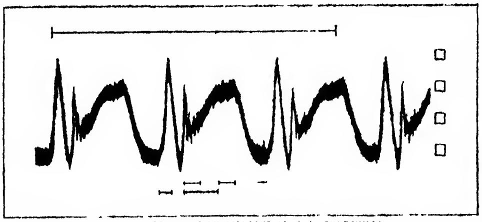
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG. 5.—PRESSURE CURVES FROM AORTA, VENTRICLE AND LEFT AURICLE, TOGETHER WITH VOLUME CURVE OF THE TWO VENTRICLES DURING ONE COMPLETE CARDIAC CYCLE (MODIFIED FROM WIGGERS)

This remarkable adaptation is due to the fact that the larger the output, the more the heart will be filled during each period of relaxation (diastole), and hence its contraction (systole) will be stronger, so that the heart will empty itself of the extra amount of blood. When a heart is in good condition, it performs a given amount of work with a smaller diastolic volume than when the contractility of the heart becomes impaired. The same work may be performed in both cases, but in the second case in order to do the work the heart has to dilate, because at the previous diastolic volume its contractions would be too weak. The dilation of the heart at constant work is thus the first sign of impairment of its functions.

Sequence of Events in the Cardiac Cycle.—The time relation between the different events occurring during a cardiac cycle can be most satisfactorily determined by measuring pressure changes in the different cavities of the heart and in the aorta. The apparatus almost universally used for this purpose is known

as the optical manometer. It consists of a small glass or metal tube which can be introduced directly into one of the cavities of the heart. The tube is filled with fluid, and the outside opening is sealed with a thin rubber membrane, which carries an excentrally placed small and light splinter of a mirror. A beam of light reflected from the mirror is made to play on a moving photographic plate or film, and thus the minute movements of the membrane,



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG. 6—CURVES OF PRESSURES IN LEFT AURICLE OF CAT (AFTER STRAUB)

which are of course proportional to the pressure changes, are greatly magnified without the danger of increasing the inertia of the apparatus.

The pressure changes in the heart (fig. 5) have been described by Starling as follows.—

"The cardiac cycle begins with the contraction of the auricles, which may or may not give rise to a slight rise of pressure in the ventricles. As the auricular contraction dies away, the ventricular contraction begins at I. This causes a very rapid rise of pressure. Almost immediately after the beginning of the rise, the auriculo-ventricular valves close The pressure then rises rapidly in the ventricular cavity During this period, the contraction of the ventricular muscle is isometric It is raising the pressure within the ventricles without causing any change in its contents, or in the length of the muscle fibres Directly the pressure exceeds that in the aorta, the aortic valves open at the point marked II, and the aortic pressure thereafter rises with the ventricular pressure. During the whole duration of the ventricular contraction, the aortic pressure remains somewhat below the ventricular pressure, showing that the blood is flowing continuously from the ventricle into the aorta. The ejection of blood is at first rapid, so that the pressure in the ventricles continues to rise As the heart gets smaller, the amount of blood ejected into the aorta becomes less than that flowing out in the unit of time through the peripheral branches, so that the pressure begins to fall in the aorta and ventricle, even though the outflow of blood is still going on.

"The ejection period may therefore be divided into two phases, that of maximum ejection and that of reduced ejection. The ventricular muscle suddenly relaxes at the point marked IV, causing a sudden fall of pressure in the ventricle and a slight fall in the aorta. The latter is, however, arrested almost at once by the closure of the aortic valves, marked by the sharp depression, the *dicrotic notch,* in the aortic tracing The pressure in the ventricle continues to fall until at the point VI. it drops below that in the auricle and the auriculo-ventricular valves open, allowing the inflow of blood from the pulmonary veins and auricles Between V. and VI. the relaxation is isometric, since all the valves guarding the orifices of the ventricles are closed

"The pressure in the ventricles then continues to fall more slowly until it reaches the line of zero pressure, and remains at or near this line during the greater part of diastole. With a big inflow there may be a slight rise towards the end of diastole, which may be accentuated by the auricular contraction If the chest is opened the pressure in the ventricle never sinks below zero during any part of diastole. In the closed chest the pressure in the heart cavities during diastole will be negative, on account of the negative pressure within the thorax."

The duration of the separate phases of the heart beat depends naturally on the rate of the beat. In all cases, of change of heart rate, the period of diastole is affected relatively much more than the period of systole. Owing to the absence of valves between the auricles and the large veins, changes of pressure within the auricle will be transmitted along the veins

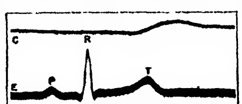
In every case the auricular pressure tracing exhibits the following features (fig. 6): (1) The first positive wave, which occurs during auricular systole. (2) The second positive wave, which is due to the sharp closure of the auriculo-ventricular valves. (3) The third positive wave, which is due to the filling of the auricles while the auriculo-ventricular valves are closed. (4) A negative wave, which is due to the rapid emptying of the auricle after the opening of the auriculo-ventricular valves. The chief function of the auricle is not to propel blood into the ventricle by its contraction, but to serve together with the big veins as a reservoir for the blood which flows in from the body but which cannot enter the ventricle while the latter is in a state of contraction

The Apex Beat.—The pulsation which is felt over the region of the heart is known as the "apex beat," and was formerly thought to be due to the twisting forward of the apex at each systole. Its origin is, however, different. During diastole, the ventricles form a flabby flattened cone, lying against the chest wall and slightly depressed by the latter. In systole, the ventricles become hard and rigid, and assume the form of a rounded cone This sudden change in shape and hardening of the ventricular wall pushes out that part of the chest wall which is in immediate proximity to the ventricle, giving rise to the "apex beat."

The Sounds of the Heart.—When the ear is applied to the chest above the cardiac region, two sounds may be heard, the first, which is heard most intensely over the apex, is a duller and longer sound than the second, which is heard best over the base of the heart The first and second sounds resemble the syllables *lubb dup–lubb dup.* The first sound is of twofold origin. It arises from the sudden closure of the auriculo-ventricular valves, and from the contraction of the thick muscular wall of the ventricles. The second sound is due to the sharp closure of the auricular and pulmonary valves.

When fluid escapes through a narrow orifice, vibrations are set up in the fluid giving rise to various sounds. Under normal conditions, when the valves of the heart are closed completely, sounds produced in this way are either absent or negligible, in abnormal conditions, *e.g.,* after disease affecting the orifices of the heart or the valves, these vibrations may become loud enough to be easily heard These murmurs or *bruits* as they are called are of great importance, for they enable the physician to judge the condition of the valves, and to determine which valve is affected.

The Electrocardiogram.—The contractions of the different cavities of the heart are accompanied by electrical changes which can be recorded if any two parts of the heart are connected to a sensitive galvanometer. The apparatus which is generally used for this purpose is the string galvanometer, in which a very delicate thread of silvered quartz or of platinum is stretched between the poles of a strong magnet. If we lead off, not from the heart itself, but from tissues which are in contact with the heart, we shall still obtain the electrical changes at each heart beat. An electrocardiogram so obtained is reproduced in fig. 7.



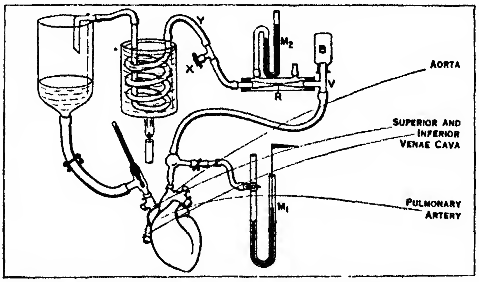
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A. CHURCHILL)

FIG 7—ELECTROCARDIOGRAM OF MAN, OBTAINED BY LEADING OFF FROM THE TWO HANDS TO A STRING GALVANOMETER, C THE CAROTID PULSE TRACING

The deflection P is due to the auricular contraction and QRS marks the beginning of the ventricular contraction Thus the P-R interval represents the period between the auricular and ventricular contractions. The total duration of the excitatory state of the ventricle is measured by the distance between Q and T. A case of *A-V* block, as for instance in Adams-Stokes' disease, is shown at once on the electrocardiogram by the dissociation of the normal relations between the auricular and ventricular deflections. A delay in conduction of the excitatory wave is accompanied by a prolongation of the P-R interval, while a beat originating from the *A-V* node instead of the *S-A* node is immediately shown by a

shortening or even disappearance of the P-R interval The exact origin of the T wave is not known The electrocardiogram has become an important aid in the study and diagnosis of abnormal heart activities.

The Isolated Mammalian Heart.—The nutrition of the mammalian heart is carried out by means of the coronary arteries, which leave the aorta at the place of its origin. A mammalian



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A. CHURCHILL)

FIG. 8.—ARRANGEMENT FOR WORKING ON THE ISOLATED MAMMALIAN HEART, WITH THE DIFFERENT PARTS NOT DRAWN TO SCALE, AND THE LUNGS NOT SHOWN

heart, which has been removed after the death of the animal, can easily be revived if the coronary arteries are perfused under pressure with blood or a salt solution which resembles the saline medium of the blood in composition This procedure was first introduced by Ludwig for the frog's heart, and by Langendorff for the mammalian heart Sydney Ringer first determined the exact amount and type of salts necessary for the most successful survival of the frog's heart, and Locke modified Ringer's solution for the mammalian heart With the use of such a solution, a mammalian heart can be restored to activity as long as 7 days after death. The beat of the isolated heart of a child can be restored 20 hours after death from pneumonia The excised heart of a cat can be kept beating for 4 days. The heart of a monkey was restored after freezing the dead body of the animal

Conditions Essential for the Heart Beat.—For perfusion experiments, a cannula is tied in the aorta pointing to the heart The pressure of the column of fluid closes the aortic valves and the only way of escape is through the coronary arteries, after having passed through the heart muscle, the fluid flows out of the coronary veins In this manner it is possible to study the influences directly affecting the heart beat and the coronary blood vessels

The first and most essential condition for reviving a heart is an abundant supply of oxygen; the second is the maintenance of the perfusion fluid at a reaction similar to that of blood, *i e.,* slightly on the alkaline side of neutrality (sodium bicarbonate is usually added for this purpose)

A third important factor is the maintenance of the temperature within physiological limits An increase in temperature causes an increase in heart rate but at about 44° C to 45° C the beat ceases entirely At temperatures ranging from 13°–19° C the beat ceases, but on rewarming the co-ordinated contractions are re-established, In all these cases the effect of temperature is primarily on the S-A node, and warming or cooling the node duplicates the effect of warming or cooling the perfusion fluid, except that at some stage the lower rhythm centre of the heart will begin to be dominant, whereas in the cooling of the whole heart the rhythm of all the centres becomes depressed

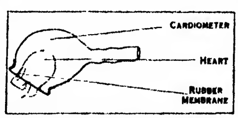
The main purpose of the sodium chloride in the fluid is to keep the osmotic pressure of the fluid the same as that of blood Calcium and potassium have however a direct influence on the contractility of the heart. After a short perfusion with a fluid that lacks calcium and potassium, the heart soon stops beating altogether Addition of calcium salts will immediately evoke contractions, which will grow in force, but the heart will soon fail to relax completely and will gradually stop in systole. On addition of potassium salts, the heart resumes a normal beat. Excess of calcium salts leads to a systolic standstill, and excess of potassium salts leads to a diastolic standstill. The normal activity can proceed only if salts of both calcium and potassium are present in the proper proportions.

The Heart-lung Preparation.—A great advance in the study of the heart was made when Starling succeeded in investigating the heart under conditions like those of the perfused heart, but with the great advantage that the heart performed work and pumped blood in exactly the same way as in the whole animal. The arrangement of the method is shown in fig 8

Artificial respiration being maintained, the chest is opened under an anaesthetic. Cannulae are placed in the brachiocephalic artery and the superior vena cava All other blood vessels going to and from the heart are tied off The blood emerging from the heart is made to flow against an artificial variable resistance (R), through a glass spiral immersed in warm water, into a reservoir From the reservoir the blood flows through the superior vena cava into the heart The aortic blood pressure can be varied in this preparation by changing the artificial resistance against which the heart is made to work.

The output of the heart can be measured at any time by opening the tube X, clamping tube Y, and allowing the blood to flow into a graduated cylinder The volume changes of the heart at each beat can be measured by the so-called cardiometric method A glass cardiometer of the shape shown in fig 9 is fitted over the beating heart The opened pericardium is tied around the lip of the cardiometer, which is then connected with a tambour with a slack rubber membrane The movements of this membrane are recorded by a lever on the smoked surface of a revolving drum The difference between the diastolic and the systolic volume thus recorded is obviously equal to the amount of blood put out by the two ventricles during a single heart beat

This preparation enabled Starling and his co-workers to study the main features of the physiological activity of the heart It was found that the heart itself cannot modify the blood flow and that, within wide variations of the heart rate and of the arterial resistance against which the heart beats, the output remains constant provided the inflow is not changed This means that the heart will adapt the strength of its beat within very wide limits, and will perform the work required if it is within the functional capacity of the organ If the inflow into the heart is say 1,000 cc a minute, this output will be maintained if the heart rate is 100 or 200 beats per minute, or if it has to beat against a pressure of 60 or 160 mm of mercury Increase in the heart rate does not modify the output, but it increases the maximum amount of blood which the heart is able to expel, since at the faster heart rates the inflow of blood can be increased without causing over-distension of the ventricles Another important observation made by Starling was that, in the heart-lung preparation, the heart rate is independent of the pressure against which the heart works and of the output The heart rate is here determined by the temperature of the *S-A* node, *i.e.,* by the temperature of the circulating blood It is clear that the extent of this effect will vary from heart to heart, depending on the natural rhythmicity of the node



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 9—HENDERSON'S GLASS CARDIOMETER

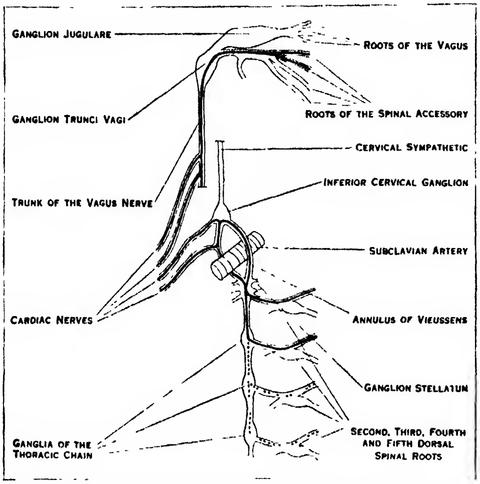
The Work of the Heart.—The energy of the contraction of the heart is expended (*a*) in forcing a certain amount of blood against a certain resistance presented by the arterial pressure, and (*b*) in imparting a certain velocity to the blood. The work done by each ventricle can be calculated from the formula.

$$W = Mr + \frac{Mv^2}{2g}$$

Where W is the work done, M is the mass of blood expelled at each beat, r is the mean arterial pressure, v is the velocity at the root of the aorta, and g the factor of acceleration. The work of the right ventricle is approximately $\frac{1}{4}$ of that of the left. The work of both ventricles in the human heart at rest is about 100 gram-

meters per beat, which is equivalent to about 10,000 kilogram-meters in 24 hours. During very strenuous muscular exercise when the output is considerably increased, the work of the heart per beat is about 400 gram.-meters, or 80,000 kilogram-meters in 24 hours. This rate of work could probably be maintained for not more than a few minutes

The energy required for the cardiac contraction is derived from the oxidation of the deposits of glycogen (possibly also of fats) within the heart itself It was found by Lovatt Evans that. on increasing the arterial pressure from 80–140 m.m of mercury, the oxygen consumption of a heart was increased from 228 to 404 cc. per hour; and on increasing the output from 9·3 to 92 litres per hour, it increased from 155–649 cc. per hour. The maximum efficiency of the heart is of the same order as that found for skeletal muscle, namely 20–28%



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A. CHURCHILL)

FIG 10 —DIAGRAM OF CARDIAC INHIBITORY AND ACCELERATOR FIBRES IN THE DOG (FROM FOSTER)

The Nervous Regulation of the Heart Beat.—In the vertebrates, the heart is supplied with two sets of nerve fibres; those which pass from the central nervous system in the vagus nerve, and those which pass in the sympathetic nerves (fig 10) The cardiac fibres of the vagus terminate around nerve cells situated in the heart itself (preganglionic fibres), the ganglionic cells serve as relays from which new fibres (postganglionic fibres) emerge and run directly to the cardiac muscle and to the *S-A* node The sympathetic fibres leave the spinal cord by the anterior roots mainly of the second and third dorsal nerves, run in the white *remi communicantes* to the Stellate ganglia where they end; from the Stellate ganglia, postganglionic fibres begin, which go to the various parts of the cardiac muscle.

The Vagus Nerve.—In 1845 the brothers Weber made the important discovery that stimulation of the vagus nerve retards or even arrests the heart beat. The cardio-inhibitory nerves have since then been found in all classes of vertebrates and in many invertebrates. During a stimulation of the vagi, the heart beat is considerably retarded or stops altogether, and as the result of this the arterial blood pressure falls. Blood accumulates on the venous side of the heart and is not forced out in sufficient amount to maintain the blood pressure. If the stimulation of the vagus is prolonged, the heart often begins to beat again with a slow rhythm; this beat is seen to be confined to the ventricles only, the auricles still remaining at a standstill. We speak of such a beat as an "escape." The ventricle is really beating at its own idio-ventricular rhythm in response to impulses originating within itself.

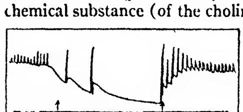
A detailed study of the effect of vagus stimulation on the heart has shown that it affects all the four fundamental properties of the heart muscle (fig. 11). By inhibiting the S-A node, it depresses the rhythmicity; by affecting the conductive system, it retards the propagation of the impulse in the auricular muscle and in the A-V bundle; by affecting the muscle proper, it diminishes its contractility and each beat becomes weaker, in consequence of which the refractory period of the heart is shortened; and finally it diminishes the irritability of the heart. Whether the vagus has a direct action on the mammalian ventricle is still doubtful

If both vagi are cut, the heart immediately begins to beat faster, showing that under normal conditions a continuous stream of impulses passes down the cardio-inhibitory nerves, which do not allow the heart to beat at its full independent rate.

For obvious reasons, section of the vagi cannot be performed in man, but we have at our disposal a drug which paralyses the peripheral nerve endings of the postganglionic vagal fibres, namely atropine, an alkaloid obtained from belladonna

The question as to what controls the normal tone of the vagi has been the subject of many researches, and at present we know of several factors that are concerned Amongst them we must mention first the blood pressure. Marey was the first to show that, other conditions being equal, the vagus tone increases with increase in the blood pressure. This effect is probably not due to the direct stimulation of the vagus centre in the medulla, but to stimulation by high blood pressure of special sensory endings in the aorta, in the ventricles, and in some of the blood vessels going to the brain The sensory impulses reflexly retard the heart by stimulation of the vagus centre Changes in the composition of the blood and various drugs may also affect the vagus centre. Asphyxia, and the action of morphine may be mentioned as such centrally acting stimuli; they retard the heart, but only if the vagi are intact. Reflexes from various sensory nerves may stimulate or inhibit the vagus centre, for instance, inflation of the lungs diminishes vagus tone (the Hering Breuer reflex); increase in the output of the heart has the same effect (Bainbridge reflex). Stimulation of the respiratory passages, as in the case of inhalation of an irritant volatile substance, retards the heart, and high intracranial pressure has the same effect. There are also stimuli which may excite the peripheral nerve endings of the vagi in the heart itself, *i.e*, substances which will act even after section of the vagi, but not after injection of atropine—for instance bile salts, which enter the general circulation in the case of jaundice

The intimate mechanism by means of which the vagus produces its effect on the heart has been a field of intense experimentation and theorisation It has been suggested that the vagus impulses produce "interference' waves with the impulses originating in the S-A node; that the vagus is a nerve which abolishes the katabolism or disintegration processes associated with activity, and leads to anabolism or reconstruction processes; that on account of similarity in the effect of stimulation of the vagus with that of potassium salts, the vagus possibly liberates free potassium from a colloidal combination or from an adsorbed state from the proteins. According to Loewi, the vagus acts by producing some chemical substance (of the choline type) which is the active factor His experiments support the theory most brilliantly. If a perfused frog's heart is stopped by stimulation of the vagus, and if the perfusion fluid is collected from the heart and transferred to a beating frog's heart, the second heart will show all the effects of vagus stimulation. The chemical substance responsible has been extracted and dried, but has not yet been obtained in a sufficiently pure form to establish its chemical nature.

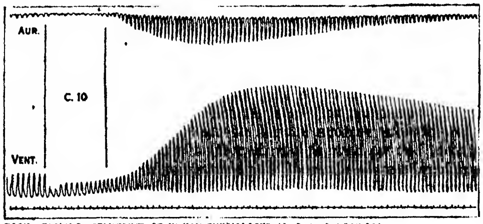


FROM STARLING "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 11 —BLOOD PRESSURE TRACING FROM CAROTID OF A DOG SHOWING EFFECT OF EXCITATION OF VAGUS (BETWEEN THE ARROWS)

The Sympathetic Nerve.—Stimulation of the sympathetic cardiac nerve produces effects which are the reverse of the vagus stimulation. It increases the rate by raising the rhythmicity of the heart, augments the contractions, increases the rate of conduc-

tion of the impulse, and raises the irritability of the heart. On account of the increased strength of contraction, the refractory period becomes somewhat more prolonged than that normally associated with the given heart rate. The sympathetic nerves are much less easily tired than the vagus fibres and have a longer after-effect. In most animals the inhibitory and the accelerator fibres, which were discovered by Cyon, become mixed in the cardiac nerves, so that if these are stimulated a double effect is produced on the heart. During the period of stimulation the vagus effect predominates, but after the end of stimulation the sympathetic effect becomes apparent, and the heart accelerates and the beat increases in strength (fig. 12).

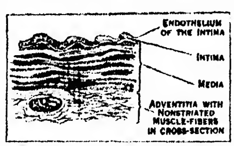


FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 12.—TRACING TO SHOW EFFECT OF STIMULATION OF THE VAGO-SYMPATHETIC NERVE ON THE FROG'S HEART (AFTER GASKELL)

Stimulation of either set of fibres before they are mixed together produces effects typical of one or the other only. In the dog, whose normal heart rate is about 100 beats per minute, stimulation of the accelerator nerves may increase it to 260 beats, and at the same time the strength of each contraction will be increased. The latter effect is most marked in hearts which have begun to fail and which are therefore dilated.

The question whether, under normal conditions, the accelerator fibres are in a state of tone like that of the inhibitory fibres of the vagus is not definitely settled. It is customary to assume the existence of such a tone, but to consider it as less pronounced than that of the vagus. In most experiments, extirpation of the Stellate ganglia leads to a retardation of the heart. Many observers have shown that the tonic conditions of the two centres stand in a reciprocal relation to one another. Whenever the tone of the inhibitory fibres is increased, that of the accelerator fibres is diminished; thus the final effect on the heart will be an algebraical summation of the two influences. The tone of the accelerator centre is greatly increased in asphyxia, in cerebral anaemia, in the case of various sensory stimuli (especially painful stimuli), and probably in the case of muscular exercise. In the first two states, which are pathological, the tone of both nerves is increased simultaneously. Thus, in the absence of the sympathetic nerves, asphyxia produces retardation of the heart by stimulating the vagus, and in the absence of the vagus it produces an acceleration. In the presence of both nerves, it first retards the heart and may even arrest it until the vagi become paralysed, after which the heart greatly accelerates above the normal, because of the co-existent stimulation of the sympathetic centre.

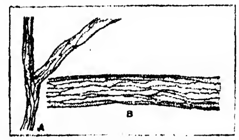


FROM BOHM, DAVIDOFF & HUBER, "TEXTBOOK OF HISTOLOGY" (SAUNDERS & CO.)

FIG. 13.—TRANSVERSE SECTION THROUGH ONE OF THE SMALLER OF THE MEDIUM SIZED HUMAN ARTERIES

The Suprarenal Gland.—It has already been mentioned that the influence of the vagus can be modified by stimuli affecting the centre, or by substances which stimulate or paralyse the peripheral nerve endings of the vagus within the heart itself. In the case of the sympathetic innervation, the organism normally produces a chemical substance which stimulates all the sympathetic nerve endings.

The production of this substance is the function of the suprarenal (or adrenal) gland, and the substance has not only been obtained in a chemically pure state, but has also been synthesised. It is known as *adrenaline* or suprarenin. Adrenaline is active in very small amounts, concentrations of one in one hundred millions producing a strongly exciting effect. Under normal conditions, however, the quantities entering the blood are probably too small to have any physiological effect. The liberation of adrenaline is under the influence of the splanchnic nerves, section of which diminishes the secretion, while stimulation greatly increases it. Certain drugs, asphyxia, various emotions such as fear or anger lead to an excessive production of adrenaline. Directly the adrenaline reaches the heart, even when its connections with the nervous system are all severed, the contractions become considerably faster and extremely energetic, and the heart becomes able to cope with a greater strain (either in the shape of arterial resistance or increased venous inflow) than it could do without the stimulus of adrenaline.



FROM BOHM, DAVIDOFF & HUBER, "TEXTBOOK OF PHYSIOLOGY" (SAUNDERS & CO.)

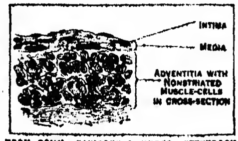
FIG. 14.—CAPILLARY BLOOD VESSELS

To summarize, we may state that the heart beat is a property of the heart itself, and as such it is independent of the nervous system. The latter may however be said to keep the activity of the heart under constant supervision, moderating its action by means of the vagus, and increasing it by means of the sympathetic nerves, thus adapting it to the general requirements of the body. Under conditions of great physical strain, the organism is able to make use of its store of adrenaline, which assists the nervous regulation of the heart beat. Thus, even after complete denervation of the heart, a certain amount of adaptation of its activity is still possible.

THE BLOOD VESSELS

Structure of the Blood Vessels.—The haemodynamic conditions in the various parts of the vascular system are very different, and it is not surprising to find that the structure of the various blood vessels is accordingly different. A cross-section of a blood vessel shows several coats. The inner consists of flattened endothelial cells and is common to all vessels. The second coat, the *tunica media,* varies greatly in thickness; it contains most of the contractile elements of the arterial wall (smooth muscle fibres) and a variable amount of elastic fibres. The latter have in general a circular arrangement; they are fused at their outer and inner surfaces to form elastic membranes (*lamina interna and externa*). Outside the media, lies the third coat, the *adventitia,* which consists in the arteries almost entirely of connective tissue, and in the veins principally of contractile elements. Between the internal elastic membrane and the endothelial layer is a fibrous structure which, together with the endothelial layer, forms the *tunica intima.*

The Arteries.—In the great arterial trunks such as the aorta, the pulmonary, the carotid and iliac arteries, the tunica media is divided by elastic fibres and membranes into a large number of concentric layers containing (especially in the aorta) only a few muscle fibres. The adventitia of the large arteries is also composed of fibro-elastic tissue, but its structure is looser and the fibrous tissue is more abundant. The medium-sized arteries differ in structure from the larger ones in that the elastic elements of the intima and media are replaced to a considerable extent by non-striated muscular fibres (fig. 13). To this type belong the majority of the arterial vessels.



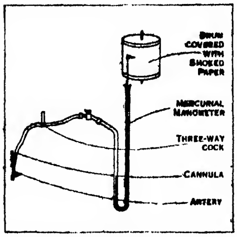
FROM BOHM, DAVIDOFF & HUBER, "TEXTBOOK OF HISTOLOGY" (SAUNDERS & CO.)

FIG. 15.—TRANSVERSE SECTION THROUGH A SMALL HUMAN VEIN

The Capillaries.—These (fig. 14) consist solely of a single layer of endothelial cells, which present little resistance to the passage of substances dissolved in the blood, such as oxygen, carbon dioxide, sugar and salts. According to some observers, the cells forming the capillary wall are contractile; according to others, the actual contractile elements are special Stellate cells which encircle the capillaries. But whatever the mechanism, the

contractility of the capillaries is unquestionable, and must play a considerable part in regulating the blood flow through an organ. The average length of capillaries is between 0·4 and 0·7 m.m.; in most organs they freely anastomose with each other, forming a more or less loose network.

The Veins.—The smallest veins result from the fusion of a variable number of capillaries. They assume a connective tissue coat, the adventitia (fig. 15), and with increase in size muscle-fibres appear in the form of a badly defined media. Some of the larger veins, such as the brachial and subcutaneous veins, have a better developed muscular layer, while in others (the jugular, the subclavian, the veins of the dura and pia mater) the media is entirely lacking. Generally speaking, the muscular and elastic elements are much less prominent in the veins than in the arteries, and they contain a preponderance of inelastic connective tissue fibres. In many veins the adventitia shows an inner longitudinal muscular layer. All subcutaneous veins and some internal veins are supplied with valves which restrict any possible back flow. The valves of the veins are reduplications of the intima, and the greater part of the valvular structure consists of fibrous connective tissue and elastic fibres.



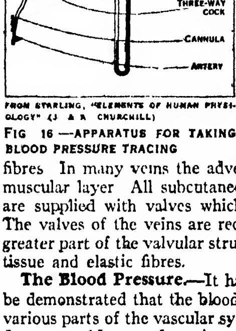
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 16.—APPARATUS FOR TAKING BLOOD PRESSURE TRACING

The Blood Pressure.—It has long been known and can easily be demonstrated that the blood is under different pressures in the various parts of the vascular system. When an artery is cut, blood flows out with great force in a series of jerks which are synchronous with the heart beat. When a large vein is cut, the blood also flows out rapidly, but the stream has very little force.

The first measurement of arterial pressure was made by the Rev. Dr. Stephen Hales. ("Statical Essays, containing Haemastaticks" 1733.)

Since Hales' work, the chief improvements in the method have been the application of the mercury manometer by Poiseuille, the invention of the recording manometer and the kymograph by Ludwig (figure 16), and the introduction of the more accurate membrane manometer by Hürthle and Frank.



FROM HOWELL, "TEXTBOOK OF PHYSIOLOGY" (SAUNDERS '00)

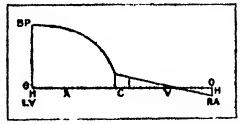
FIG. 17.—A RECORD OF ARTERIAL BLOOD PRESSURE TAKEN WITH A MERCURY MANOMETER FROM THE CAROTID ARTERY OF THE RABBIT, RECORDED IN SECONDS

The manometer of Ludwig consists of a U-tube which is half-filled with mercury. On the surface of the mercury of one limb is a float from which a stiff light rod projects, bearing on its upper end a writing point which is made to write on the smoked surface of a revolving drum. The other limb of the manometer is connected by means of a glass or metal cannula to the artery. The tube between the artery and the manometer is filled with a solution of some anticoagulant salt (sodium citrate, magnesium sulphate).

The mercury manometer allows a direct reading of pressure, but on account of its inertia it does not accurately record rapid changes in the pressure. The membrane manometer, which is merely a tube filled with fluid and sealed at one end with a stretched rubber membrane, records rapid changes in pressure more accurately, but each membrane requires special calibration if absolute values are desired. The venous pressure is recorded by a similar method, but with a water manometer or a manometer with a lightly stretched membrane.

The highest pressure, which occurs while the blood is passing from the heart into the aorta, is called the *systolic arterial pressure,* and the pressure at the end of diastole is the *diastolic pressure;* the range between these two extremes is known as the *pulse pressure.* In the dog, with a mean arterial pressure of about 120 mm. of mercury, the systolic pressure may be as high as 160 mm., and the diastolic pressure as low as 65 mm., here the pulse pressure would be 95 mm. of mercury. By taking the pressure at different parts of the vascular system, we obtain a result which is diagrammatically represented in figure 18.

Close to the heart, the mean arterial pressure is about 100–120 mm. It falls only slowly in the large arteries, but between the smaller arteries and the capillaries there is a very extensive fall of pressure, so that the capillary pressure is only about 10 to 30 mm. of mercury; from the capillaries to the veins the blood pressure falls steadily, until in the large veins near the heart it may be negative.



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 18.—BLOOD PRESSURES IN VARIOUS PARTS OF VASCULAR SYSTEM

A. In the arteries, C. capillaries, and V. in the veins

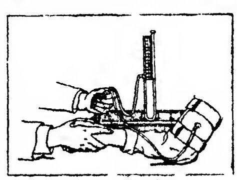
The arterial blood pressure in man is determined by means of the Riva Rocci sphygmomanometer (figure 19), which consists of a rubber bag that can be strapped round the upper arm. The bag is connected with a manometer, and the pressure in the bag is raised by pumping air into it. The pressure at which all pulsations disappear in an artery below the place of compression represents the systolic pressure. The diastolic pressure can also be determined by the same apparatus.

To determine the venous pressure in man, an apparatus is used which is constructed on the same principle as the sphygmomanometer. The skin is greased, and an annular rubber bag is placed over a vein and cemented over with a glass plate (figure 20). On blowing air into the bag, the pressure can be determined at which the vein collapses. The blood pressure in the capillaries is usually determined by the von Kries method (figure 21). A small glass plate is placed over the skin, attached to this plate is a small scale pan on which weights are placed until the pressure is just sufficient to blanch the underlying skin.

The mean blood pressure in the circulatory system of a young adult man in the horizontal position was found to be as follows:

Large arteries	90 mm. mercury (65–110)
Medium arteries	85 mm.
Capillaries	10–30 mm.
Small veins	9 mm.
Large veins	0–8 mm.

From this we see that the largest drop in pressure occurs between the small arteries and the small veins. This shows that the main resistance of the vascular system is situated in the arterioles. The arterioles are always in a semi-contracted state (tone), partly determined by impulses coming from the central nervous system, and partly by the properties of the plain muscles of which they are composed. Since the total vascular bed of the capillaries is very much larger than that of the arterioles, the main drop in the pressure must occur just past the arterioles. The mean arterial pressure depends on two factors: (a) the total resistance to the outflow of blood from the arterial system, *i.e.,* the state of constriction of the arterioles; (b) the output of the heart in a given time, which depends on the inflow of blood.

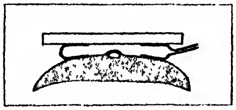


FROM STARLING, "PRINCIPLES OF HUMAN PHYSIOLOGY" (HAWKSLEY BROS.)

FIG. 19.—MEASUREMENT OF BLOOD PRESSURE IN MAN WITH THE RIVA ROCCI SPHYGMOMANOMETER

The Arterial Pulse.—Owing to the elasticity of the arteries, every systolic rise of the blood pressure produces an expansion of their walls, which can be felt by placing a finger on any superficial artery. It is obvious that the nearer the artery is to the

heart, the more pronounced will be the pulse The rate of transmission of this pressure wave will depend on the elasticity of the arteries If they were rigid, no pulse could be recorded. The more elastic the arteries, the slower will be the transmission of pressure along them. Under normal conditions, the pulse wave in man is transmitted at the rate of about 7 meters per second, but if the arteries are initially stretched by high pressure their walls will tend to approximate to rigidity, and therefore the propagation of the pulse wave will be faster It is important not to confuse the velocity of the pulse wave, which is simply a transmission of pressure along the tubes, with the velocity of the blood flow The latter is of the order of about 0·5 meters per second in the aorta, and considerably less in the smaller blood vessels



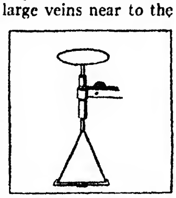
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 20 —APPARATUS FOR DETERMINATION OF VENOUS PRESSURE

The elasticity of the arterial system determines another important feature of the blood flow; it is the cause of the continuity of the blood flow (except for slight increases during systole and decreases during diastole), in spite of an intermittent ejection of blood by the heart into the aorta A sufficient amount of blood is accommodated in the arterial system to maintain a flow into the capillaries during the whole period of diastole In the capillaries the pulse disappears, and the blood flow is continuous Arterial pulse tracings recorded by means of sphygmographs (a system of levers which can be placed on a pulsating artery, the pulsation of which is thus registered on a moving plate with blackened surface) show various secondary undulations, either in the ascending part of the wave (anacrotic pulse), or in the descending (catacrotic pulse). These are partly due to extra vibrations set up in the arterial wall by the inrushing blood, and partly to pressure waves reflected from the periphery.

The Velocity of the Blood Flow.—This depends on the relation between the bore of the blood vessel and the amount of blood passing through it in a unit of time The total area of the cross sections of the arterial system gradually increases from the aorta to the periphery. The increase in area is especially great when the arteries break up into capillaries, the area of which is probably over a thousand times larger than that of the cross section of the aorta. The velocity of the blood flow will obviously be proportionately reduced the further we go towards the periphery, so that while in the aorta the mean velocity under resting conditions may be about 500 mm per second, in capillaries it is barely 0·5 mm per second. As the capillaries join to form veins, the area of the vascular bed diminishes and the velocity of the blood flow increases; however, it never reaches the velocity which is observed in the aorta since the cross section of the large veins near to the heart is about double that of the aorta.

Intensity of the Circulation.—The amount of blood received by the heart from the veins and passed to the arteries in a unit of time, cannot be measured directly. However, a knowledge of the cardiac output is of considerable importance because it controls the amount of oxygen carried to the tissues and the rate of the removal of various products of metabolism from the tissues. The great value of the study of the cardiac output of man and animals has only been realised comparatively recently, and there still remains much to be done; nevertheless methods of sufficient precision have been worked out, and the main factors governing the cardiac output are gradually being disclosed.



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 21 —APPARATUS OF VON KRIES FOR MEASURING CAPILLARY BLOOD PRESSURE

Zuntz calculated the output by comparing the difference in the oxygen content of the arterial and venous blood with the amount of oxygen consumed in a given time For instance in a horse weighing 360 kilo., 2,735 cc. of oxygen were consumed per minute; the arterial blood contained 10·33% more oxygen than the venous. Since every 100 cc. of blood that passed through the lungs had taken up 10·33 cc of oxygen, 2,733 cc. of oxygen had been taken up in the course of one minute by $\frac{100 \times 2733}{10 \cdot 33} = 26{,}457$ cc of blood. Krogh modified this method by making the animal or man breathe a gas which was harmless and easy to detect, viz. nitrous oxide He knew how much of the gas could be absorbed by 1cc. of blood, and was therefore able to calculate the cardiac output by determining the amount of gas taken in during one minute. Recently other methods have been introduced which are claimed to be more exact. In one of them, ethyl iodide is the gas absorbed, and in another the principle of Zuntz is modified and the output is calculated by comparing the carbon dioxide content of the arterial and venous blood with the amount of carbon dioxide given off in a unit of time.

Cardiac Output in Man.—In man, under conditions of rest, the cardiac output varies in different individuals between about 3½ and 6 litres of blood per minute, that is between 60 and about 110 cc for each heart beat. The cardiac output, *i.e.*, the inflow of blood into the heart, as in the heart-lung preparation, is within wide limits independent of the heart rate It primarily depends on (a) how freely the blood passes from the arterial system through the tissues into the venous system, *i e*, on the peripheral resistance; and (b) the power of the heart to pump the inflowing blood into the arteries, and (c) the capacity of the vascular system relative to the amount of blood When the arterioles dilate, the blood passes quickly through the organs and, since the capacity of the vascular bed will be changed but little, the blood will reach the heart during the next few beats in a larger amount The heart will therefore force more blood into the arterial system, and thus within limits prevent a fall of arterial blood pressure, which would have taken place if the arterioles dilated without causing an increase in the blood flow

If we turn now to the second way in which the output may be increased, namely the strengthening of the heart beat, it is clear that, if the pumping action of the heart becomes inadequate, blood will stagnate on the venous side, and the output will diminish If the heart beat is improved by nervous or pharmacological agencies, there will be better emptying of the venous side, and a consequent increase in the circulation rate.

The third factor governing the output is the capacity of the vascular bed relative to the amount of blood This factor can be appreciated by considering the tremendous capacity of the capillary system Krogh has shown that $\frac{1}{20}$ to $\frac{1}{10}$ of a muscle is made up of capillaries, and in the heart there is at least one capillary to every muscle fibre. If all these capillaries lost their tone, the animal would literally bleed into them, the arterial and venous system would become empty, and the output of the heart would fall to vanishing point.

The amount of blood in the circulation and the capacity of the vascular bed should not be considered as rigidly fixed for any individual. The vascular system is in a perpetual state of variation on account of the continuous changes of the vasomotor tone It is obvious that unless vasoconstriction is compensated for by a simultaneous vasodilation elsewhere it will lead to a change in the resistance as well as a change of capacity. Arterial vasoconstriction will chiefly affect the resistance, while even small changes in the tone of the enormous capillary bed will mainly affect capacity. Thus on account of these changes of capacity more or less blood may be in active circulation, and more or less blood may be left behind to fill the vascular bed.

Spleen, Lungs and Other Factors.—There are however two organs which play a predominant rôle as reservoirs of blood, namely the spleen and the lungs, the difference being that the spleen seems to change its capacity mainly as the result of active contraction and relaxation, while the lungs play a purely passive rôle and act only because of the very great elasticity of their blood vessels. With every increase in the pulmonary blood pressure or with a certain decrease in the intrathoracic pressure, the pulmonary blood vessels contain more blood, and therefore less blood is available for the systemic circulation. On the other hand, the capacity of the spleen is to a much greater extent independent

somewhat peculiar, since this organ is enclosed in a rigid bony covering. The limbs, glands and viscera can expand considerably when the blood pressure rises, but the expansion of the brain is confined. By the expression of venous blood from the veins and sinuses, the brain can receive a larger supply of arterial blood at each pulse. Increase in arterial pressure increases the velocity of flow through the brain, the whole cerebral vascular system behaving like a system of rigid tubes when the limits of expansion have been reached. The pressure of the brain against the skull wall is circulatory in origin; in the infant's fontanelle the brain can be felt to pulse with each heart-beat and to expand with expiration. The arterial supply to the brain by the two carotid and two vertebral arteries is so abundant, and so assured by the anastomosis of these vessels in the circle of Willis, that at least two of the arteries can be tied without grave effect Sudden compression of both carotids may render a man unconscious, but will not destroy life, for the centres of respiration, etc., are supplied by the vertebral arteries. The vertebral arteries in their passage to the brain are protected from compression by the cervical vertebrae.

Whether the muscular coat of the cerebral arteries is supplied with vasomotor nerves is uncertain

The Coronary Circulation.—Extremely peculiar conditions exist in the coronary circulation, *i e*, the blood supply to the heart muscle itself The coronary arteries originate at the root of the aorta They turn back into the substance of the cardiac muscle and break up into a rich meshwork of capillaries which convey the blood into the coronary veins, the majority of which collect the blood into the coronary sinus, while some open on the inner surface of the chambers of the heart (Thebesian veins) During systole the heart muscle develops a pressure which must be higher than that in the aorta, as otherwise no ejection of blood from the ventricle into the aorta would be possible The coronary arteries, which are at any time distended by the pressure prevailing in the aorta, are thus compressed, and during systole the inflow of blood into those of the left ventricle is stopped. The right ventricle by its weak contraction only affects the coronary circulation to a slight extent. While restraining the inflow of blood into the coronary arteries, the contraction of the heart greatly facilitates the outflow from the veins by mechanically expressing their contents. It is interesting to note that adrenaline, which greatly increases the strength of the cardiac beat, also produces a great dilation of the coronary blood vessels, so that a larger amount of blood is provided to meet the increased expenditure of energy. The coronary blood vessels are richly provided with vasodilator and vasoconstrictor nerves; the sympathetic supplies the vasodilator, and the vagus the vasoconstrictor fibres

Since the coronary blood flow is so readily affected by the heart beat, great difficulties are encountered in the study of the regulation of the coronary circulation. A knowledge of all the influences affecting it is, however, extremely important because the activity of the heart, and therefore the fate of the organism, ultimately depends on the blood supply to the cardiac muscle. It is known that even temporary occlusion of the coronary blood vessels is fatal. The disease known as *Angina pectoris,* which usually leads to death, is most probably due to such occlusion as the result of arteriosclerosis or thrombosis of the arteries; it is highly probable that in some cases it may also be due to disorders of the nerves which regulate the tone of the coronary blood vessels. In most cases of weakening of the heart, the coronary flow increases. Lack of oxygen produces an enormous augmentation of the coronary circulation, thus ensuring the survival of the heart so long as there is a trace of oxygen left in the blood.

The Influence of Posture on the Circulation.—The circulation remains efficient not only in the horizontal but also in the erect position. Yet in a man standing six feet high the hydrostatic pressure of a column of blood reaching from the vertex to the soles of the feet is equal to 14 cm of mercury. The blood, owing to its weight continually presses downwards, and under the influence of gravity would sink if the veins and capillaries of the lower parts were sufficiently extensile to contain it. During the evolution of man, there have been developed special mechanisms by which the determination of the blood to the lower parts is prevented, and the assumption of the erect posture rendered possible. The abdominal viscera are slung upwards to the spine, while below they are supported by the pelvic basin and the wall of the abdomen, the muscles of which are arranged so as to act as a natural waistband In tame hutch rabbits, with large patulous abdomens, death may follow in from 15 to 20 minutes if the animals are suspended and immobilized in the erect posture, for the circulation through the brain ceases, and the heart soon becomes emptied of blood. If, however, the capacious veins of the abdomen be confined by an abdominal bandage, no such result occurs Man is naturally provided with an efficient abdominal belt, although this is often rendered toneless by neglect of exercise or gross and indolent living The splanchnic arterioles are maintained in tonic contraction by the vasomotor centre, and thus the flow of blood to the abdominal viscera is confined within due limits

The veins of the limbs are broken into short segments by valves, and these support the weight of the blood in the erect posture Every contraction of the skeletal muscles compresses the veins of the body and limbs, for these are confined beneath the taut and elastic skin Guided by the valves of the veins, the blood is by such means driven upwards into the venae cavae.

Circulation During Muscular Exercise.—An attempt to understand the changes in the circulation during muscular exercise can only be made if every part of the complex regulation of the cardio-vascular system is kept in mind.

In muscular exercise, every available mechanism concerned in the regulation of the blood flow is brought into operation, everything being centred on the achievement of two objects, (a) to carry the all important oxygen to the muscles, and (b) to remove the excess of waste products as quickly as possible. In violent exercise the common effort of all the cardio-vascular mechanisms involved is often inadequate, but fortunately the muscles and other organs do not require an immediate supply of sufficient oxygen to fulfill their needs; fortunately also the muscles can withstand a certain degree of accumulation of waste products without much alteration of the intensity of the activity. In other words the muscles can to some extent run into debt as regards the oxygen supply. But the excess oxygen requirements must at some time be made good, or the activity will have to stop. The complete adaptation of the vascular and respiratory systems, when the oxygen supply and the removal of waste products entirely meets the demand, is achieved comparatively slowly. The first period of severe muscular activity proceeds under somewhat less favourable conditions than hold after complete adjustment has been attained. This is probably the explanation of the phenomenon of "second wind." The organism is better adapted to exercise, the more rapidly this state of adjustment is reached.

Since the arterial blood is normally about 95% saturated with oxygen, not much extra oxygen can be obtained by increasing the saturation of the haemoglobin. As already explained, the muscle obtains the required oxygen in two ways: (*a*) by increased utilization of the oxygen of the blood, *i e*, by a greater desaturation of the haemoglobin, and (*b*) by an increase in the blood flow. The first factor alone would be inadequate even if the muscles were able to remove all the oxygen from the blood A simple example will serve to illustrate this If we take the total blood flow as 4 5 litres per minute, even if we make the impossible assumption that the whole of the blood goes through the muscles, it will mean that the muscles will only be supplied with about 800 cc. of oxygen per minute. Now the normal oxygen requirements at complete rest are about 300 cc per minute, and during severe exercise they may rise to 3,000 cc. per minute or more Moreover, the desaturation of haemoglobin is never carried to completion, and even during severe muscular exercise the venous blood still contains some oxygen. Thus the increased oxygen demand can be met to only a limited extent by increasing the coefficient of the oxygen utilization.

The second factor, namely the increase in the output of the heart, is far more important. Amongst all the factors involved in this increase in the blood flow, we will first consider the heart This organ plays only a subordinate rôle The output of the

heart depends on the inflow and, under normal conditions, changes in the activity of the heart have little or no effect on blood flow. The main factor in the augmentation of the inflow concerns the peripheral blood vessels. Considerable changes in the heart beat must, however, take place in order to make it possible for the heart to cope with the larger inflow. The first effect of the larger inflow will be to increase the filling of the heart and therefore the output on account of the stronger beat. This is a purely automatic reaction of the cardiac muscle, and is independent of the central nervous system. The adaptation of a denervated heart stops at this point. The limit to this adaptation of the heart muscle is set by the pericardium. The adaptation of the innervated heart does not, however, stop here. The increase in the strength of contraction in this case is out of proportion to the inflow, so that the heart becomes able to give progressively stronger beats It is not only more filled in diastole but it also empties better during systole This additional strengthening of contraction depends on the diminution of the influence of the vagus nerve, and on the excitation of the augmentor fibres of the sympathetic nerve.

But usually in addition to this increase in strength of the beat there is a quickening of the heart rate. This is also based in the first instance on a diminution of the vagus tone, and probably in most cases on an augmentation of the sympathetic tone Further increase of the inflow is therefore met by a corresponding quickening of the heart beat The acceleration of the heart in muscular exercise is a purely reflex phenomenon, based (especially at the beginning of the exercise) partly on impulses descending to the cardiac medullary centres from the cortex of the hemispheres, which are probably conditioned reflexes In part the acceleration is due to concurrent changes in the respiratory activity and to reflexes originating within the vascular system of the animal itself We have seen that each inspiratory phase is accompanied by a diminution of the vagus tone and hence by an acceleration of the heart Thus if there is a greater number of respirations per minute, the periods of acceleration become more frequent and finally fuse, so that the periods of retardation typical of the expiratory state have no time to develop.

Amongst the reflexes which affect the cardiac rhythm and which originate within the organs of the body itself, the reflexes from the heart should be considered first. It has been shown by several observers that an increased inflow into the heart brings about a reflex acceleration of the heart beat. Changes in the activity of the heart should not be regarded as the cause of increased intensity of circulation, but as an adaptation which enables the increase to be performed.

The chief causes of increased total blood flow during muscular exercise can be grouped under the following headings:

1. The increase in the aspiration by the thorax;
2. The pumping action of the contracting muscles,
3. The increase in the amount of circulating blood,
4. The diminution of the total vascular resistance

To these should be added the factors which are not likely to affect the total blood flow, but which alter the distribution of the blood between the various organs. These are:

1. The constriction of the splanchnic area;
2. The dilation of the blood vessels of the muscles.

These factors have all been discussed in the preceding pages and need only be mentioned shortly. The increased and more frequent expansion of the chest, which follows the deepening and acceleration of respiration, accentuates the negative pressure in the thorax, and tends to diminish the pressure in the large veins. These are therefore more quickly and more completely filled with blood from the periphery The working muscles expel, by each contraction, blood from their capillaries to the veins, and thus actively help the propulsion of blood into the heart. The spleen contracts and empties its blood into the vascular system, and an extra amount of blood thus becomes available. The dilation of the blood vessels in the muscles is so intense that the general resistance diminishes and the blood passes from the aorta into the venous system at a considerably faster rate All these factors are helped by the contraction of the splanchnic vascular area, which diverts the blood to the muscles. The blood vessels in the muscle dilate, and the capillaries open so that the capillary bed in the muscles may increase 40 to 100 times during maximal activity This dilation is chiefly if not exclusively due to the local production of vasodilator substances It is not at present known how far the vasomotor innervation participates in this dilation

Thus we see that during muscular exercise the organism meets the demand for an increased oxygen supply to the muscle by an intricate series of correlated mechanisms. The necessary adjustments involve the respiratory system and the whole cardio-vascular system, and probably afford one of the finest examples of co-ordination that has yet been discovered in the realm of physiology.

(G An.)

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